American Railway Signaling Principles and Practices

CHAPTER XX

Interlocking Circuits

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CHAPTER XX

INTERLOCKING CIRCUITS

In the description and explanation of the operation of interlocking circuits in this chapter it is to be understood that the circuits, special symbols and wire nomenclature are not necessarily specifications, nor the recommended practice of the Signal Section, Association of American Railroads, but are indicative of those that are in use in connection with the interlockings described. The descriptions are given with the thought that they will enable the student to more readily understand circuits of a similar nature, the details of which, however, may be somewhat different, depending upon the practice of the individual railroad.

General.

Interlocking circuits were designed to bring about more adequate facilities to handle properly, speedily and safely the units which comprise mechanical interlocking. Many circuits have been designed as a means of overcoming some incumbrance which had been experienced with mechanical devices with the result that today many obstacles formerly encountered have been overcome. Circuits designed for special reasons will not be considered; the most important ones in general use will be covered in this chapter.

Signals and switches, originally, were operated by means of wire or pipe lines manipulated by mechanical levers. Mechanical locking was interposed between levers to prevent the establishing of conflicting routes and to enforce a predetermined order in their operation; mechanical detector bars were added to the switches to prevent their operation while trains were passing over same, and electrical slots were designed for mechanical signals to provide a means of causing the signal automatically to display its most restrictive indication by the passing of a train. Of the three features mentioned the latter two are fast becoming obsolete, the mechanical locking remaining unchanged.

The use of wire for operating signals mechanically was found to be unreliable and while the use of pipe was more satisfactory, various reasons have brought about the necessity for a substitute. In the operation of switches, mechanically-operated pipe connections are still used extensively.

For convenience and to better present the circuits involved, they will be classified as to their use with respect to the various units with which they are used and as they have been applied to the various types of interlockings: namely, mechanical, electro-mechanical, electro-pneumatic, electric, automatic, and electric without mechanical locking. The type of interlocking commonly used, the best known and the one to which the greater number of revisions and application of new designs have been applied, is the mechanical interlocking. Many systems of this type are still in service; however, in most cases revisions have been made to substitute power-operated for wire and pipe-connected signals, and electric switch locking for the mechanical detector bars.

While all the circuits necessary for the complete control of the electrical units involved are shown, no attempt will be made to explain in detail the operation of all circuits, it being considered sufficient to explain one circuit of each type used.

Circuit Nomenclature and Written Circuits

The recommended practice of the Signal Section, A.A.R., for circuit nomenclature and written circuits is as follows:

The purpose of the following is to supply a standard scheme of abbreviated designations for electrically-operated signal units and wires.

Letters suggestive of the words they represent have been assigned as far as practicable but there are some letters that stand for names that cannot be associated, such as "G" Signal; "W" Switch; etc. Some of the letters represent several different meanings or words, such as "N" Normal; "N" Negative; "N" North, depending upon the use and location with respect to numerals and other letters, but if the scheme is consistently used there should be no mistake in the meaning.

Nomenclature of electrically-operated units.

The term "electrically-operated unit" is used to signify a signaling device in which an electric light or magnetic coil is usually essential to its operation, as, for instance, color light signal, a relay, electric lock, etc. In order to provide a concise, suggestive graphic code for marking these units on plans, the following system has been evolved, which makes use of a designation made up of two parts: namely,

First—Numerical Prefix: The number of the principal lever, signal, track circuit, or other device entering into the control of or controlled by the unit.

Second—Alphabetic Term: Consisting of one or more letters. The last letter of this term designates the general kind of unit, while the first letter or letters, when used, describe specifically the operated unit.

The complete designation of a unit is written as follows:

(Numerical Prefix)	(First Letter)	(Last Letter)
10	H	R

Written 10HR

In this example, 10 is the number of a signal. 10R means relay having to do with signal 10, and 10HR means home relay for signal 10. In other words, the letter R means relay in general. The letter H indicates that the function of this relay is to control the approach indication of a three-position signal or the proceed indication of a two-position signal in one-arm signaling. The number 10 definitely indicates the signal which this relay controls.

Track circuit numbering.

A track circuit is designated by the letter T preceded by a number. If within interlocking limits, it will take a number of a movable point frog, switch or derail lying within the track circuit, the preference being in the order named.

When there are no interlocked switches in a track circuit, it is numbered from a signal governing over the track circuit. Progressive alphabetical prefixes are used in the case of a plurality of track sections that govern one signal. Arbitrary numbers, as 01T, 02T, 03T, etc., are given track circuits in which there are no interlocked switches and which do not govern signals.

Wire nomenclature.

A wire carrying positive energy to one or more operated units is in general designated by nomenclature similar to that applied to the operated

unit controlled by it, followed by a number indicating the number of circuit controlling contacts in the circuit between the wire and unit.

A wire carrying negative energy from one or more operated units is designated in the same manner except that the designation is preceded by the letter N.

Example: See Fig. A.

In case of branch wiring the above method is applied to the principal circuit. The letter A is appended to distinguish the first branch, the letter B distinguishes the second, etc. The branch connection is shown terminated at point desired. This latter feature eliminates necessity of tagging wire to show destination or source.

Example: See Fig. A.

Table of meaning of letters—Descriptive and designative terms.

A —Approach
B —Block—Button—Positive energy
C —Common—Changer—Counter—Correspondence—Circuit—Controller —Code
D —Proceed indication of a signal—Detector—Decoding
E —East—Eastward—Electric light—Element
F —Traffic
G —Green—Signal (operating mechanism)—Ground
H—Home—Approach indication of a signal
J —Skate
K —Indicator (visual)
L —Left—Lock preventing initial movement of a lever from normal or reverse position—Locking—Lever—Light—Split battery
M—Lock preventing final or indicating movement of a lever—Magnetic—Marker
N —Normal—North—Northward—Negative
O —Order—Operating—Off—Overload—Out
P —Pole—Power—Purple—Push—Repeating—Primary
Q —Local or secondary coil (as in double-element relay or mechanism)
R —Right—Red—Reverse—Relay—Power-operated controller or contactor—Route—Stop indication of a signal
S —South—Stick—Storage—Southward
T —Track—Time—Train—Telephone—Transformer—Transmitter
U —Retarder—Unit
V —Train stop (track element)
W—Switch (operating mechanism)—West—Westward—White
X—Crossing—Interlocking—Bell—Buzzer—A. C.
Y —Slot—Yellow—Hold clear
Z—Use for any special term (to be noted on plan)

In order to distinguish between right and left position of three-position levers, use R (right) or L (left) after the lever number, as 10R, 10L.

When one lever controls two or more functions, use letters A, B, C, etc., after the lever numbers: for example, 10A, 10B, 10C, etc.

In case of three-position levers controlling two or more functions in each position, use combinations as follows: 10RA, 10LA, etc.

Example of combinations used to designate wires and operated units.

Energy Wires

(Suffix figure should be used to indicate voltages; for example, CX110 meaning common AC 110 volts.)

C	—Common D.C.
EC	—Common east, meaning D.C. from system east, likewise north, south and west
FC	—Common traffic locking
CX	—Common A.C.
ENX	—Negative energy A.C. from POR for an electric light, or east negative A.C. energy, likewise north, south and west
NX	—Negative A.C. energy
BL	—Positive side of split battery
NL	—Negative side of split battery
CL	—Common of split battery
N	—Negative D.C. energy
B	—Positive D.C. energy
EB	—Positive energy east, likewise north, south and west
BB	—Battery, second battery
BBB	—Battery, third battery
BX	—Positive A.C. energy
EBX	—Positive energy A.C. from POR for an electric light or east positive A.C. energy, likewise north, south and west

Operated Units Relating to Track Circuits

T	—Track section
TR	—Track relay
TPR	—Relay repeating a track relay
TPPR	—Relay repeating a track repeating relay
TSR	—Track stick relay
TSPR	—Relay repeating track stick relay
TK	—Indicator, indicating condition of a track circuit
TPSR	—Stick relay repeating track relay
BPR	—Block repeater relay, relay repeating the track circuits in a block
BK	—Block indicator

Wires Relating to Track Circuits

TB	—Track positive—Positive energy to rail
TN	—Track negative—Negative energy from rail
RB	—Relay positive—Wire from positive rail to relay
RN	—Relay negative—Wire from negative rail to relay
TQ	—Positive control of local coil, double-element A.C. track relay
TP	—Positive control of TPR
TPP	—Positive control of TPPR
TPS	—Positive control of TPSR
TK	—Positive control of TK
BP	—Positive control of BPR

Operated Units Relating to Switches

W —Switch operating mechanism or lock valve
WR —Relay, controller or contactor controlling both normal and reverse operations of a switch or an electric switch lock
WNR —Relay, controller or contactor controlling the normal operation of a switch or an electric switch lock
WRR —Relay, controller or contactor controlling the reverse operation of a switch or an electric switch lock
WRPR —Relay repeating WR
WNRPR —Relay repeating WNR or normal position of WR
WRRPR —Relay repeating WRR or reverse position of WR
WPR —Relay repeating position of switch
NWPR —Relay repeating normal position of switch or normal position of WPR
RWPR —Relay repeating reverse position of switch or reverse position of WPR
WK —Indicator indicating the positions of a switch
WL —Switch lock operating mechanism on a switch
NWLPR —Relay repeating normal position of switch lock
NWK —Indicator indicating the normal position of a switch
RWK —Indicator indicating the reverse position of a switch
WAK —Indicator indicating the condition approaching a switch
RWLPR —Relay repeating reverse position of switch lock
WCR —Switch correspondence relay

Wires Relating to Switches

NW —Normal control of switch operating mechanism
RW —Reverse control of switch operating mechanism
N10W —Individual return wire to 10 switch operating mechanism
WR —Positive control of WR
N10WR —Negative control of 10WR
WNR —Positive control of WNR
WRR —Positive control of WRR
WRP —Positive control of WRPR
WNRP —Positive control of WNRPR
WRRP —Positive control of WRRPR
WP —Positive control of WPR
N10WP —Negative control of 10WPR
NWP —Positive control of NWPR
RWP —Positive control of RWPR
NWLP —Positive control of NWLPR
WK —Positive control of WK
N10WK —Negative control of 10WK
NWK —Positive control of NWK
RWK —Positive control of RWK
WA —Positive control of WAK
WL —Positive control of WL
RWLP —Positive control of RWLPR
WC —Positive control of WCR

Operating Units Relating to Signals

HR —Relay controlling approach indication of a three-position signal or the proceed indication of a two-position signal in one-arm signaling
DR —Relay controlling proceed indication of a signal
HDR —Relay controlling approach and proceed indication of a signal
HPR —Relay repeating HR or approach indication position of HDR
HSR —Home stick relay controlling the approach indication of a signal
DPR —Relay repeating DR or proceed indication position of HDR
RGPR —Relay repeating signal mechanism at stop
HGPR —Relay repeating signal mechanism at approach
DGPR —Relay repeating signal mechanism at proceed
RGK —Indicator indicating signal mechanism at stop
HGK —Indicator indicating signal mechanism at approach
DGK —Indicator indicating signal mechanism at proceed
ETOHR —East train order HR, likewise west, north and south
ETOHDR —East train order HDR, likewise west, north and south
ETOPHR —East train order repeater HR, likewise west, north and south
ETOPDR —East train order repeater DR, likewise west, north and south
HDGPR —Relay repeating signal mechanism in the approach and proceed position
HDGK —Indicator indicating signal mechanism in the approach and proceed position
HY —Hold clear or retaining mechanism of the approach indication of a signal
DY —Hold clear or retaining mechanism of the proceed indication of a signal
HG —Approach indication operating mechanism of a signal
DG —Proceed indication operating mechanism of a signal
RG —Stop indication operating mechanism of a signal

Wires Relating to Signals

H —Positive control of HR
D —Positive control of DR
HD —Positive control of HDR
N10HD —Negative control of 10HDR
HP —Positive control of HPR
HS —Positive control of HSR
DP —Positive control of DPR
RGP —Positive control of RGPR
HGP —Positive control of HGPR
DGP —Positive control of DGPR
ETOH —Positive control of ETOHR
ETOHD —Positive control of ETOHDR
ETOPH —Positive control of ETOPHR
ETOPD —Positive control of ETOPDR
HDGP —Positive control of HDGPR
HDGK —Positive control of HDGK

RGK —Positive control of RGK
HGK —Positive control of HGK
DGK —Positive control of DGK
HG —Positive control of HG
DG —Positive control of DG
RG —Positive control of RG
N10HG —Negative control of 10HG
HY —Positive control of HY
DY —Positive control of DY

Stick, Traffic and Directional Operated Units

SR —Stick relay
ESR —East stick relay, likewise north, south and west
LSR —Locking stick relay
EASR —East approach stick relay, likewise north, south and west
ASR —Approach stick relay
FL —Traffic lock preventing initial movement of a traffic lever from normal or reverse
FLM —Traffic lock preventing initial movement of a traffic lever from normal or reverse and also preventing final or indicating movement of same lever
FR —Traffic relay
FLR —Traffic lock relay controlling FL
FLMR —Traffic lock relay controlling FLM
FLK —Traffic lock indicator
FSR —Traffic stick relay
EFSR —East traffic stick relay, likewise north, south and west

Wires Relating to Stick, Traffic and Directional Units

S —Positive control of SR
ES —Positive control of ESR
LS —Positive control of LSR
EAS —Positive control of EASR
AS —Positive control of ASR
FL —Positive control of FL
FLM —Positive control of FLM
F —Positive control of FR
FLR —Positive control of FLR
FLMR —Positive control of FLMR
FLK —Positive control of FLK
FS —Positive control of FSR
EFS —Positive control of EFSR

Operated Units Relating to Indicators, Locks, Indication Magnets, and Relays Used for Locking Purposes

M —Lock preventing the final movement of a lever
L —Lock preventing the initial movement of a controlled function or lever
NK —Normal indicator indicating normal position of a unit
RK —Reverse indicator indicating reverse position of a unit

TER —Time element relay
NM —Lock preventing the final movement of a lever to the normal position
RM —Lock preventing the final movement of a lever to the reverse position
NL —Lock preventing the movement of a lever or a controlled function from its normal position
RL —Lock preventing the movement of a lever or a controlled function from its reverse position
LR —Relay controlling L lock
LPR —Repeater of L lock relay
MR —Relay controlling M lock
MPR —Repeater of M lock relay
TE —Time element
TESR —Time element stick relay
LK —Lock indicator repeating electric locking

Wires Relating to Locks, Indication Magnets and Relays for Locking Purposes

M —Positive control of M
L —Positive control of L
NK —Positive control of NK
RK —Positive control of RK
TE —Positive control of TER
NM —Positive control of NM
RM —Positive control of RM
NL —Positive control of NL
RL —Positive control of RL
LR —Positive control of LR
LP —Positive control of LPR
MR —Positive control of MR
MPR —Positive control of MPR
TES —Positive control of TESR
LK —Positive control of LK

Operated Units Relating to Highway Crossing Signals

XX —Crossing bell
EXR —Eastward interlocking or crossing relay, likewise north, south and west
XG —Wig-wag mechanism
XY —Slot for wig-wag mechanism
EOR —Electric light operating relay (flasher relay)

Wires Relating to Highway Crossing Signals

XG —Positive control of XG
E1 —Positive wire to No. 1 unit of flashing light signal
E2 —Positive wire to No. 2 unit of flashing light signal

Operated Units Relating to Approach and Annunciating of Trains

AX —Annunciator indicating approach traffic
EAX —Eastward annunciator indicating approach of eastward traffic, likewise north, south and west
AER —Relay used for approach lighting

Wires Relating to Approach and Annunciating of Trains

AX —Positive control of AX
EA —Positive control of EA
E —Positive control of ER

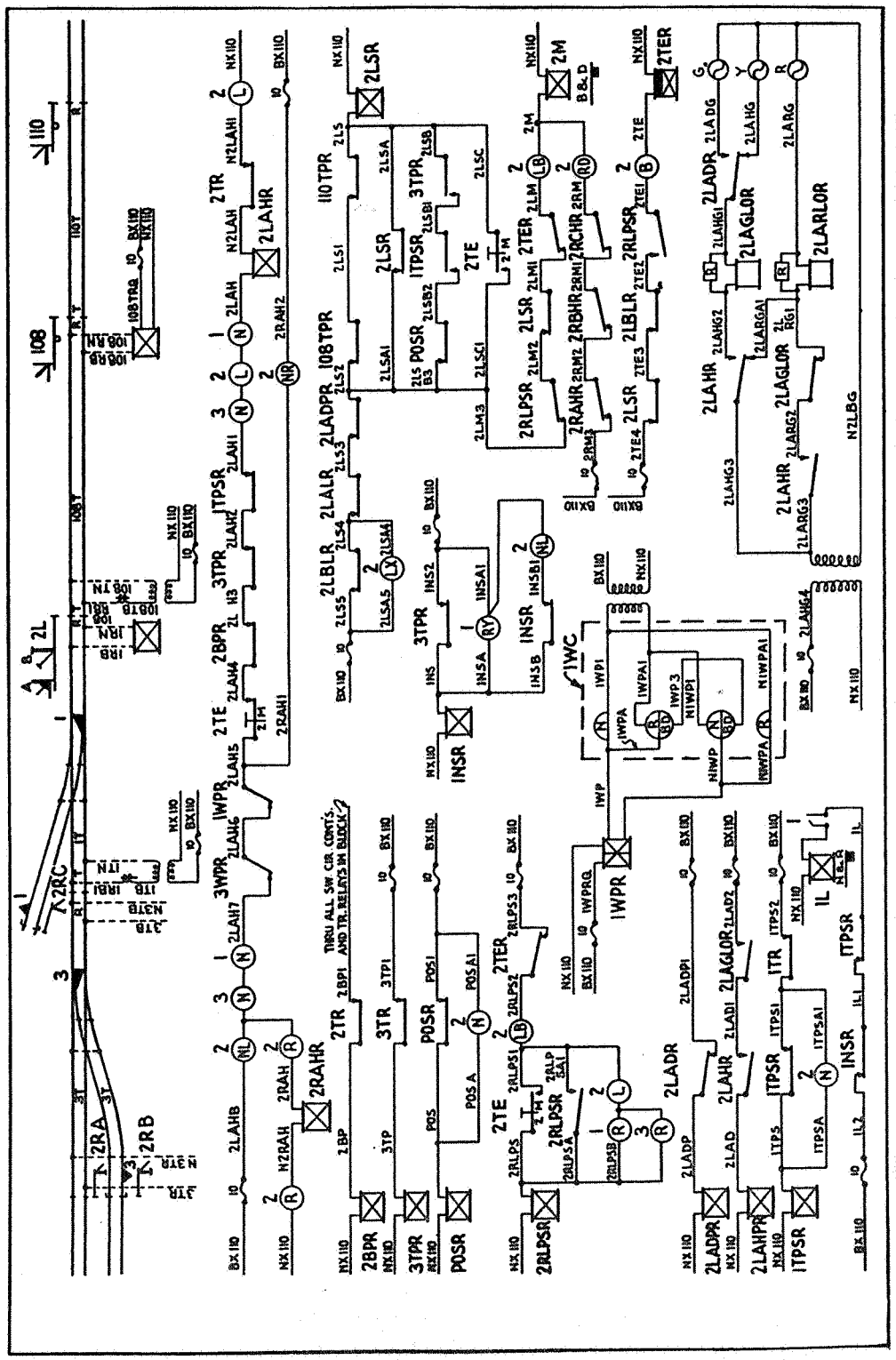


Fig. A.
Example of Application of Symbols and Wire Nomenclature.

Miscellaneous Operated Units

AK —Approach indicator
AR —Approach relay
PCR —Pole changing relay
NLPR —Relay repeating the normal position of a lever
RLPR —Relay repeating the reverse position of a lever
E —Electric light
TO —Train order
WTO —West train order signal governing westward traffic, likewise north, south and east
RR —Route relay
VR —Train stop relay
VSR —Train stop stick relay
VPR —Train stop repeater relay
VY —Train stop retaining mechanism
XR —Interlocking relay
TOR —Train order relay
POR —Power off relay
LOR —Light out relay
ME —Marker light
OR —Overload relay
GDR —Ground detector relay
CT —Code transmitter
DU —Decoding unit

Wires Relating to Miscellaneous Operated Units

AK —Positive control of AK
A —Positive control of AR
PC —Positive control of PCR
NLP —Positive control of NLPR
RLP —Positive control of RLPR
R —Positive control of RR
V —Positive control of VR
VS —Positive control of VSR
VP —Positive control of VPR
VY —Positive control of VY
X —Positive control of XR
TO —Positive control of TOR
PO —Positive control of POR
LO —Positive control of LOR
ME —Positive control of ME
O —Positive control of OR
GD —Positive control of GDR
CT —Positive control of CT
DU —Positive control of DU

The graphical symbols for written circuits are shown on Drawings 1660 to 1669, inclusive, and 1673 to 1681, inclusive, which follow:

GRAPHICAL SYMBOLS

POSITION OR EQUIVALENT	NON-AUTOMATIC	SEMI-AUTOMATIC		AUTOMATIC	SPECIAL REQUIRES REFERENCE TO NOTES
		STICK	NON-STICK		
0° U.Q. 45°					
0° L.Q. 45°					
0° U.Q. 90°					
U.Q. 45 L.Q. 45					
U.Q. 45° 90°					
L.Q. 45° U.Q. 90°					
0° U.Q. 45° L.Q. 45°					
0° U.Q. 45° 90°					
0° U.Q. 90° L.Q. 45°					
U.Q. 45° 90° L.Q. 45°					
0° U.Q. 45° 90° L.Q. 45°					

EXPLANATORY DATA

THREE-POSITION
SEMI-AUTOMATIC STICK 45° TO 90°
SEMI-AUTO. NON-STICK 0° TO U.Q 45°

FOUR-POSITION
SEMI-AUTO. STICK 0° TO U.Q. 45° TO 90°
NON-AUTO. 0° TO L.Q 45°

NON-OPERATING

MARKERS

NORMALLY LIGHTED : NON STICK

NORMALLY NOT LIGHTED: NON-STICK

NORMALLY LIGHTED: STICK

NORMALLY NOT LIGHTED: STICK

GRADE SIGNAL

HEAVY LINE INDICATES NORMAL POSITION OR IT'S EQUIVALENT—THUS →
PREFIX THE LETTER "A" TO ABBREVIATION IF USED FOR APPROACH LIGHTING
ABBREVIATIONS TO BE USED ONLY WHERE MORE THAN ONE TYPE OF SIGNAL IS SHOWN ON PLAN.

ABBREVIATIONS

E- ELECTRIC SEMAPHORE
P- POSITION LIGHT
CP- COLOR POSITION LIGHT
M- MECHANICAL
C- COLOR LIGHT
SL- SEARCHLIGHT

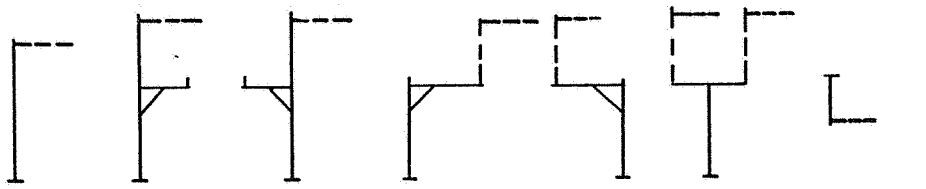
SMASHBOARD SIGNALS

POWER MECHANICAL

GRAPHICAL SYMBOLS
WAYSIDE SIGNAL OPERATING CHARACTERISTICS

ARA SIG. SEC. 1660A

M-1934 MAR1934



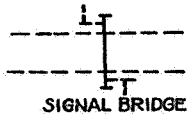
GROUND MAST

GROUND MAST WITH BRACKET ATTACHMENT

CANTILEVER POST

BRACKET POST

SUSPENDED MAST



SIGNAL BRIDGE

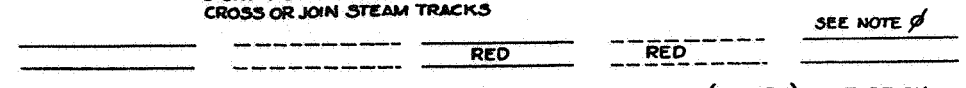
GRAPHICAL SYMBOLS
SIGNAL SUPPORTS

ARA SIG. SEC. 166 A

M-1934 MAR1934

RAILWAY TRACKS

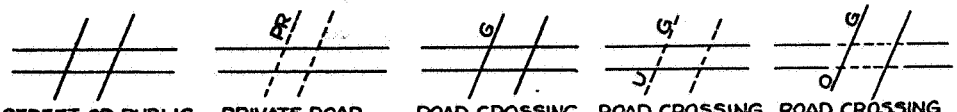
SIGNIFY STEAM OR ELECTRIC WHERE ELECTRIC TRACKS CROSS OR JOIN STEAM TRACKS



RAILWAY TRACK OR OLD TRACK TO REMAIN | OLD TRACK TO BE TAKEN UP | PROPOSED TRACKS | PROPOSED (FUTURE) TRACKS | FOREIGN TRACKS

NOTE: ϕ - COLOR OTHER THAN RED OR BLACK WITH INITIALS OF ROAD

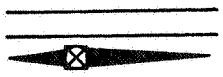
HIGHWAY CROSSINGS



STREET OR PUBLIC ROAD CROSSING | PRIVATE ROAD CROSSING | ROAD CROSSING AT GRADE | ROAD CROSSING UNDERGRADE | ROAD CROSSING OVERHEAD

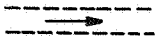
HIGHWAY CROSSING SIGNALS

CROSSING SIGN | BELL | WIG-WAG | ONE WAY FLASHING LIGHTS | BOTH WAYS



CROSSING GATE

MERIDIAN



TRAFFIC DIRECTION

GRAPHICAL SYMBOLS
TRACKS AND HIGHWAY CROSSINGS

ARA SIG. SEC. 1662A

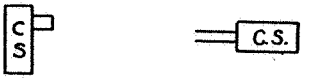
M-1934 MAR1934

BUILDINGS

PASSENGER STATION — FREIGHT STATION — GENERATING STATION — SUB-STATION

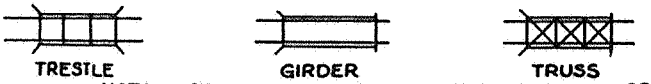
INTERLOCKING OR BLOCK STATION

OPERATOR FACING TRACK — OPERATOR WITH BACK TO TRACK



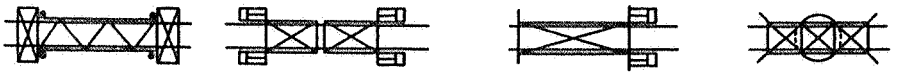
COAL CHUTE (MECHANICAL) — COAL CHUTE (TRESTLE)

BRIDGES



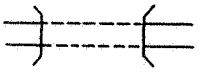
TRESTLE — GIRDER — TRUSS

NOTE :- STATE WHETHER DECK, HALF THRU OR THRU BRIDGE



LIFT SPAN — BASCULE, DOUBLE LEAF — BASCULE, SINGLE LEAF — DRAW SPAN

DRAWBRIDGE RAIL LOCK — DRAWBRIDGE LOCK — DRAWBRIDGE PIPE COUPLER

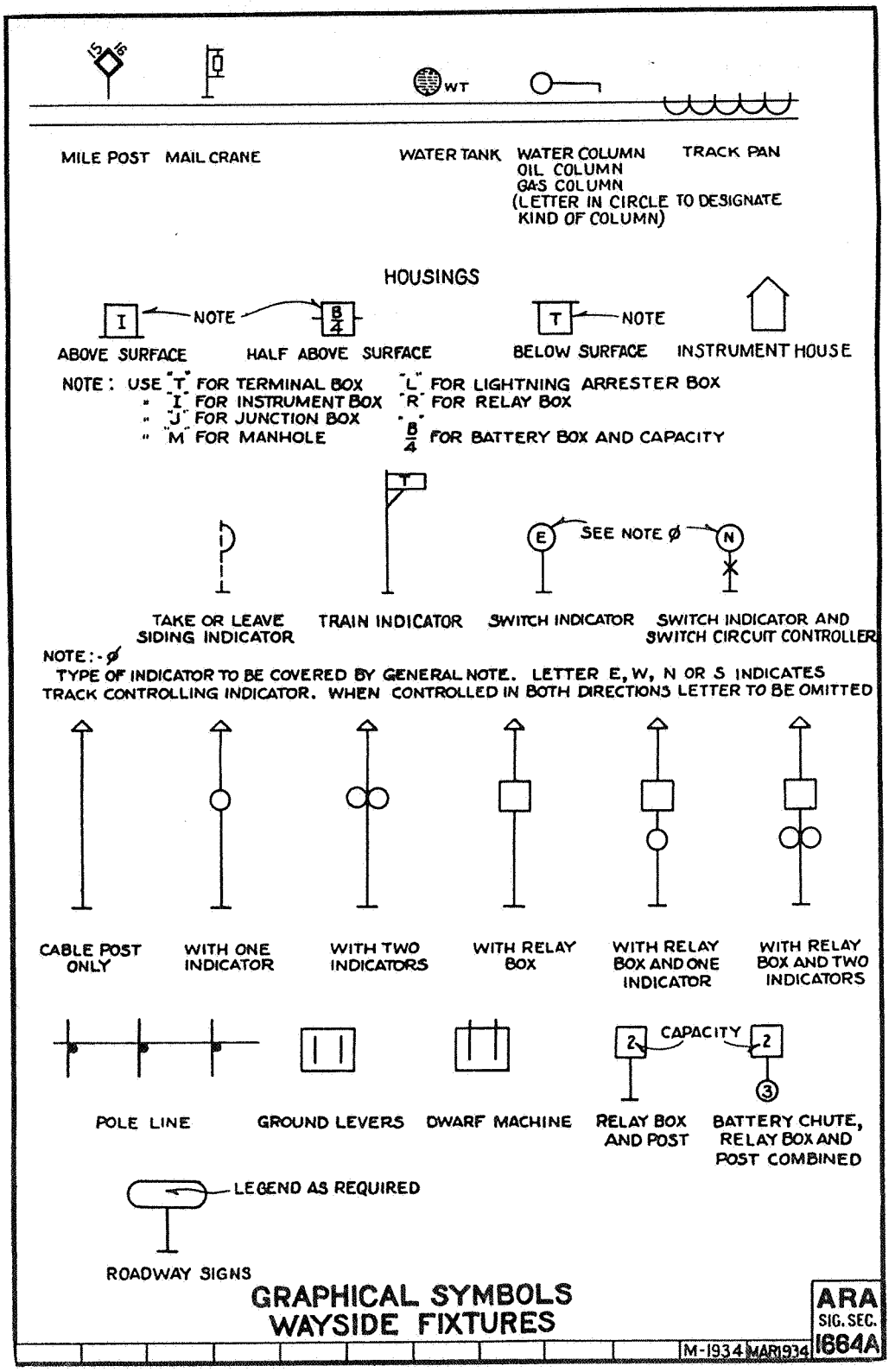


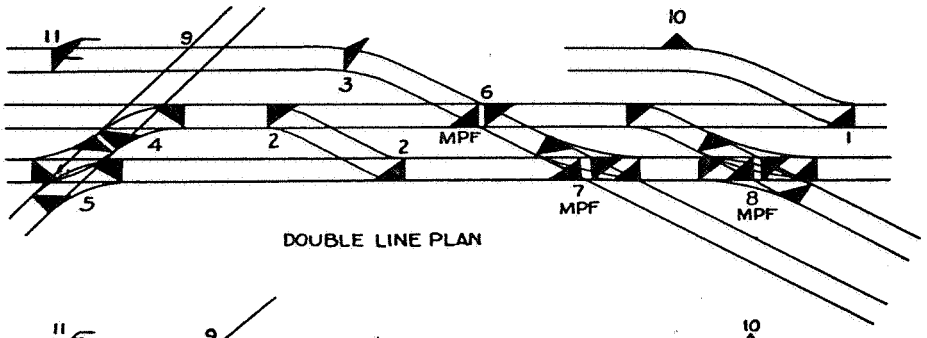
TUNNEL

GRAPHICAL SYMBOLS
BUILDINGS, BRIDGES AND TUNNELS

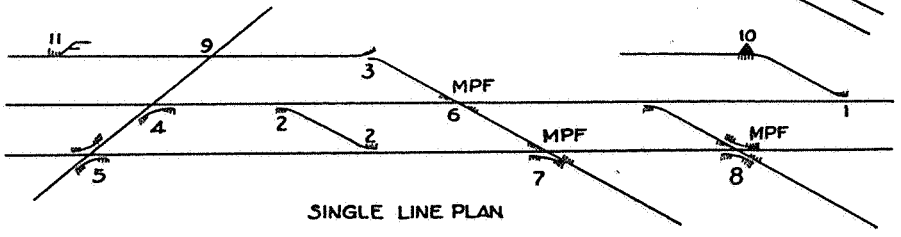
ARA SIG. SEC. 1663A

M-1934 MAR 1934


MILE POST
MAIL CRANE
WT
WATER TANK
WATER COLUMN
OIL COLUMN
GAS COLUMN
(LETTER IN CIRCLE TO DESIGNATE KIND OF COLUMN)
TRACK PAN
HOUSINGS
I
NOTE
B/4
ABOVE SURFACE
HALF ABOVE SURFACE
T
NOTE
BELOW SURFACE
INSTRUMENT HOUSE
NOTE: USE "T" FOR TERMINAL BOX
"I" FOR INSTRUMENT BOX
"J" FOR JUNCTION BOX
"M" FOR MANHOLE
"L" FOR LIGHTNING ARRESTER BOX
"R" FOR RELAY BOX
"B/4" FOR BATTERY BOX AND CAPACITY
I
T
E
SEE NOTE ø
N
TAKE OR LEAVE SIDING INDICATOR
TRAIN INDICATOR
SWITCH INDICATOR
SWITCH INDICATOR AND SWITCH CIRCUIT CONTROLLER
NOTE:-ø
TYPE OF INDICATOR TO BE COVERED BY GENERAL NOTE. LETTER E, W, N OR S INDICATES TRACK CONTROLLING INDICATOR. WHEN CONTROLLED IN BOTH DIRECTIONS LETTER TO BE OMITTED
CABLE POST ONLY
WITH ONE INDICATOR
WITH TWO INDICATORS
WITH RELAY BOX
WITH RELAY BOX AND ONE INDICATOR
WITH RELAY BOX AND TWO INDICATORS
POLE LINE
GROUND LEVERS
DWARF MACHINE
2
CAPACITY
2
3
RELAY BOX AND POST
BATTERY CHUTE, RELAY BOX AND POST COMBINED
LEGEND AS REQUIRED
ROADWAY SIGNS
GRAPHICAL SYMBOLS
WAYSIDE FIXTURES
ARA
SIG. SEC.
1664A
M-1934 MAR 1934



DOUBLE LINE PLAN



SINGLE LINE PLAN

EXPLANATION

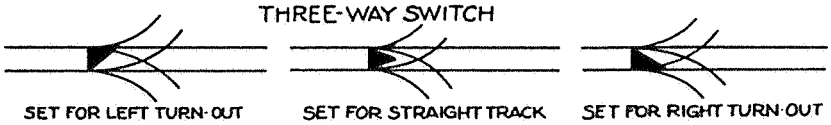
1- SIMPLE TURNOUT
2- SIMPLE CROSSOVER
3- DERAIL, SINGLE POINT
4- SINGLE SLIP SWITCH
5- DOUBLE SLIP SWITCH
6- MOVABLE POINT CROSSING FROG
7- SINGLE SLIP SWITCH WITH M.P.F
8- DOUBLE SLIP SWITCH WITH M.P.F.
9- RIGID CROSSING FROG
10- LIFTING DERAIL
11- LIFTING RAIL DERAIL

SINGLE SWITCH

SET FOR TURNOUT

SET FOR STRAIGHT TRACK

THREE-WAY SWITCH



SET FOR LEFT TURN-OUT

SET FOR STRAIGHT TRACK

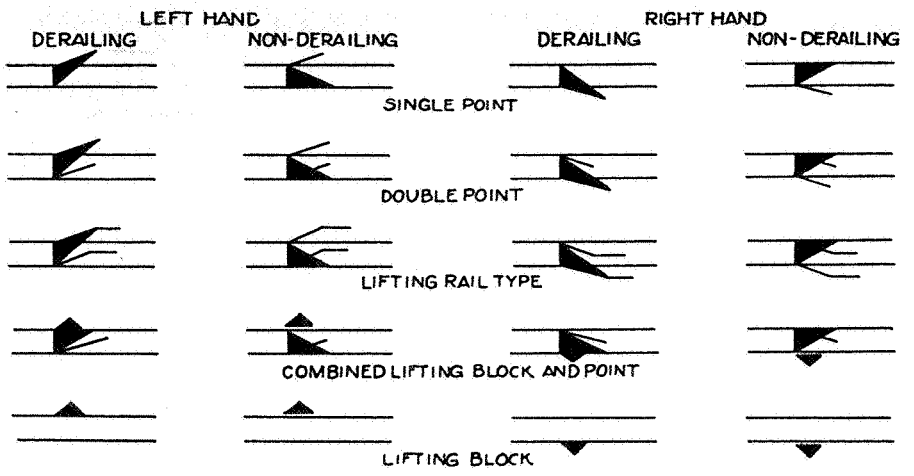
SET FOR RIGHT TURN-OUT

NOTE:-THE ABOVE SYMBOLS ARE FOR INTERLOCKED SWITCHES
NON-INTERLOCKED SWITCHES TO BE SHOWN SAME AS ABOVE EXCEPT SHADING IN TRIANGLES OMITTED. WHERE HAND-THROWN SWITCHES ARE PIPE-CONNECTED TO OTHERS, AT LEAST ONE SWITCH (THE ONE FARTHEST FROM POINT OF OPERATION) SHOULD HAVE LETTERS "PC" PLACED BESIDE IT.

GRAPHICAL SYMBOLS SWITCHES

ARA SIG. SEC. 1665A

M-1934 MAR1934

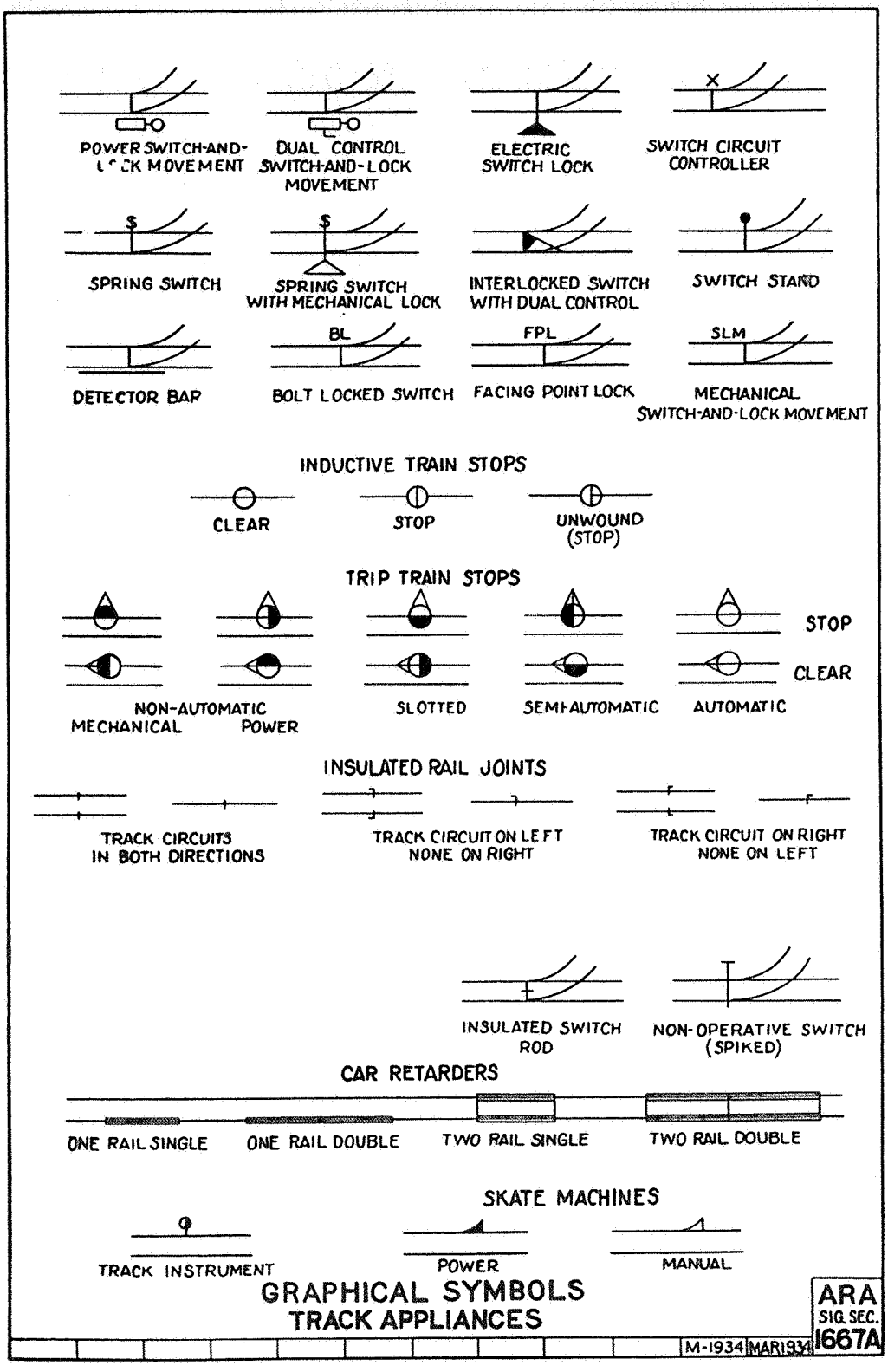


NOTE:-THE ABOVE SYMBOLS ARE FOR INTERLOCKED DERAILS. NON-INTERLOCKED DERAILS TO BE SHOWN AS ABOVE EXCEPT SHADING TO BE OMITTED. WHERE HAND THROWN DERAILS ARE PIPE CONNECTED TO OTHERS, AT LEAST ONE DERAIL (THE ONE FARTHEST FROM POINT OF OPERATION) SHOULD HAVE LETTERS PC PLACED BESIDE IT.

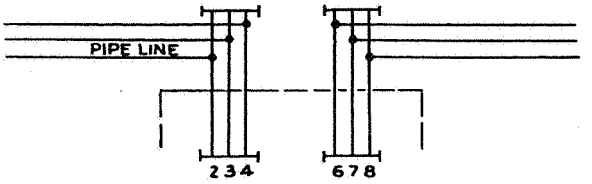
GRAPHICAL SYMBOLS
DERAILS

ARA SIG. SEC. 1666A

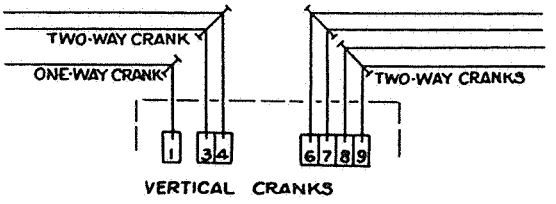
M-1934 MAR 1934


POWER SWITCH-AND-LOCK MOVEMENT
DUAL CONTROL SWITCH-AND-LOCK MOVEMENT
ELECTRIC SWITCH LOCK
SWITCH CIRCUIT CONTROLLER
SPRING SWITCH
SPRING SWITCH WITH MECHANICAL LOCK
INTERLOCKED SWITCH WITH DUAL CONTROL
SWITCH STAND
DETECTOR BAR
BL
BOLT LOCKED SWITCH
FPL
FACING POINT LOCK
SLM
MECHANICAL SWITCH-AND-LOCK MOVEMENT
INDUCTIVE TRAIN STOPS
CLEAR
STOP
UNWOUND (STOP)
TRIP TRAIN STOPS
STOP
CLEAR
NON-AUTOMATIC MECHANICAL
POWER
SLOTTED
SEMI-AUTOMATIC
AUTOMATIC
INSULATED RAIL JOINTS
TRACK CIRCUITS IN BOTH DIRECTIONS
TRACK CIRCUIT ON LEFT NONE ON RIGHT
TRACK CIRCUIT ON RIGHT NONE ON LEFT
INSULATED SWITCH ROD
NON-OPERATIVE SWITCH (SPIKED)
CAR RETARDERS
ONE RAIL SINGLE
ONE RAIL DOUBLE
TWO RAIL SINGLE
TWO RAIL DOUBLE
SKATE MACHINES
TRACK INSTRUMENT
POWER
MANUAL
GRAPHICAL SYMBOLS
TRACK APPLIANCES
ARA
SIG. SEC.
1667A
M-1934 MAR1934

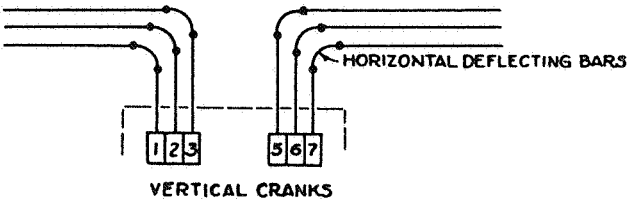
ROCKING SHAFT LEAD-OUT

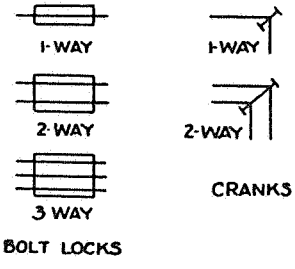


CRANK LEAD-OUT



DEFLECTING BAR LEAD-OUT.

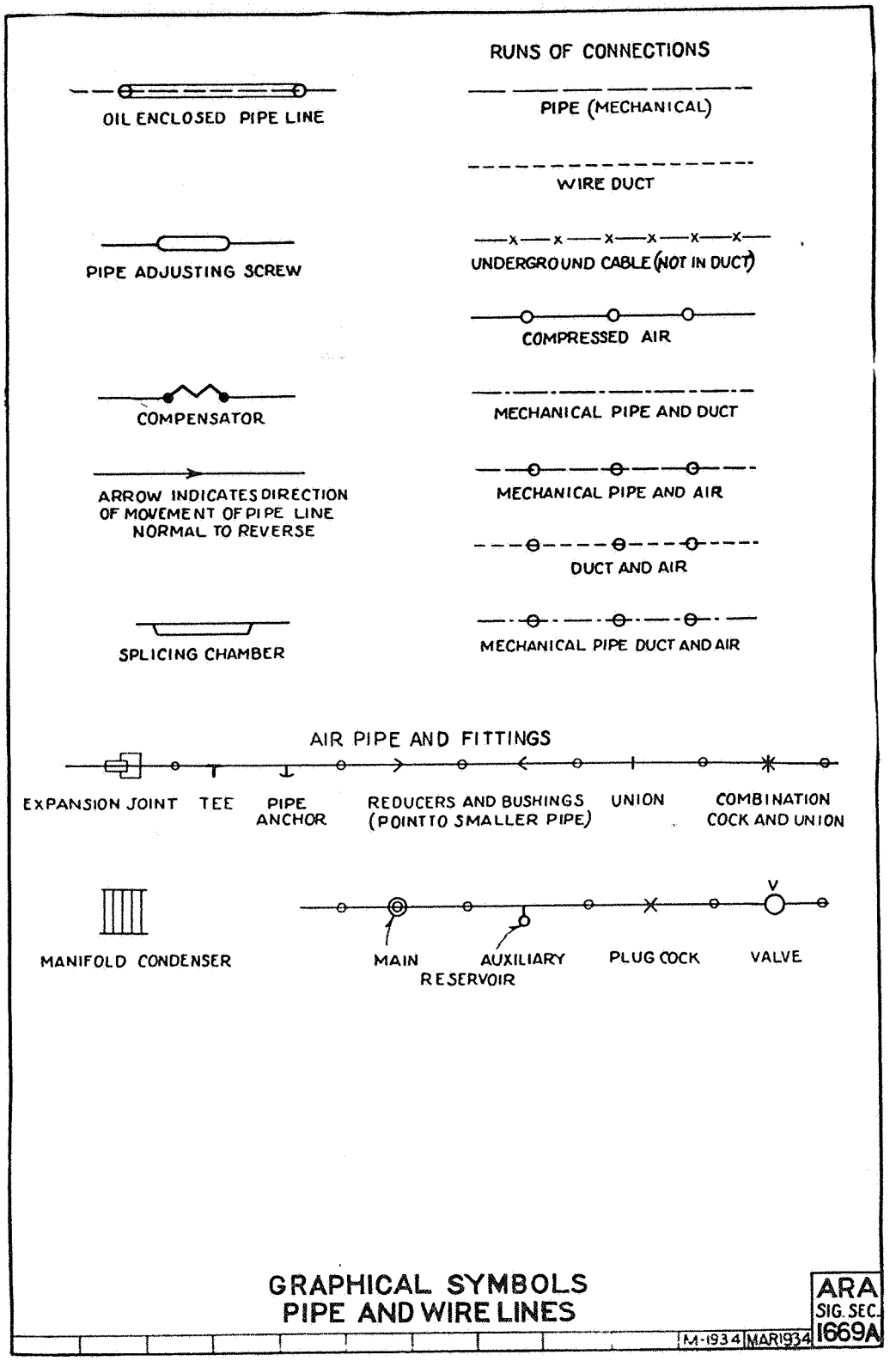


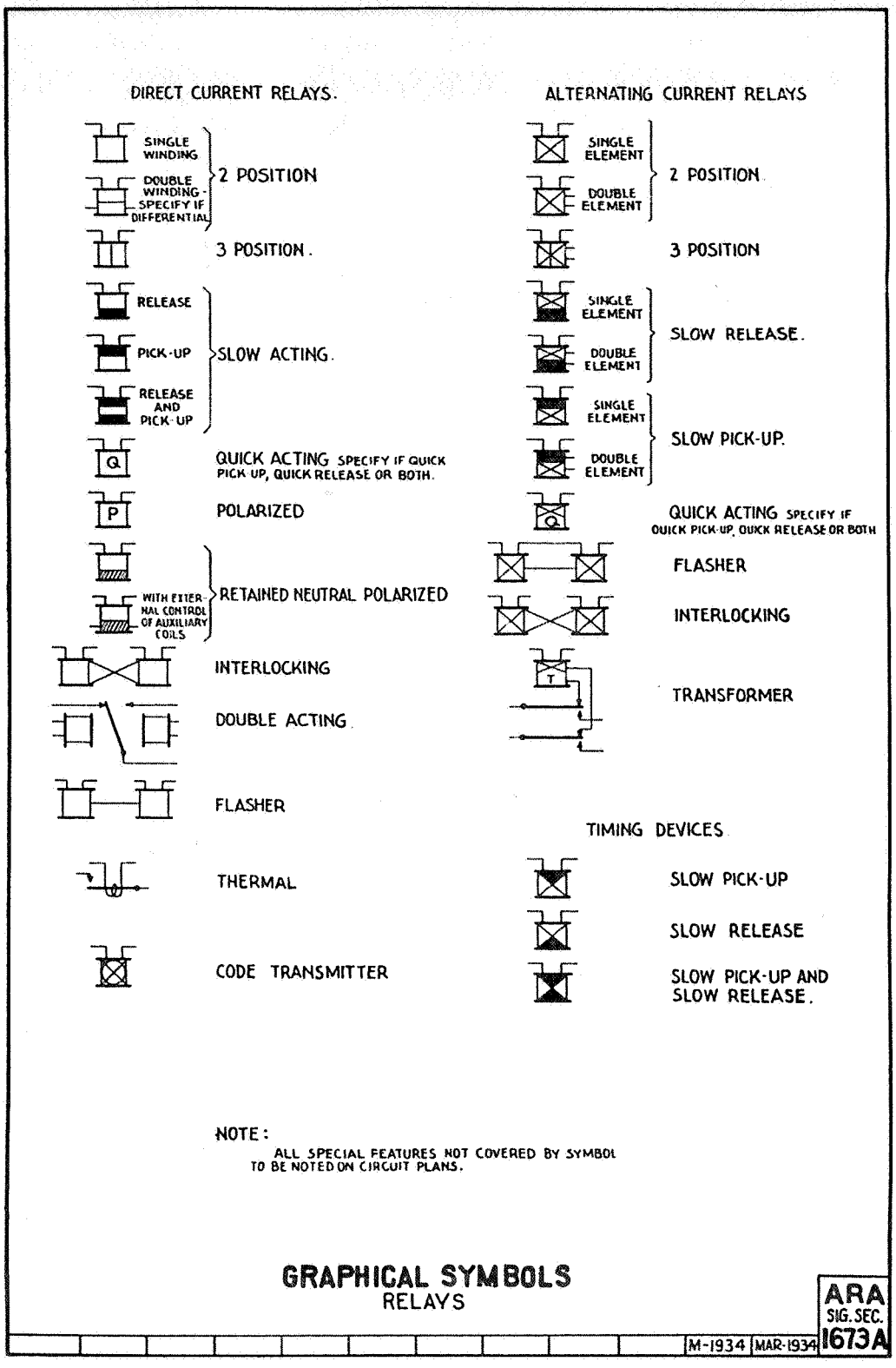


GRAPHICAL SYMBOLS
LEAD-OUTS, BOLT LOCKS AND STANDS

ARA SIG. SEC. 668A

M-1934 MAR1934


RUNS OF CONNECTIONS
OIL ENCLOSED PIPE LINE
PIPE (MECHANICAL)
WIRE DUCT
PIPE ADJUSTING SCREW
UNDERGROUND CABLE (NOT IN DUCT)
COMPRESSED AIR
COMPENSATOR
MECHANICAL PIPE AND DUCT
ARROW INDICATES DIRECTION OF MOVEMENT OF PIPE LINE NORMAL TO REVERSE
MECHANICAL PIPE AND AIR
DUCT AND AIR
SPLICING CHAMBER
MECHANICAL PIPE DUCT AND AIR
AIR PIPE AND FITTINGS
EXPANSION JOINT
TEE
PIPE ANCHOR
REDUCERS AND BUSHINGS (POINT TO SMALLER PIPE)
UNION
COMBINATION COCK AND UNION
MANIFOLD CONDENSER
MAIN RESERVOIR
AUXILIARY
PLUG COCK
VALVE
V
GRAPHICAL SYMBOLS
PIPE AND WIRE LINES
M-1934 MAR1934
ARA SIG. SEC. 1669A


DIRECT CURRENT RELAYS.
SINGLE WINDING
DOUBLE WINDING - SPECIFY IF DIFFERENTIAL
2 POSITION
3 POSITION.
RELEASE
PICK-UP
RELEASE AND PICK-UP
SLOW ACTING.
Q
QUICK ACTING SPECIFY IF QUICK PICK UP, QUICK RELEASE OR BOTH.
P
POLARIZED
WITH EITERNAL CONTROL OF AUXILIARY COILS
RETAINED NEUTRAL POLARIZED
INTERLOCKING
DOUBLE ACTING.
FLASHER
THERMAL
CODE TRANSMITTER
ALTERNATING CURRENT RELAYS
SINGLE ELEMENT
DOUBLE ELEMENT
2 POSITION.
3 POSITION
SLOW RELEASE.
SLOW PICK-UP.
QUICK ACTING SPECIFY IF QUICK PICK-UP, QUICK RELEASE OR BOTH
FLASHER
INTERLOCKING
T
TRANSFORMER
TIMING DEVICES
SLOW PICK-UP
SLOW RELEASE
SLOW PICK-UP AND SLOW RELEASE.
NOTE:
ALL SPECIAL FEATURES NOT COVERED BY SYMBOL TO BE NOTED ON CIRCUIT PLANS.
GRAPHICAL SYMBOLS
RELAYS
ARA
SIG. SEC.
1673A
M-1934
MAR-1934

NEUTRAL FRONT CONTACT
CLOSED RELAY ENERGIZED.

NEUTRAL FRONT CONTACT
OPEN RELAY DE-ENERGIZED.

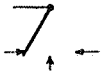
NEUTRAL BACK CONTACT.

HIGH CURRENT CONTACT.

MAGNETIC BLOW-OUT CONTACT.

CONSTANTLY MOVING CONTACT.

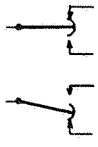
POLAR CONTACT CLOSED NORMAL.



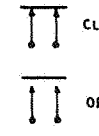
3 POSITION CONTACT.

CODE TRANSMITTER CONTACT
120 BREAKS PER MINUTE

FLASHER RELAY CONTACT.

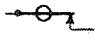


MAKE BEFORE BREAK CONTACT.



SOLENOID CONTACT.

FLAGMAN CONTACT.
CLOSED WHEN ARMATURE IS LOCKED.

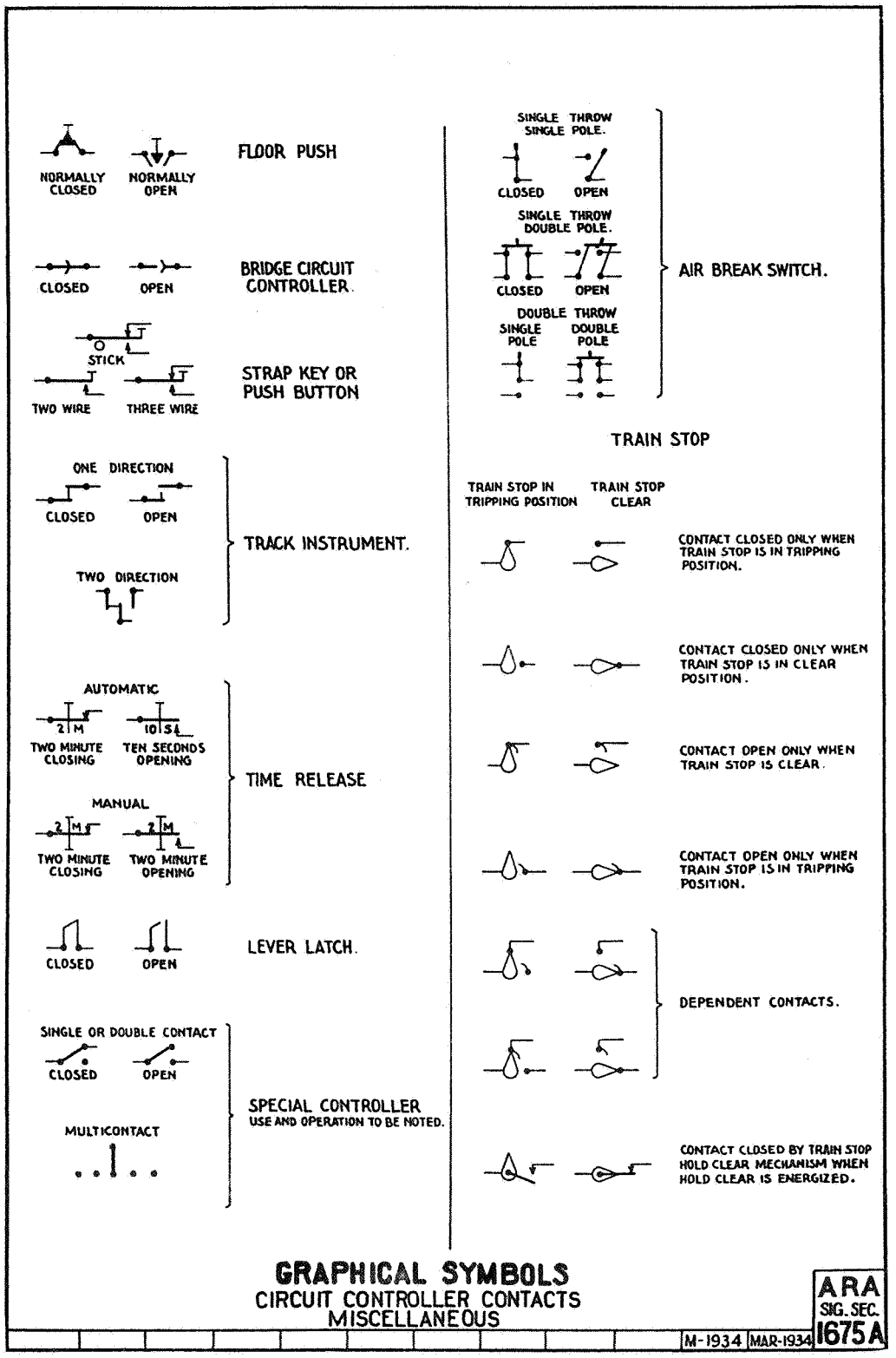


CHECKING CONTACT OF
THERMAL RELAY.

GRAPHICAL SYMBOLS
RELAY CONTACTS

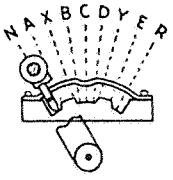
ARA
SIG. SEC.
1674A

M-1934 MAR-1934

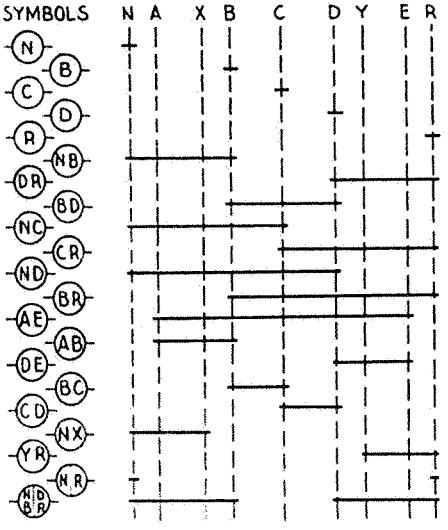

NORMALLY CLOSED
NORMALLY OPEN
FLOOR PUSH
CLOSED
OPEN
BRIDGE CIRCUIT CONTROLLER.
STICK
TWO WIRE
THREE WIRE
STRAP KEY OR PUSH BUTTON
ONE DIRECTION
CLOSED
OPEN
TWO DIRECTION
TRACK INSTRUMENT.
AUTOMATIC
TWO MINUTE CLOSING
TEN SECONDS OPENING
MANUAL
TWO MINUTE CLOSING
TWO MINUTE OPENING
TIME RELEASE
CLOSED
OPEN
LEVER LATCH.
SINGLE OR DOUBLE CONTACT
CLOSED
OPEN
MULTICONTACT
SPECIAL CONTROLLER
USE AND OPERATION TO BE NOTED.
SINGLE THROW SINGLE POLE.
CLOSED
OPEN
SINGLE THROW DOUBLE POLE.
CLOSED
OPEN
DOUBLE THROW
SINGLE POLE
DOUBLE POLE
AIR BREAK SWITCH.
TRAIN STOP
TRAIN STOP IN TRIPPING POSITION
TRAIN STOP CLEAR
CONTACT CLOSED ONLY WHEN TRAIN STOP IS IN TRIPPING POSITION.
CONTACT CLOSED ONLY WHEN TRAIN STOP IS IN CLEAR POSITION.
CONTACT OPEN ONLY WHEN TRAIN STOP IS CLEAR.
CONTACT OPEN ONLY WHEN TRAIN STOP IS IN TRIPPING POSITION.
DEPENDENT CONTACTS.
CONTACT CLOSED BY TRAIN STOP HOLD CLEAR MECHANISM WHEN HOLD CLEAR IS ENERGIZED.
GRAPHICAL SYMBOLS
CIRCUIT CONTROLLER CONTACTS
MISCELLANEOUS
M-1934 MAR-1934
ARA SIG. SEC. 1675A

LEVERS WITH END POSITION AS NORMAL

N - NORMAL POSITION
A - LEVER SLIGHTLY MOVED FROM N TOWARD B
X - LEVER SLIGHTLY MOVED FROM B TOWARD N
B - NORMAL INDICATION POSITION.
C - CENTRAL POSITION
D - REVERSE INDICATION POSITION
Y - LEVER SLIGHTLY MOVED FROM D TOWARD R
E - LEVER SLIGHTLY MOVED FROM R TOWARD D
R - REVERSE POSITION

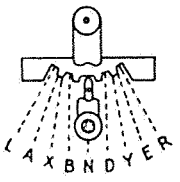


POSITIONS INDICATED

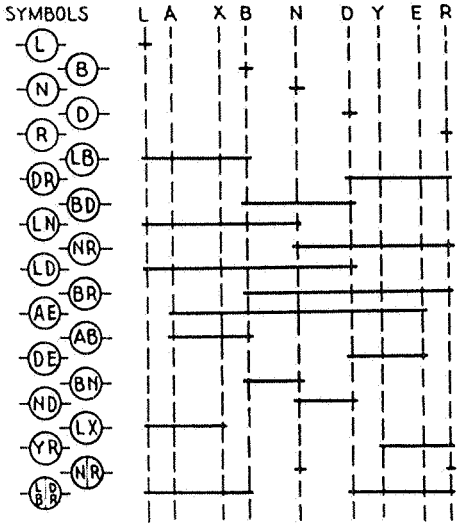


LEVERS WITH MIDDLE POSITION AS NORMAL

L - REVERSE POSITION TO LEFT.
A - LEVER SLIGHTLY MOVED FROM L TOWARD B
X - LEVER SLIGHTLY MOVED FROM B TOWARD L.
B - INDICATION POSITION TO LEFT
N - NORMAL POSITION
D - INDICATION POSITION TO RIGHT
Y - LEVER SLIGHTLY MOVED FROM D TOWARD R.
E - LEVER SLIGHTLY MOVED FROM R TOWARD D.
R - REVERSE POSITION TO RIGHT



POSITIONS INDICATED



HORIZONTAL LINES INDICATE THAT PORTION OF THE CYCLE OF LEVER MOVEMENT DURING WHICH THE CIRCUIT IS CLOSED

INDEPENDENT TYPE CONTACT 

HIGH VOLTAGE TYPE CONTACT 

DEPENDENT TYPE CONTACTS 

ABSENCE OF A VERTICAL LINE BETWEEN LETTERS IN A SYMBOL INDICATES THAT THE CIRCUIT IS CLOSED AT AND BETWEEN THE POINTS INDICATED.

PRESENCE OF A VERTICAL LINE BETWEEN LETTERS IN A SYMBOL INDICATES THAT THE CIRCUIT IS CLOSED AT AND OPEN BETWEEN THE POINTS INDICATED.

GRAPHICAL SYMBOLS

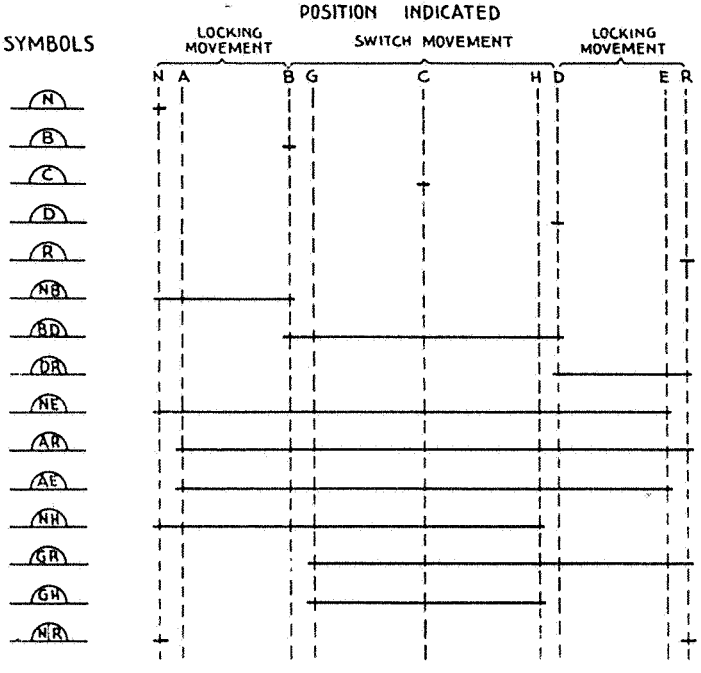
CIRCUIT CONTROLLER CONTACTS

CONTACTS ACTUATED MECHANICALLY BY INTERLOCKING MACHINE LEVER

M-1934 MAR-1934

ARA SIG. SEC. 1676 A

N - SWITCH IN NORMAL POSITION AND LOCKED
A - LOCKING SLIGHTLY REMOVED FROM NORMAL
B - SWITCH IN NORMAL POSITION AND UNLOCKED
G - SWITCH SLIGHTLY REMOVED FROM NORMAL
C - SWITCH IN CENTRAL POSITION
H - SWITCH SLIGHTLY REMOVED FROM REVERSE.
D - SWITCH IN REVERSE POSITION AND UNLOCKED.
E - LOCKING SLIGHTLY REMOVED FROM REVERSE
R - SWITCH IN REVERSE POSITION AND LOCKED.



HORIZONTAL LINES INDICATE THAT PORTION OF THE CYCLE OF SWITCH AND LOCKING MOVEMENT DURING WHICH THE CIRCUIT IS CLOSED

INDEPENDENT TYPE CONTACT (N) DEPENDENT TYPE CONTACT (N R)

ABSENCE OF A VERTICAL LINE BETWEEN LETTERS IN A SYMBOL INDICATES THAT THE CIRCUIT IS CLOSED AT AND BETWEEN THE POINTS INDICATED.
PRESENCE OF A VERTICAL LINE BETWEEN LETTERS IN A SYMBOL INDICATES THAT THE CIRCUIT IS CLOSED AT AND OPEN BETWEEN THE POINTS INDICATED.

CONTACTS ACTUATED BY AND CONTROLLING THE SWITCH MOVEMENT

POWER-OPERATED SWITCH MOVEMENT

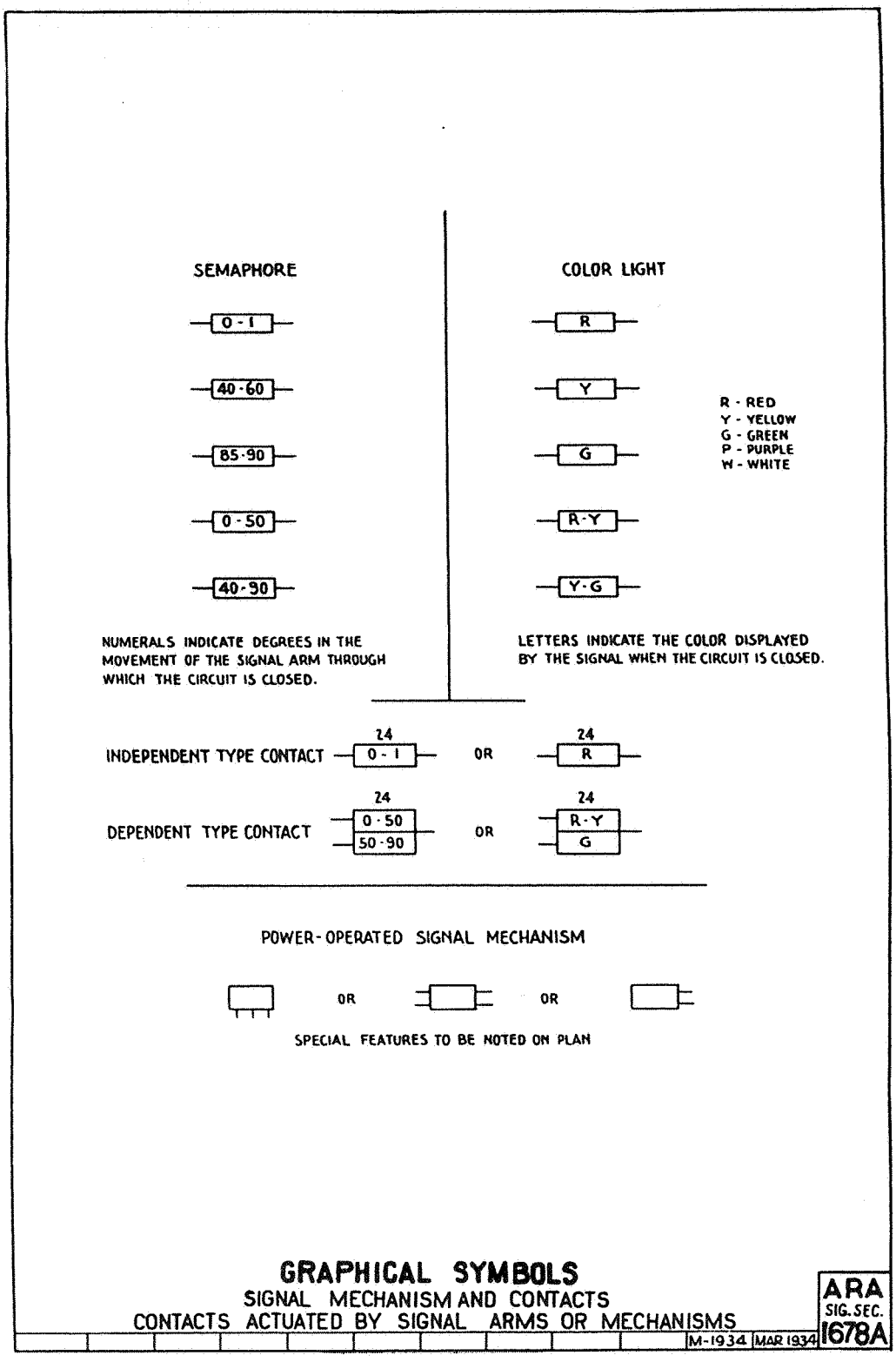
SPECIAL FEATURES TO BE NOTED ON PLAN

GRAPHICAL SYMBOLS

SWITCH MOVEMENT AND CONTACTS
CONTACTS ACTUATED BY SWITCH POINTS, DERAILS OR LOCKING CONNECTIONS

M-1934 MAR-1934

ARA SIG. SEC. 1677A



GRAPHICAL SYMBOLS

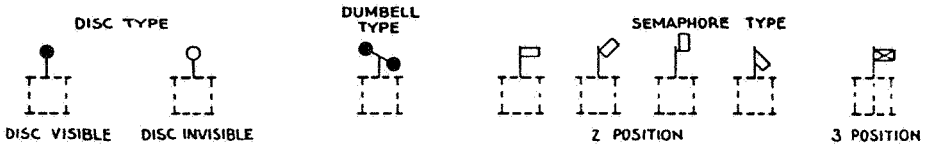
SIGNAL MECHANISM AND CONTACTS

CONTACTS ACTUATED BY SIGNAL ARMS OR MECHANISMS

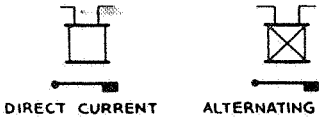
M-1934 MAR 1934

ARA SIG. SEC. 1678A

INDICATORS



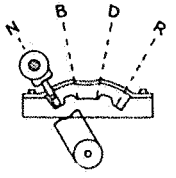
ELECTRIC LOCKS



LOCKING POSITION TO BE SPECIFIED AS
N & R — D — ETC.

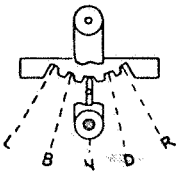
LEVERS WITH END POSITION AS NORMAL

N - NORMAL POSITION
B - NORMAL INDICATION POSITION
D - REVERSE INDICATION POSITION
R - REVERSE POSITION



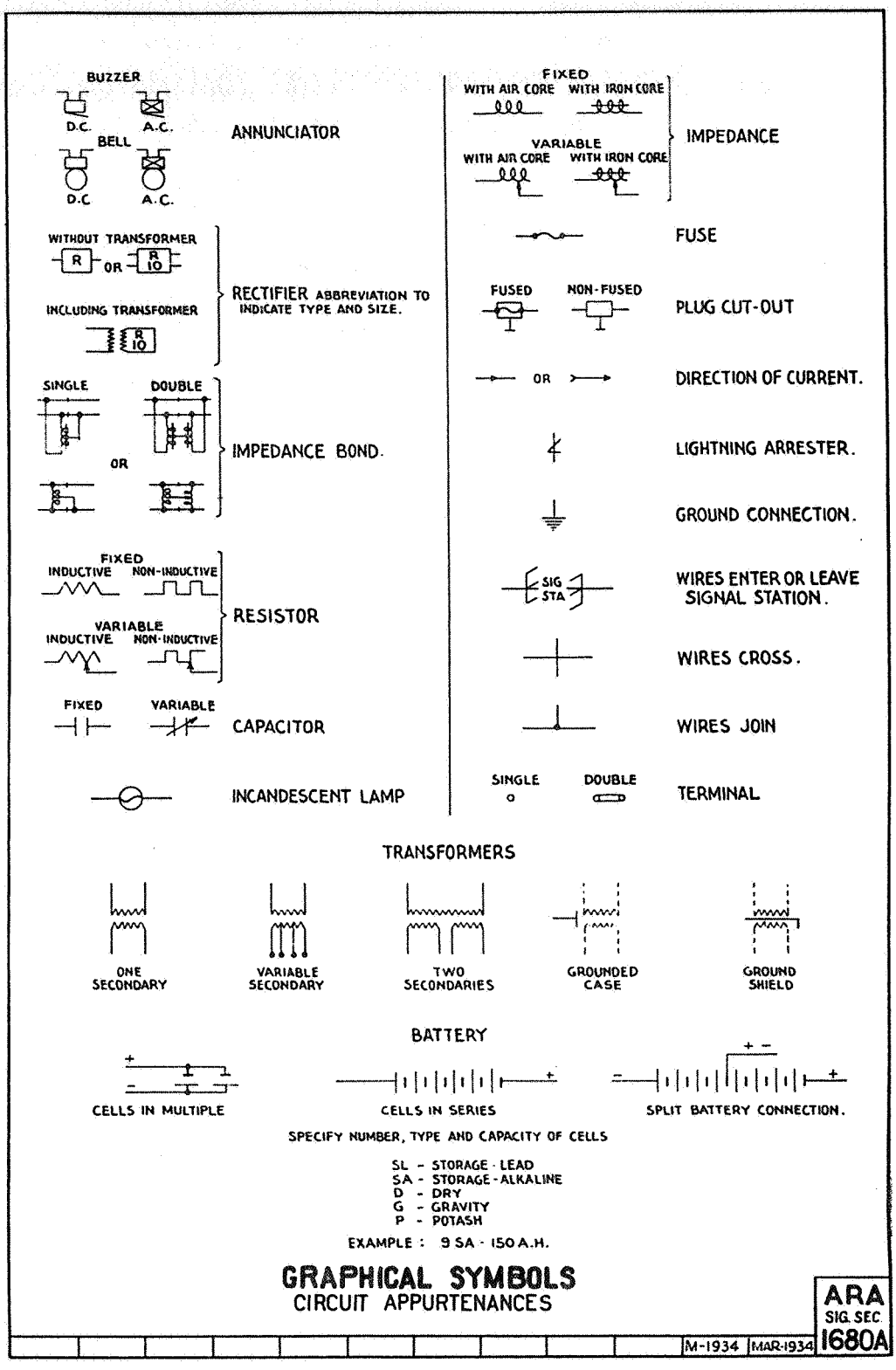
LEVERS WITH MIDDLE POSITION AS NORMAL

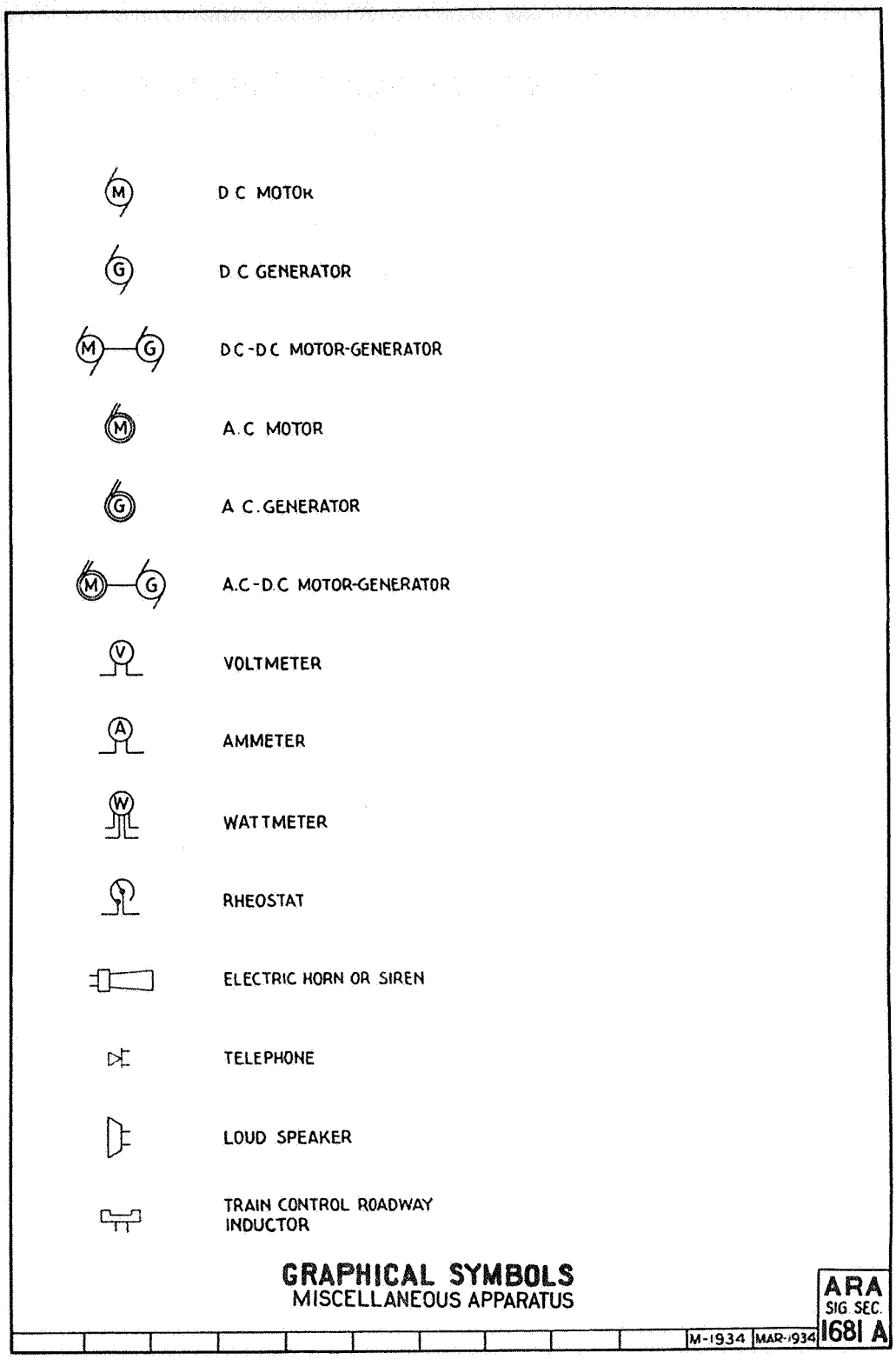
L - REVERSE POSITION TO LEFT.
B - INDICATION POSITION TO LEFT
N - NORMAL POSITION
D - INDICATION POSITION TO RIGHT.
R - REVERSE POSITION TO RIGHT.



GRAPHICAL SYMBOLS
INDICATORS AND LOCKS

M-1934 MAR-1934 ARA SIG. SEC. 1679A


BUZZER
D.C.
A.C.
BELL
D.C
A.C.
ANNUNCIATOR
WITHOUT TRANSFORMER
R
OR
R
10
INCLUDING TRANSFORMER
R
10
RECTIFIER ABBREVIATION TO INDICATE TYPE AND SIZE.
SINGLE
DOUBLE
OR
IMPEDANCE BOND.
FIXED
INDUCTIVE
NON-INDUCTIVE
VARIABLE
INDUCTIVE
NON-INDUCTIVE
RESISTOR
FIXED
VARIABLE
CAPACITOR
INCANDESCENT LAMP
FIXED
WITH AIR CORE
WITH IRON CORE
VARIABLE
WITH AIR CORE
WITH IRON CORE
IMPEDANCE
FUSE
FUSED
NON-FUSED
PLUG CUT-OUT
OR
DIRECTION OF CURRENT.
LIGHTNING ARRESTER.
GROUND CONNECTION.
SIG
STA
WIRES ENTER OR LEAVE SIGNAL STATION.
WIRES CROSS.
WIRES JOIN
SINGLE
DOUBLE
TERMINAL
TRANSFORMERS
ONE SECONDARY
VARIABLE SECONDARY
TWO SECONDARIES
GROUNDED CASE
GROUND SHIELD
BATTERY
CELLS IN MULTIPLE
CELLS IN SERIES
SPLIT BATTERY CONNECTION.
SPECIFY NUMBER, TYPE AND CAPACITY OF CELLS
SL - STORAGE - LEAD
SA - STORAGE - ALKALINE
D - DRY
G - GRAVITY
P - POTASH
EXAMPLE : 9 SA - 150 A.H.
GRAPHICAL SYMBOLS
CIRCUIT APPURTENANCES
M-1934
MAR-1934
ARA
SIG. SEC
1680A


M
D C MOTOR
G
D C GENERATOR
M G
D C - D C MOTOR-GENERATOR
M
A C MOTOR
G
A C GENERATOR
M G
A C - D C MOTOR-GENERATOR
V
VOLTMETER
A
AMMETER
W
WATTMETER
RHEOSTAT
ELECTRIC HORN OR SIREN
TELEPHONE
LOUD SPEAKER
TRAIN CONTROL ROADWAY INDUCTOR
GRAPHICAL SYMBOLS
MISCELLANEOUS APPARATUS
M-1934
MAR-1934
ARA
SIG. SEC.
1681 A

Mechanical Interlocking

Track and signal layout.

Figure 1 shows the track and signal layout of an interlocking operated by means of a mechanical machine. The track circuits are direct current, the operation of which is fully explained in Chapter VII—Direct Current Track Circuits.

The switches, derails and facing point locks are pipe-connected; signals 1, 2, 3, 4, 5, 6, 30, 31 and 32 are power-operated, semaphore type; dwarf signals 7, 28 and 29 are pipe-connected, mechanically-operated, semaphore type. Direct current is used throughout for the control of all electrical apparatus, except for the signal lighting circuits where alternating current is used.

Track and signal repeating and approach relay circuits.

Repeating relays are used to provide additional contacts when required, also to repeat in the interlocking station or at a central location track and other relays located some distance away so that the relay contacts may be available at either location where the circuit arrangement requires them, thereby using the minimum amount of wire.

Referring to Fig. 2, the control of track repeating relay 23TP is as follows: positive battery B through a front contact of track relay 23TR to the coils of relay 23TP, through the coils of the relay, to negative battery C, so that when track circuit 23T is occupied relay 23TP will be de-energized.

The signal repeating relays are used to repeat the position of the signals. Referring to the control of signal repeating relay 3NGP it will be noted that positive battery B passes through a contact on the circuit controller of signal 3 closed with the signal arm between zero and 5 degrees to insure that the signal arm is in the stop position before closing the circuit for the repeating relay, through the coils of relay 3NGP, to negative battery C.

The approach of a train to an interlocking station is usually announced at the station by means of an annunciator, usually controlled by means of approach relays which relays are also sometimes used in the approach and route locking circuits.

Relays 31-32AR and 1-2AR are approach relays used in connection with signals 1, 2, 31 and 32. The control of relay 31-32AR is as follows: positive battery B through a front contact of relay 69.1TR1, through a front contact of relay 68.1TR1, through a front contact of relay 68.1TR2, to the coils of relay 31-32AR, to negative battery C. By referring to Fig. 1 it will be noted that 69.1T and 68.1T are track circuits approaching home signal 31-32. When a train occupies one of these circuits the corresponding track relay is de-energized and thus relay 31-32AR is de-energized, at which time an indication of the approaching train is announced in the interlocking station.

Approach bell and approach stick relay circuits.

Figure 3 shows the control circuits for the audible indicator in the interlocking station. The control circuit for the AX or approach bell is as follows: positive battery B through a back contact of relay 31-32AR, through a back contact of relay 31-32XSR, through the coils of the bell AX, to negative battery C. It will thus be noted that with relays 31-32AR and

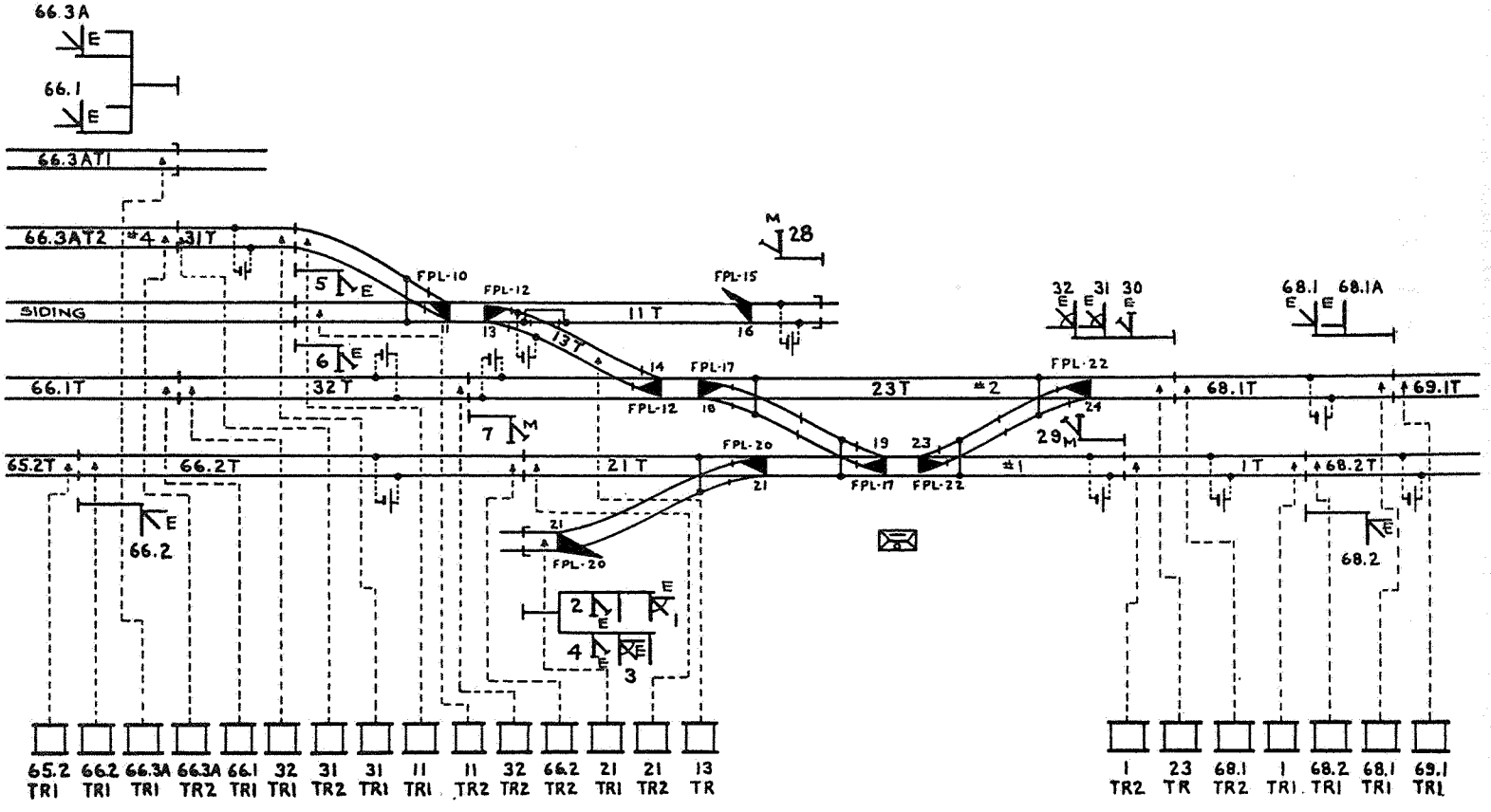


Fig. 1.
Track and Signal Layout.

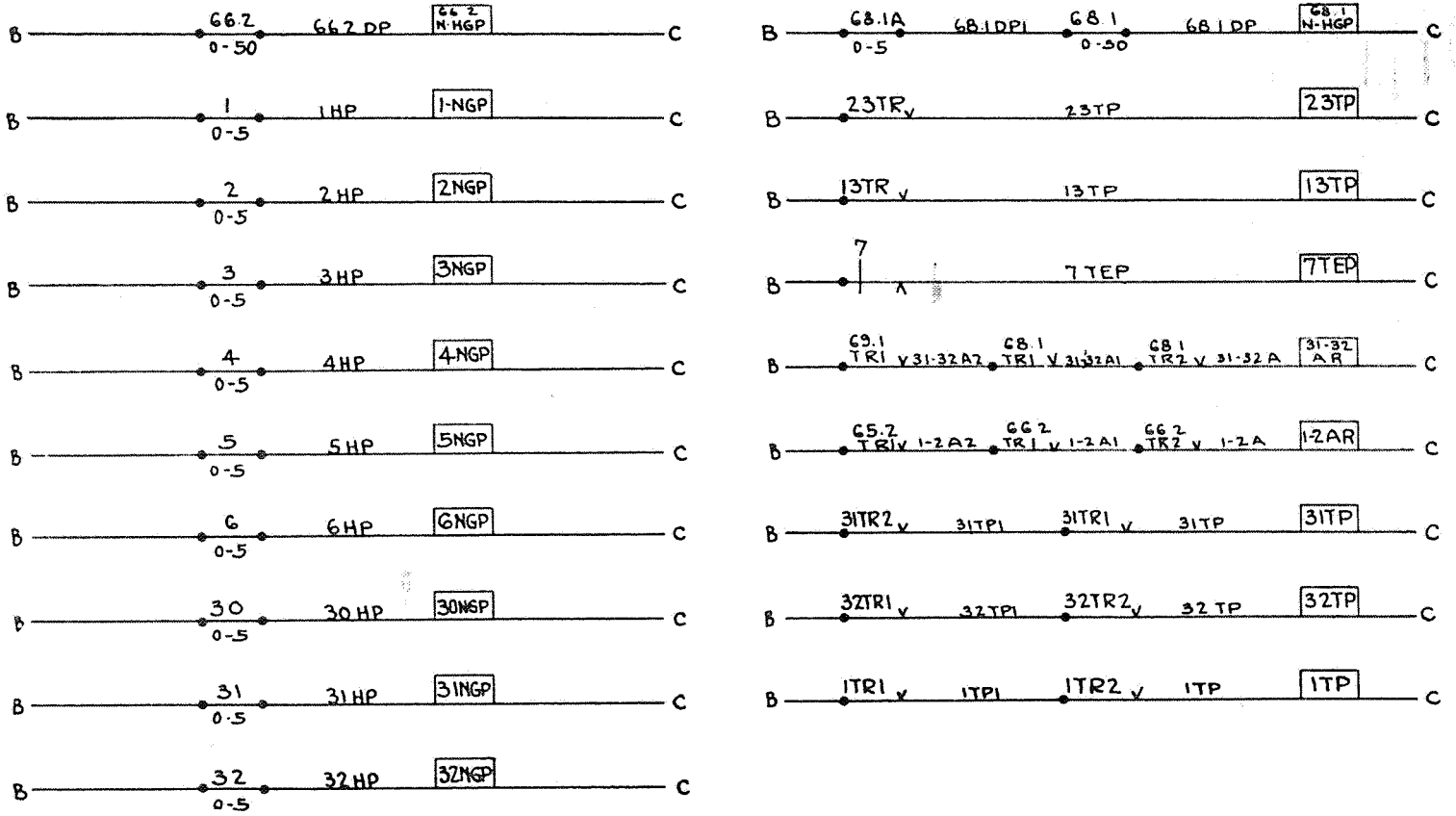


Fig. 2.
Track and Signal Repeating and Approach Relay Circuits.

31-32XSR de-energized, the bell will ring. At the right of contact on relay 31-32AR a tap is taken to the coils of relay 31-32XSR, a bell stick relay; through the coils of the relay to a back contact of relay 30NGP, 31NGP or 32NGP, to negative battery C. With this circuit if one of the three home signals is displaying an indication other than Stop, a single stroke announcement is given when the approach track circuits are occupied; if, however, the home signals are at Stop, the bell would ring continuously if the normally open contact in push button 31-32 was not closed. As soon as the bell starts to ring the operator pushes button 31-32 energizing relay 31-32XSR, causing the bell to cease ringing. Relay 31-32XSR is known as a stick relay as once it is energized it remains energized through one of its own contacts which will be noted by referring to the circuit tapped off after going through the coils of relay 31-32XSR, through its own front contact, to negative battery C. Relay 31-32XSR will then remain energized as long as relay 31-32AR is de-energized. It will thus be noted that announcement is provided from two track circuits in approach of the home signals.

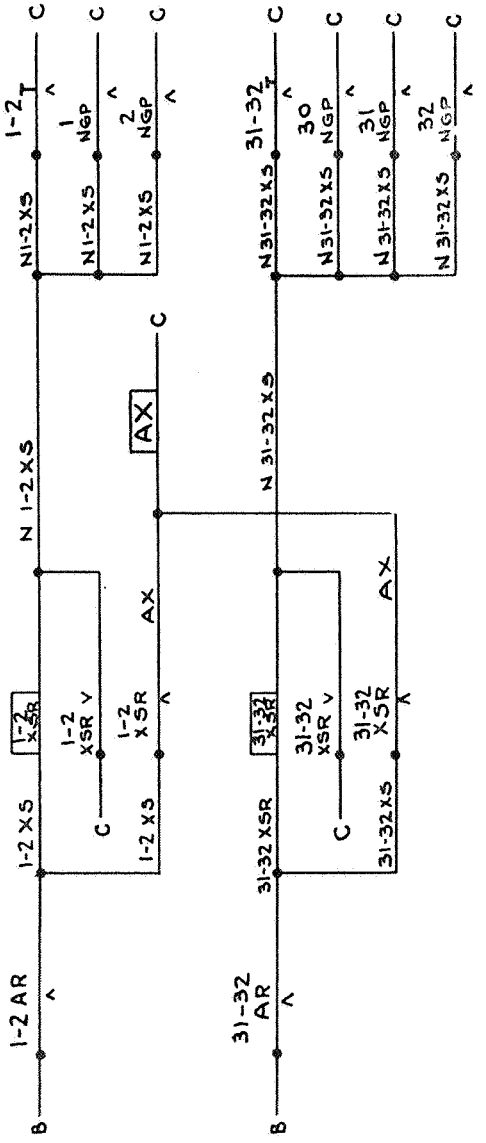


Fig. 3.
Approach Bell and Approach Stick Relay Circuits.

Switch repeating relay circuits.

The switches, although operated mechanically, are provided with electrical protection for proper operation. Relays known as WP relays are provided to repeat the position of the switches and are energized only when the switches are in the normal or reverse position. Relays are provided for both positions of a switch: namely, RWP, reverse switch repeating relay and NWP, normal switch repeating relay. Figure 4 shows the control circuits for these relays and the circuit for 13-14NWP and 13-14RWP is as follows: positive battery B through a contact of the switch circuit controller on switch 13 which is closed when the switch is in normal position, through a contact of switch circuit controller on switch 14 which is closed when the switch is in normal position, as switch 14 is one end of the crossover and switch 13 the other end, to the coils of relay 13-14NWP, through the coils of the relay, through a back contact of relay 13-14RWP, to negative battery C. As relay 13-14RWP is the relay energized when the switch is in reverse position, by breaking the circuit through a back contact of relay 13-14RWP it insures that the reverse switch repeating relay is de-energized. It will be noted that a tap is taken at the right of coils of relay 13-14NWP, through a front contact of relay 13-14RWP, to the left side of coils of relay 13-14NWP. This circuit is provided to further insure that both relays 13-14NWP and 13-14-RWP cannot be energized at the same time as it will be noted from this circuit that when one relay is energized a shunt is applied to the coils of the other relay, through a front contact of the relay which is energized. An additional circuit is provided to insure that the relay coils cannot be energized while the switch is being operated from normal to reverse position, or vice versa, by connecting the control wire to common, through contacts in the switch circuit controller.

The control circuit of relay 13-14RWP is similar to the control circuit for relay 13-14NWP except that positive battery B is through the switch circuit controller contacts closed when the switches are in reverse position, through the coils of relay 13-14RWP, through a back contact of relay 13-14NWP, to negative battery C. The coils of relay 13-14RWP are shunted through a front contact of relay 13-14NWP to provide the additional protection against both relays being energized at the same time. The control circuit for a switch repeating relay for a turnout is similar to the circuit for a crossover except that only one switch is involved.

Electric switch lever locking circuits.

This interlocking is equipped with what is known as electric switch lever locking circuits, making the use of detector bars unnecessary. Electric switch lever locking provides protection for the movement of a train over switches by electrically locking the switch over a given route. The locking is provided by using an electric lock on the lever which mechanically locks the switch, the electric lock securing the lever in the locked position when the track circuits are occupied. A description of electric locks will be found in Chapter XVII—Mechanical and Electro-Mechanical Interlocking. Figure 5 shows electric switch lever locking circuits for the mechanical levers locking the switches. Referring to the control of electric lock 10L the circuit is as follows: positive battery B through a normally closed contact of time

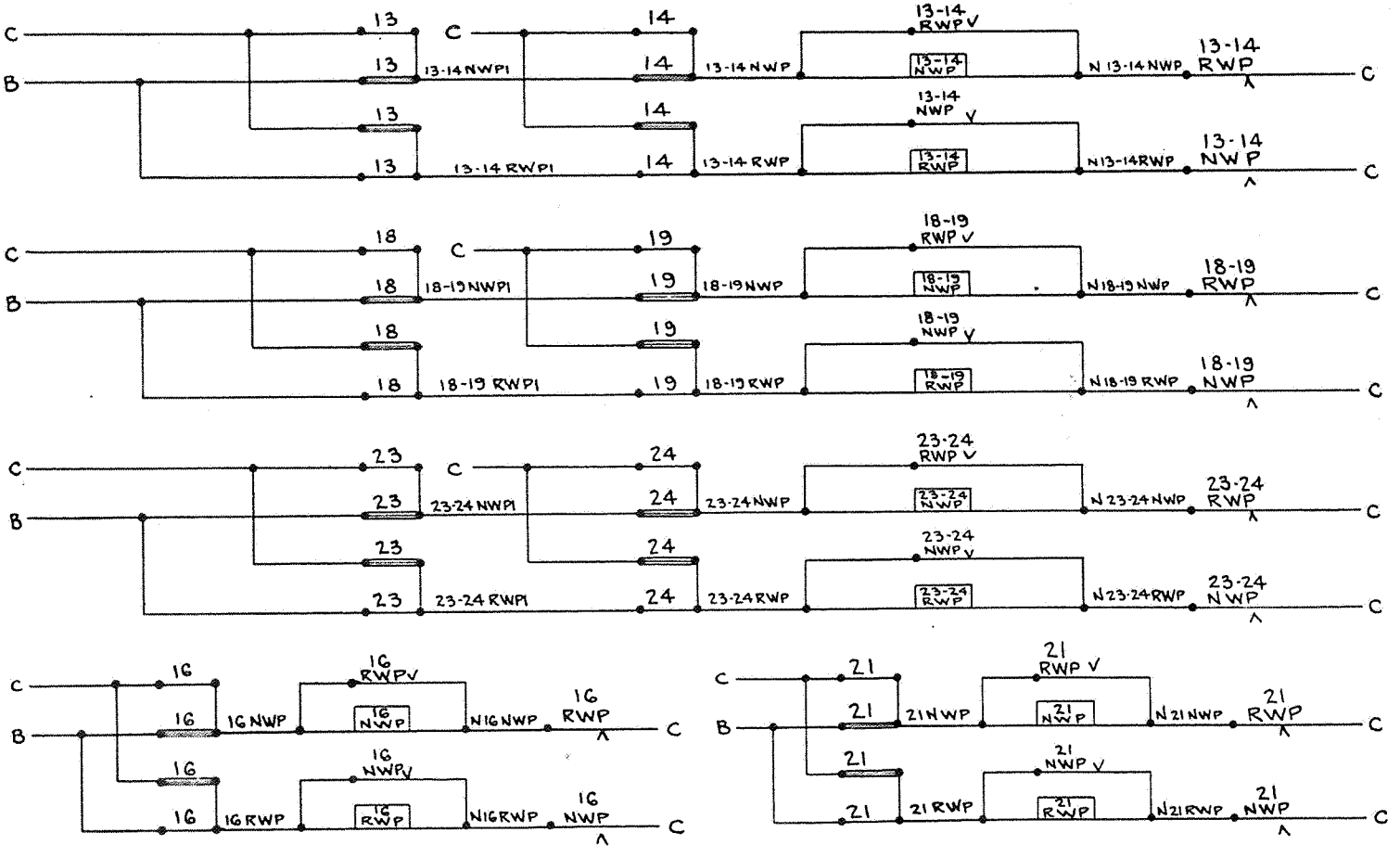


Fig. 4.
WP Relay Circuits.

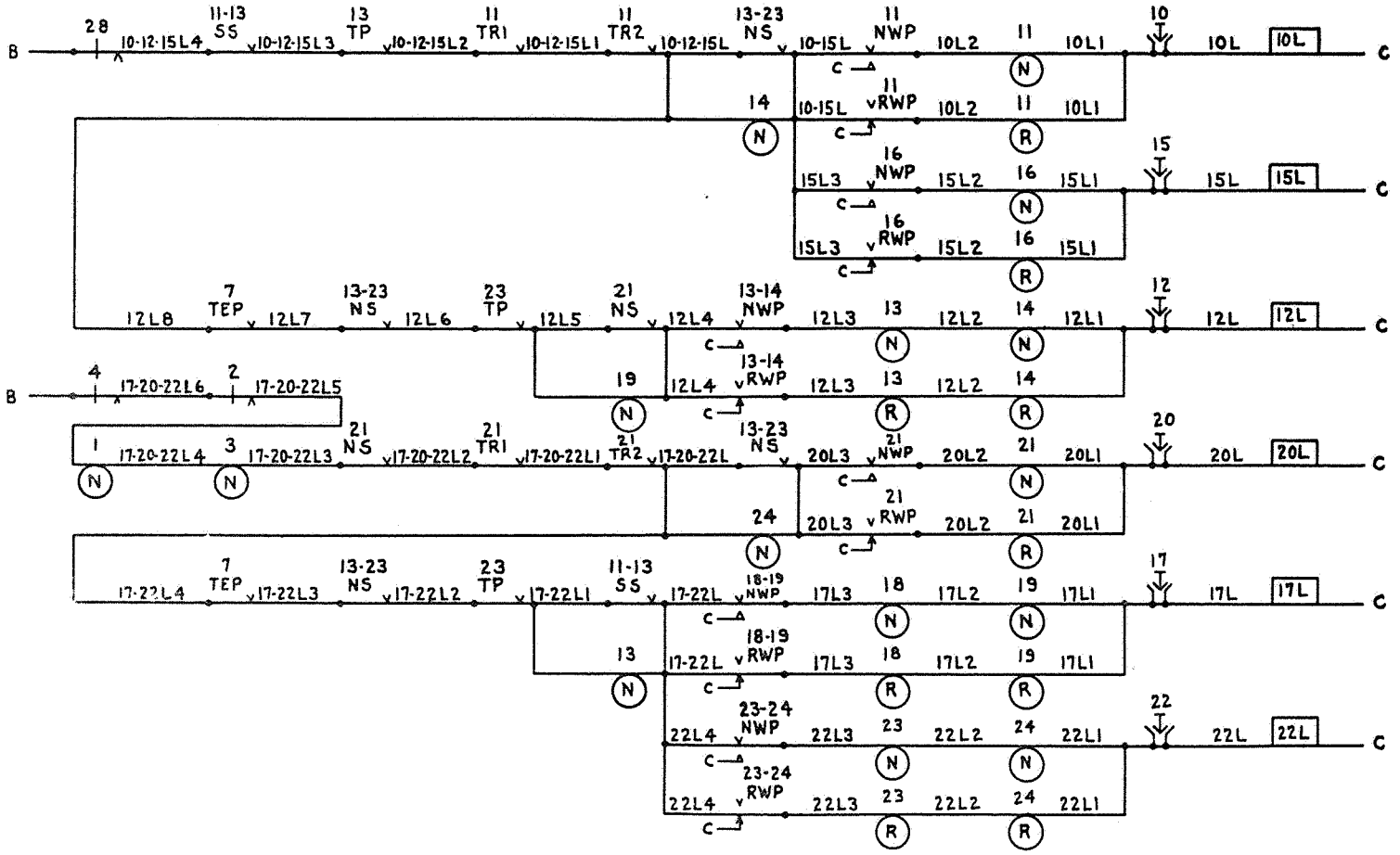


Fig. 5.
Electric Switch Lever Locking Circuits.

release for signal 28 which insures that a time interval will be interposed between the placing of signal lever 28 in the normal position and the release of lock 10, through a front contact of relay 11-13SS (see Fig. 12), through a front contact of track repeater relay 13TP, through front contacts of track relays 11TR1 and 11TR2 to prevent the energizing of lock 10 when these track circuits are occupied, through a front contact of relay 13-23NS cut around by a contact on switch lever 14 closed in the normal position, to insure proper route locking when lever 14 is reversed, through a normally closed contact on relay 11NWP which indicates that switch 11 is in the normal position, through a closed contact on switch lever 11 closed in the normal position to insure that lever 11 is in the same position as switch 11, through a normally open contact on floor push 10, which is a battery saving device, through the coils of lock 10, to negative battery C. Connection is also made to negative battery C through the back contacts of the WP relays to provide additional protection against crosses and grounds.

Home or 45 degree relay control circuits.

Figure 6 shows the control circuits for the home or 45 degree relays. The control circuit for relay 32HR is as follows: positive battery B through a normally closed contact of time release for signals 31 and 32 to insure that the release is in its normal position, through front contacts of track relays 23TR and 13TR so that when these track circuits are occupied the signal cannot clear, through front contacts of relays 18-19NWP, 23-24NWP and 13-14NWP to insure that switches 18-19, 23-24 and 13-14 are in their normal positions, through a front contact of track repeating relay 32TP so that when track circuit 32T is occupied the signal cannot clear, through a contact in circuit controller operated by signal lever 32 closed when the lever is in reverse position, through the coils of relay 32HR, through a back contact of relay 31-32AR, so that signal 32 will not clear until a train enters the approach track circuit, to negative battery C.

The control circuit for relay 68.1HR is as follows: positive battery B through a front contact of track relays 68.1TR2 and 68.1TR1 so that with these track circuits occupied the signal cannot clear, through the two coils of relay 68.1HR, through a back contact of track relay 69.1TR1, to negative battery C, for the purpose of keeping the 45 degree relay energized after it has once been energized over the rear 90 degree wire as will be explained under Fig. 7.

90 degree signal relay control circuits.

The 90 degree signal control circuits are shown in Fig. 7. The control circuit for relay 32DR is as follows: positive battery B through a front contact of relays 66.1TR2 and 66.1TR1, through the coils of relay 66.1HR, through a front contact of relay 13-14NWP, to insure that crossover 13-14 is in the normal position, through a front contact of relay 32HR, as the home or 45 degree control relay must be energized before the 90 degree relay can be energized, through the coils of relay 32DR, through back contact of track relay 68.1TR2 to obtain the approach clearing feature, to negative battery C. It will be noted that the 90 degree wire is used to operate the signal in advance to the 45 degree position. In this circuit taps are taken from the 90 degree control circuit through back contacts of track relays

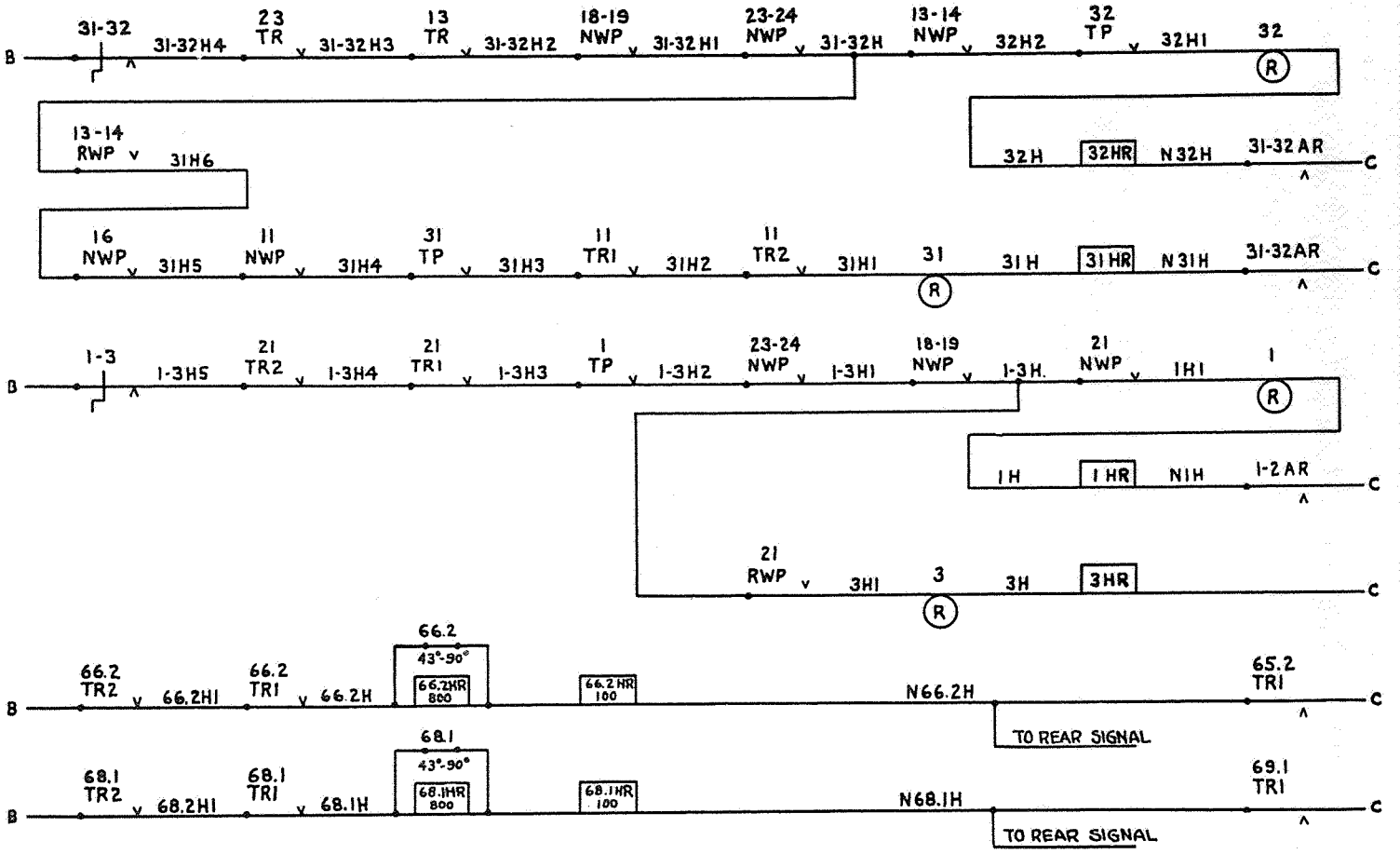


Fig. 6.
Home or 45 Degree Relay Circuits.

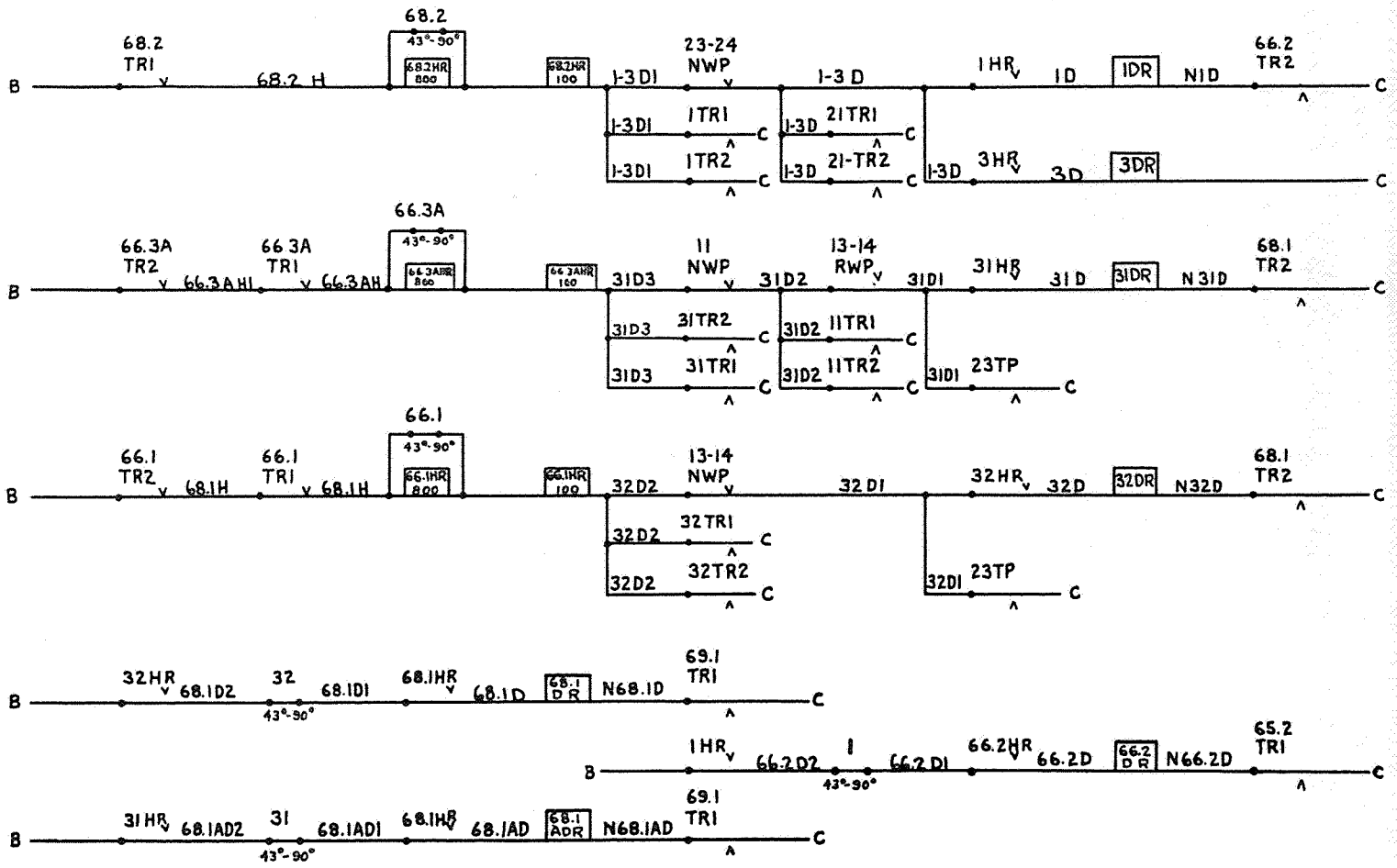


Fig. 7.
90 Degree Relay Circuits.

32TR1 and 32TR2, and track repeating relay 23TP, to negative battery C, to keep the 45 degree relay for signal 66.1 energized after it has been energized over the 90 degree control wire for signal 32 as the train passes onto these track circuits. The 800 ohm coil of relay 66.1HR is by-passed by a circuit through a circuit controller contact on signal mechanism 66.1 closed when the signal arm reaches the 43 degree position, and remains closed to the 90 degree position. With this explanation it will be noted that with the home or 45 degree control relay for signal 32 energized and track relay 68.1TR2 de-energized, the 90 degree circuit for signal 32 is complete but because of the high resistance in this circuit, on account of the 800 and 100-ohm coils of relay 66.1HR in series, the 90 degree control relay will not be energized but sufficient current will flow to energize the home or 45 degree relay for signal 66.1 and that when signal 66.1 has reached the 43 degree position, the 800-ohm coil will be cut around allowing enough current to flow to energize the 90 degree relay for signal 32.

The operation of the 90 degree control circuit for the top arm of signal 68.1 is as follows: positive battery B through a front contact of relay 32HR, through a circuit controller contact on signal mechanism 32 closed with the signal arm between the 43 and 90 degree positions, to insure that the 45 degree relay is energized and that the signal arm is in the 45 or 90 degree position, through a front contact of relay 68.1HR to insure that the 45 degree relay for signal 68.1 is also energized, through the coils of the 90 degree relay for signal 68.1, to a back contact of track relay 69.1TR1, to negative battery C.

Signal mechanism operating circuits.

The explanation just given has dealt with the control circuits for the signal control relays. Figure 8 shows the control circuits for the signal mechanisms. Referring to Fig. 8, the motor control circuit for signal 32 is as follows: positive and negative battery through front contacts of relay 32HR, as relay 32HR must be energized to operate the motor for signal 32, through circuit controller contacts on signal lever 32 closed in the reverse position, as the lever controlling the signal must be in the reverse position for signal to operate. The 45 degree motor control circuit 32HG is connected to contact 6 in Fig. 8a, the 90 degree motor control circuit is through a front contact of the 90 degree control relay for signal 32, as relay 32DR must be energized before signal 32 will go to the proceed position, over wire 32DG to contact 8; negative 32CG is connected to terminal on signal motor as shown in Fig. 8a. A shunt is placed between positive and negative motor control circuits through a circuit controller contact on lever 32 closed in the normal position so that when lever 32 is in the normal position the motor circuit is not only opened but the wires leading to the motor are short circuited.

The control circuit for signal 2, which is a two-position signal, differs from that described for signal 32 in that control relays are eliminated, the controlling circuit being closed by a circuit controller operated by lever 2 in the reverse position, then direct to the circuit controller of the signal mechanism.

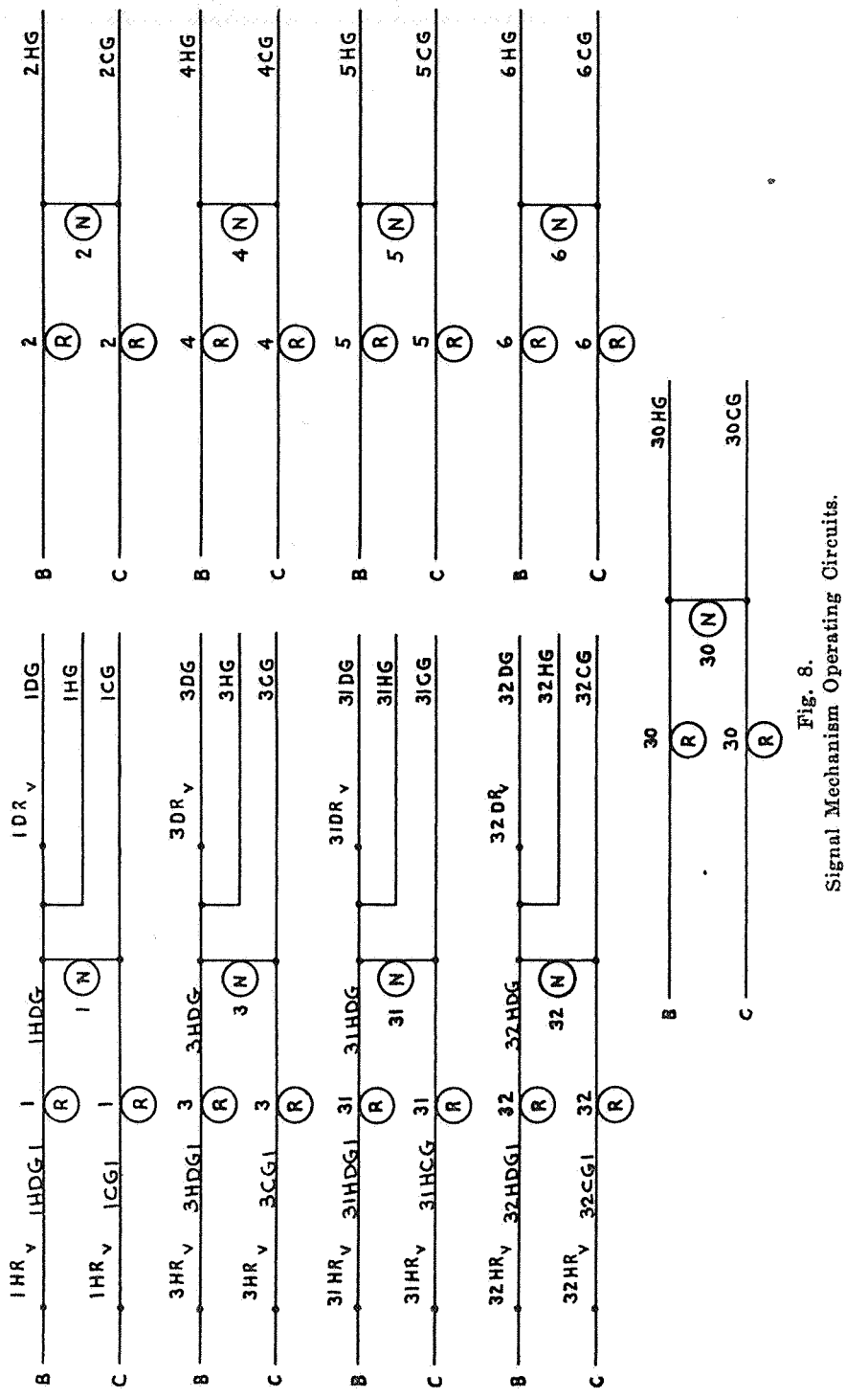
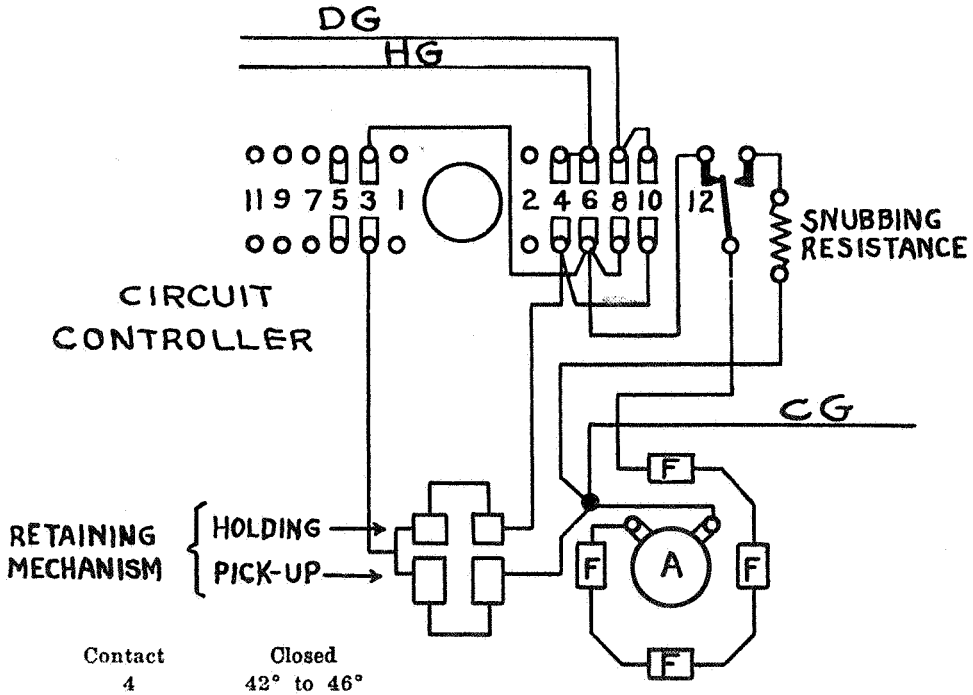


Fig. 8.
Signal Mechanism Operating Circuits.

Three-position signal mechanism circuits.

Figure 8a shows typical signal mechanism wiring for all the three-position power-operated signals. The operation is as follows: with positive battery B on the 45 degree control or HG wire, through contact 6 closed with the signal arm in the zero to the 43 degree position, through contact 12, which opens only when the signal arm is moving from the proceed or approach position, to the stop position, through the four field coils, through the motor

armature, to negative wire CG, thus causing the mechanism to operate. When the arm has reached the 40 degree position, contact 3 closes, energizing the pick-up coils of the retaining mechanism and contact 3 remains closed until the arm has reached the 43 degree position. When the arm has reached the 42 degree position, contact 4 closes, energizing the holding coils of the retaining mechanism from positive battery on the 45 degree motor control wire HG, through closed contact 4, through holding and pick-up coils, to wire CG. When the arm reaches the 43 degree position, contact 6 opens thereby opening the motor circuit and causing the mechanism to stop at the 45 degree position. The circuit for the operation of the signal mechanism from the 45 to the 90 degree position is the same as for the circuit from zero to the 45 degree position except that it is necessary for the arm to be in the 45 degree position before the 90 degree control circuit can be effective and that contacts 8 and 10 for the 90 degree position operate the same as contacts 4 and 6 when the signal arm moves from zero to the 45 degree position. One side of contact 12 is used for a snubbing circuit and is closed through the snubbing resistance when the arm is moving from the proceed or 45 to the zero degree position and then only between the 65 to 48 and the 20 to 3 degree position, thus checking the downward movement of the arm avoiding undue shock to the signal mechanism. The snubbing effect is due to the fact that when the signal arm is moving from the proceed or the 45 to the zero degree position the armature revolves in the opposite direction to that which it did when the signal



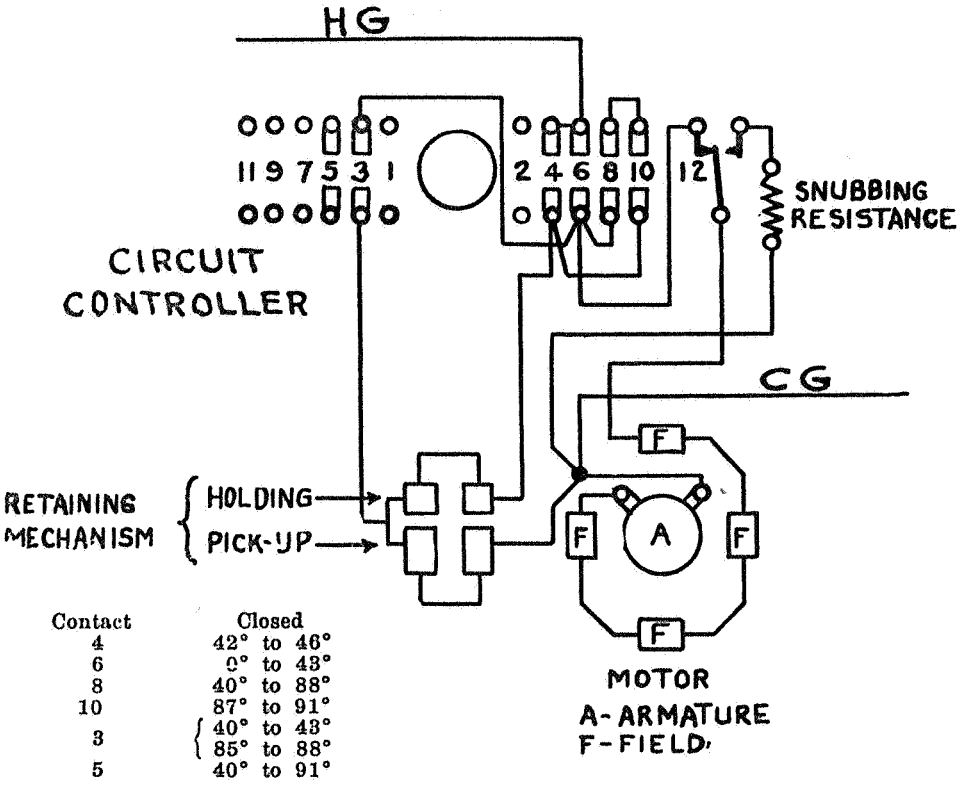
Contact	Closed
4	42° to 46°
6	0° to 43°
8	40° to 88°
10	87° to 91°
3	40° to 43° 85° to 88°
5	40° to 91°

Fig. 8a.
Three-Position Signal Mechanism Circuits.

was clearing the motor thus acting as a generator, and when contact 12 closes a short circuit is effected creating the snubbing action.

Two-position signal mechanism circuits.

Figure 8b shows typical signal mechanism wiring for the two-position motor-operated signals. The operation is the same as described for Fig. 8a except that no 90 degree control circuit is used and that the control relays are eliminated.



Contact	Closed
4	42° to 46°
6	0° to 43°
8	40° to 88°
10	87° to 91°
3	40° to 43°
	85° to 88°
5	40° to 91°

Fig. 8b.
Two-Position Signal Mechanism Circuits.

Signal lighting circuits.

Figure 9 shows the signal lighting circuits. The operation is as follows: 110-volt alternating current through knife switch and fuses, to primary of transformer, from secondary of transformer to coils of alternating current relay to energize the relay, through front contacts of relay, through snap switch to signal lights. An emergency supply of direct current is provided from a battery, through two back contacts of the alternating current relay to light the signals in case of alternating current power failure which would de-energize the alternating current relay opening the front contacts and closing the back contacts.

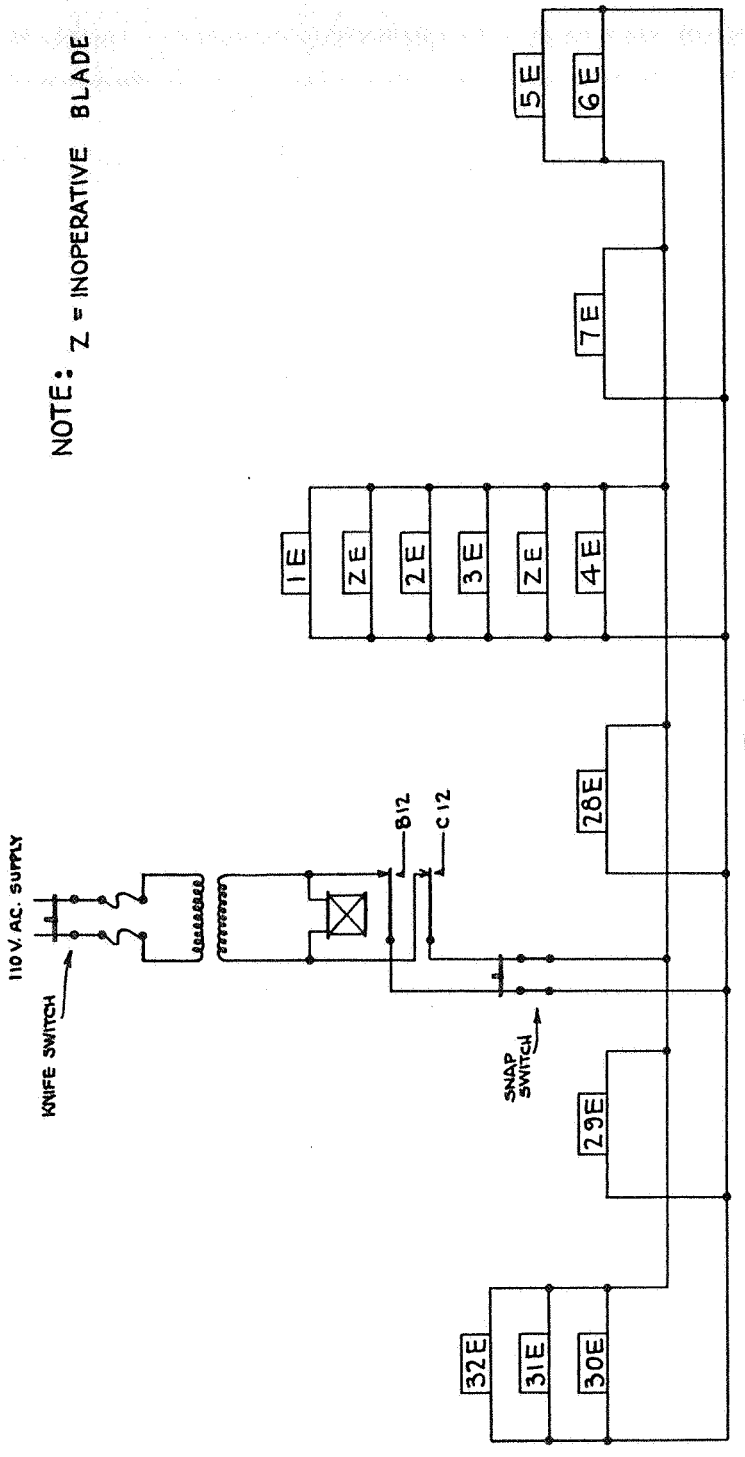


Fig. 9.
Signal Lighting Circuits.

Signal indication lock and stick relay circuits.

Figure 10 shows the indication lock and stick relay circuits for the high signals. The indication lock circuit is used to check the position of the signals to insure that they have returned to their normal position after a train movement has been made, or route is to be changed. If the signals have not functioned properly the electric lock provided on the signal lever

prevents the lever from being restored to the normal position preventing the release of the mechanical locking. Approach locking is provided to prevent the changing of a route after the signal has been cleared for a train movement and the approaching train has reached the approach or AR circuit until the elapse of a definite period of time (by the use of a time release) after the signal has been restored to its normal position. Approach and indication lock circuits for signals 31 and 32 are as follows: positive battery B through a front contact of relay 68.1NHGP, which is the repeating relay for signals 68.1 and 68.1A to insure that these signals are in their

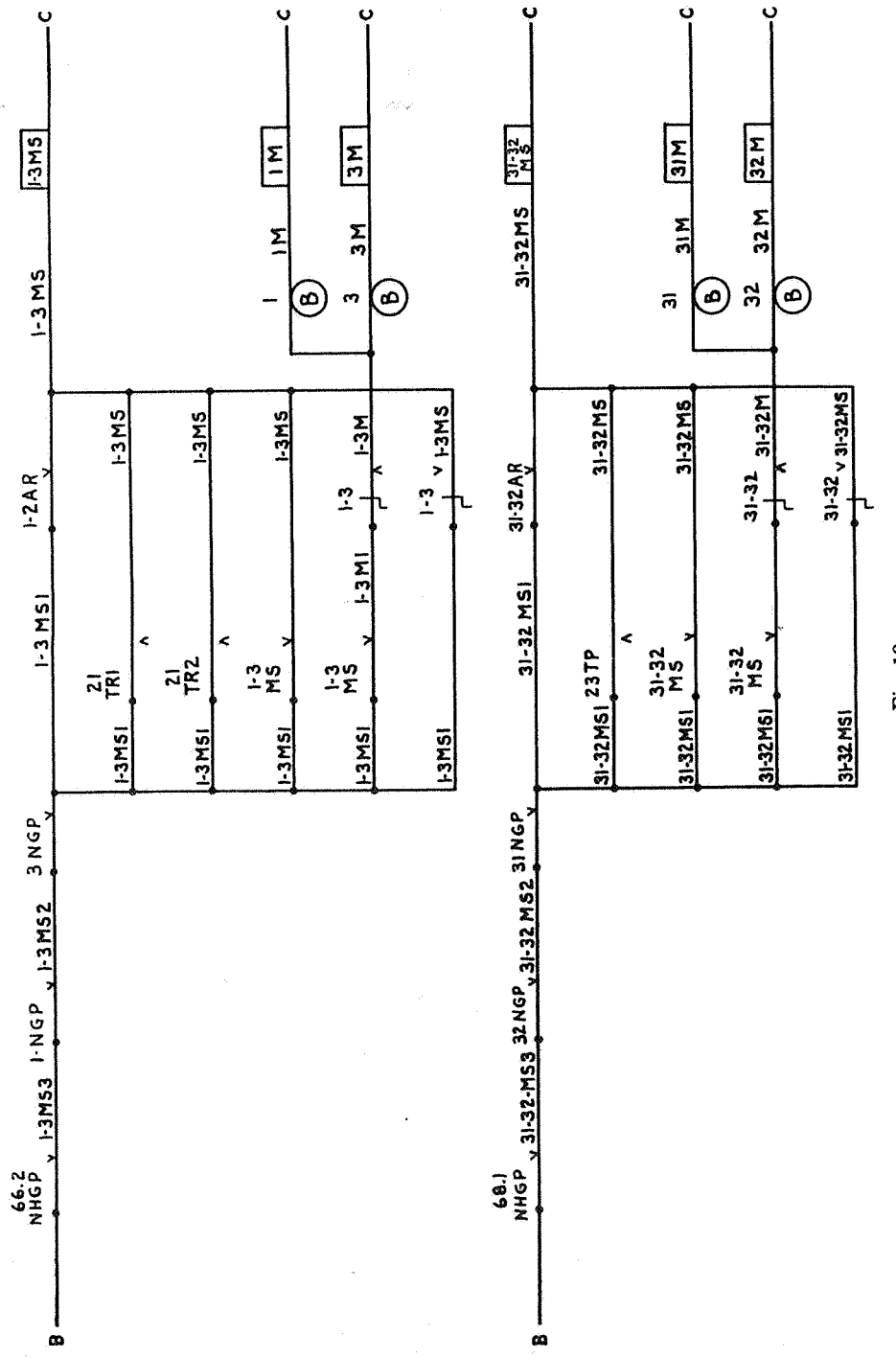


Fig. 10.
Signal Indication Lock and Stick Relay Circuits.

proper positions, through front contacts of relays 32NGP and 31NGP, repeating relays for signals 32 and 31 to insure that these signals have returned to the stop position, through a front contact of relay 31-32AR, the approach relay for the track governed by these signals, through the coils of relay 31-32MS, to negative battery C. A tap is taken from the circuit just described after going through front contact of relay 31NGP, through a back contact of relay 23TP to the coils of relay 31-32MS, so that relay 31-32MS will energize and lever 31 or 32 may be restored to normal position when track circuit 23T is occupied by the train passing over the route. A second tap is taken through a front contact of relay 31-32MS to the coils of relay 31-32MS to provide the stick circuit feature for relay 31-32MS. Another tap is taken through a normally open contact of time release 31-32 to the coils of 31-32MS, to provide for the time locking of levers 31 and 32 so that if signal 31 or 32 has been cleared for a train and for some reason the signal is returned to the stop position after the approach relay has de-energized, it will be impossible to restore lever 31 or 32 to the normal position until such time as an operation of the time release is made. It will be noted that as soon as the normally open contact of time release 31-32 is closed, providing signals 68.1, 32 and 31 have returned to their normal position, relay 31-32MS will be energized. As soon as it is energized it will remain energized through its own front contact and as soon as time release 31-32 has returned to its normal position, positive battery passes through front contacts of relays 68.1NHGP, 32NGP and 31NGP, through a front contact of relay 31-32MS, through the normally closed contact of time release 31-32, to a circuit controller contact on lever 31 or 32 closed at the normal indication position, which is a battery saving contact, to the coils of locks on lever 31 or 32, to negative battery C, thus allowing levers 31 or 32 to be restored to their normal position when approach relay 31-32AR is de-energized.

It will be noted that if approach relay 31-32AR is not de-energized that the locks on levers 31 and 32 will be energized, without operating time

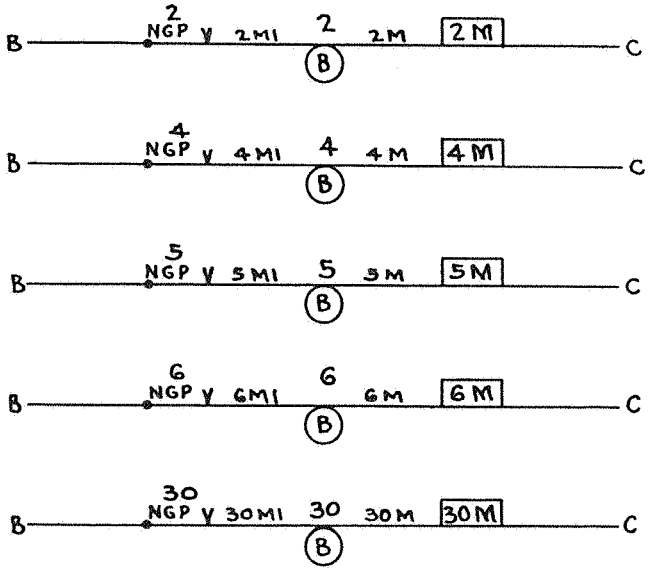


Fig. 11.
Signal Indication Lock Circuits on Slow-Speed Signals.

release 31-32, as soon as signal repeating relays 68.1NHGP, 31NGP and 32NGP are energized.

Signal indication lock circuits on slow-speed signals.

Figure 11 shows control circuits for electric locks on slow-speed signal levers. The control of the indication lock circuit on signal lever 2 is as follows: positive battery B through front contact on relay 2NGP signal repeating relay to insure that signal 2 is in the stop position, then through a circuit controller contact on signal lever 2 closed in the normal indication position of the lever which is used as a battery saving contact, through the coils of lock 2M, to negative battery C. It will be noted from this circuit that the signal must be displaying the Stop indication before the lever can be restored to its normal position.

Directional stick relay circuits.

Figure 12 shows the directional stick relay circuits. Where electric switch lever locking is in effect and in order to provide full protection for train movements over a route involving switches located in more than one track circuit, route or directional stick locking is provided. The circuit for relay 13-23NS is as follows: positive battery B through a normally closed contact of time release operated by signal lever 30, through circuit controller contacts on levers 31 and 32 closed in the normal position, to insure that when either one of the foregoing levers is reversed, relay 13-23NS will be de-energized, through a front contact of relay 21NS, cut around through a circuit controller contact on lever 19 closed in the normal position so that when switch 19 is reversed and relay 21NS is de-energized relay 13-23NS will also be de-energized, through front contacts on track repeating relays 23TP and 13TP to insure that when relay 13-23NS has been de-energized by levers 31 or 32 reversed or by relay 21NS de-energized with switch 19 reversed, it will remain de-energized as long as either relay 23TP or 13TP is de-energized, through the coils of relay 13-23NS, to negative battery C. A by-pass circuit, around contacts of relays 13TP and 23TP, is provided through a front contact of relay 13-23NS to hold relay 13-23NS energized when relays 13TP or 23TP may be de-energized by a train passing over them in the opposite direction. It will thus be noted that relay 13-23NS is de-energized only when contacts on either lever 30-31 or 32 or the front contact of relay 21NS with switch 19 reversed are opened and that after the relay is de-energized and track repeating relays 13TP and 23TP are de-energized relay 13-23NS will remain so until all contacts controlling relay 13-23NS are closed.

It will be noted that with a route set up for a train movement from track 1 to track 4 (Fig. 1) that the circuits controlling electric locks 10, 12, 15, 17, 20 and 22 will be opened when signal 29 is cleared, as follows: the opening of contact on time release operated by lever 29 de-energizes relay 21NS (Fig. 12); relay 21NS opens the circuit controlling locks 17, 20 and 22 (Fig. 5), also the circuit controlling lock 12 since switch 19 is reversed; and opens the circuit controlling relay 12-23NS (Fig. 12) since switch 19 is reversed. Relay 13-23NS opens the circuits controlling locks 10 and 15 (Fig. 5) since switch 14 is reversed. After lever 29 is restored to its normal position all locks remain de-energized as long as track circuit 21T is occupied since relays 21TR1 and 21TR2 hold relay 21NS de-energized.

After the train passes off track circuit 21T, lock 20 will be energized but locks 10, 12, 15, 17 and 22 will remain de-energized due to the train on track circuits 23T and 13T and relay 13-23NS still being de-energized. After the train passes off track circuits 23T and 13T, relay 13-23NS will be energized, allowing locks 17 and 22 to be energized; but locks 10, 12 and 15 will remain de-energized due to the train now on track circuit 11T. After train clears track circuit 11T, locks 10 and 12 will be energized. It will therefore be seen that with this circuit arrangement positive electric locking prevents the operation of any levers in the route in advance of a train movement and that this locking is released as the train clears portions of the route.

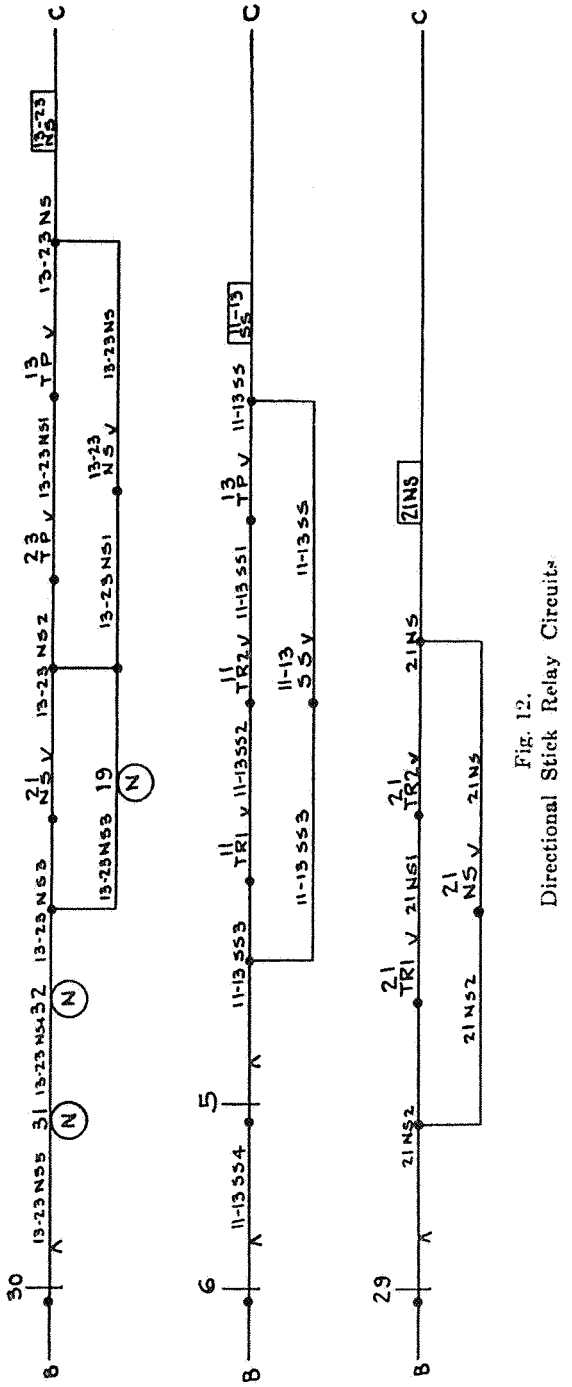


Fig. 12.
Directional Stick Relay Circuits

Track diagram light circuits.

Figure 13 shows track diagram light circuits. The circuits for illuminating track section 23T are as follows: positive battery B through a back contact on relay 23TR, through the lamp, to negative battery C. Thus it will be seen that lamps are only lighted when their controlling relays are de-energized. The lamps for signals 5, 6 and 7 are lighted when the lever is in the reverse position.

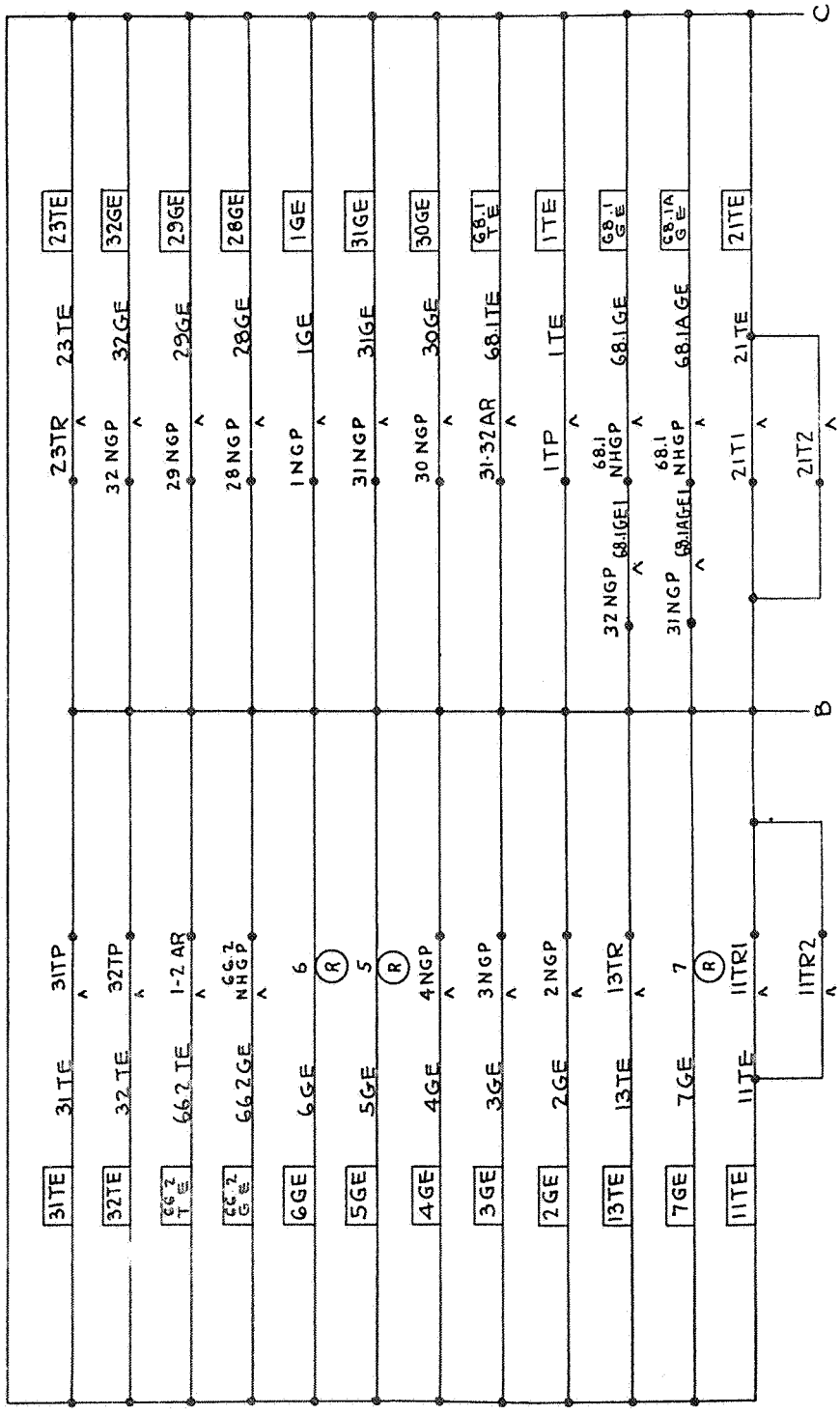


Fig. 13.
Track Diagram Light Circuits

Battery charging circuits.

Figure 14 shows circuits for charging main and track batteries by the floating system which is fully explained in Chapter IX—Rectifiers.

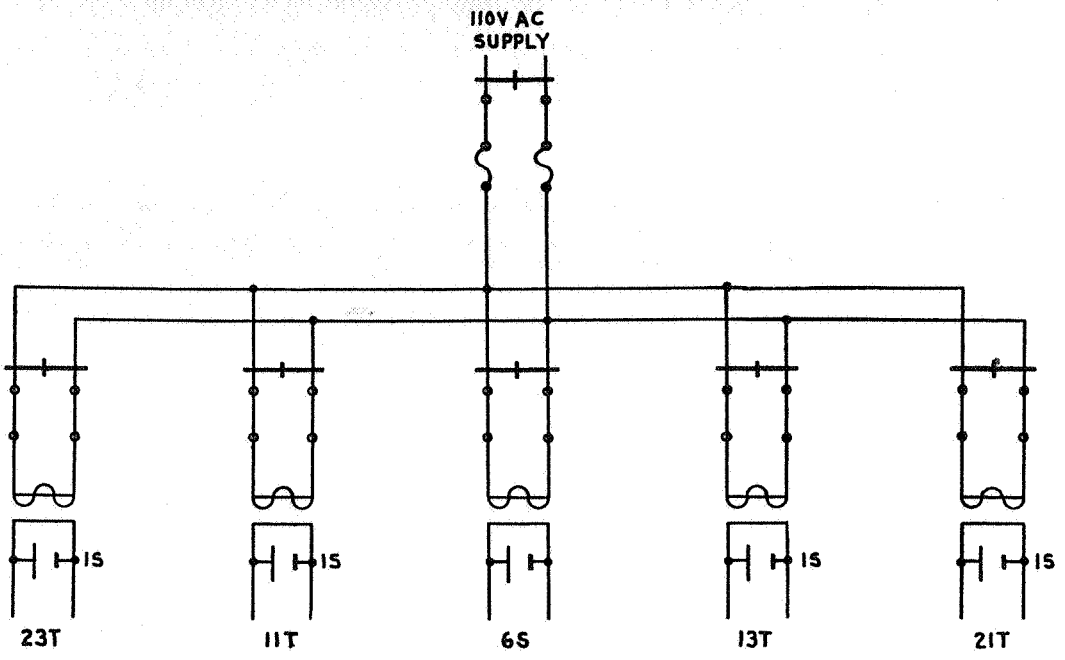


Fig. 14.
Battery Charging Circuits.

Electro-Mechanical Interlocking

Track and signal layout.

Figure 15 shows a track and signal layout of an interlocking operated by means of an electro-mechanical machine. The switches are operated mechanically; the high signals are the light type, and the dwarf signals are power-operated, semaphore type.

This interlocking is in electric traction territory, with alternating propulsion current of a frequency of 25 cycles; the signal apparatus is operated by alternating current of a frequency of 60 cycles. The operation of alternating current track circuits is explained in detail in Chapter XI—Alternating Current Track Circuits.

Track, track repeating relay and annunciator circuits.

Figure 16 shows track, track repeating relay and annunciator circuits. Considering the control of two-element track relay 9TR, it is seen that track wires 9RB and 9RN connect the track to the track coils of relay 9TR while 110 volts alternating current is connected to the local coils 9TQ of the relay to supply the local flux for the relay operation.

Relays A8TP, 8TP, A24TP and 24TP are repeating relays. These relays are single element and are controlled by alternating current at 110 volts. The circuit for A8TP is as follows: BX110 through a front contact of A8TR, through the coils of relay A8TP, through front contact of A8TR, to CX110. The return circuit passes through a front contact of A8TR to provide added protection against crosses or grounds.

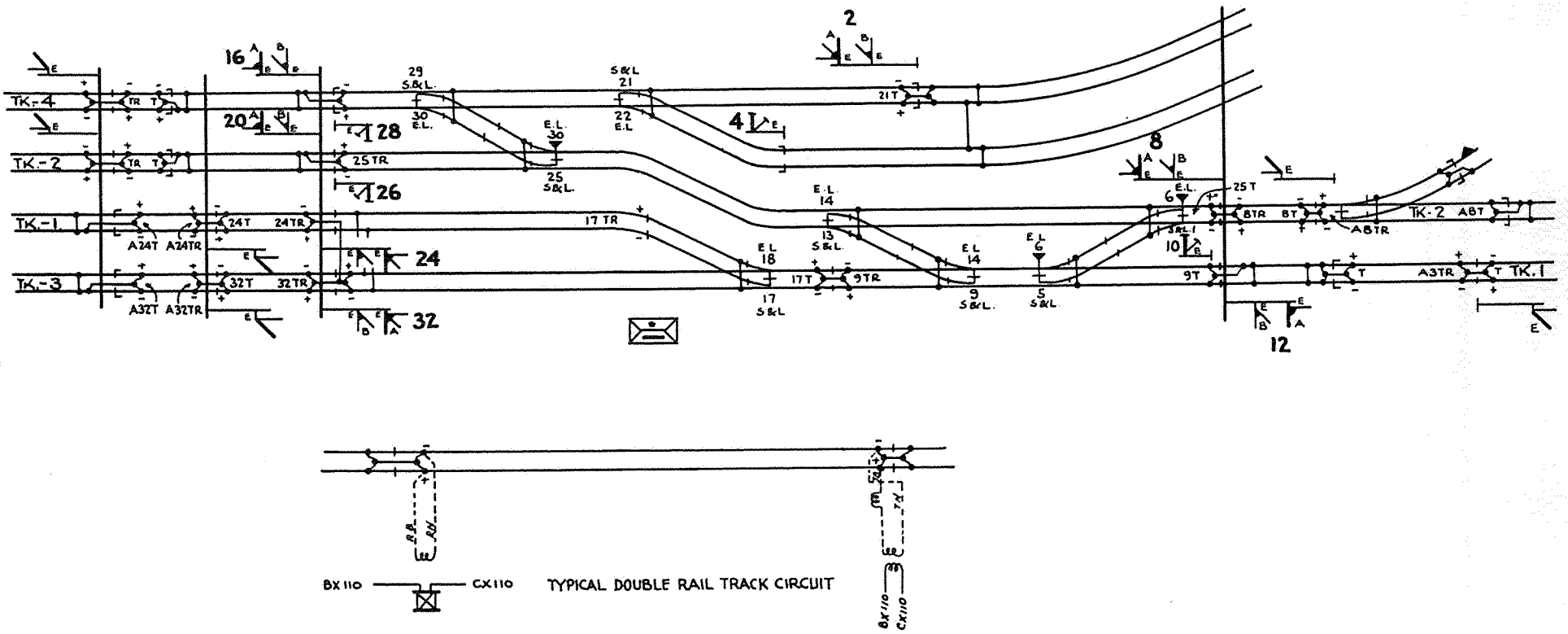


Fig. 15.
Track and Signal Layout.

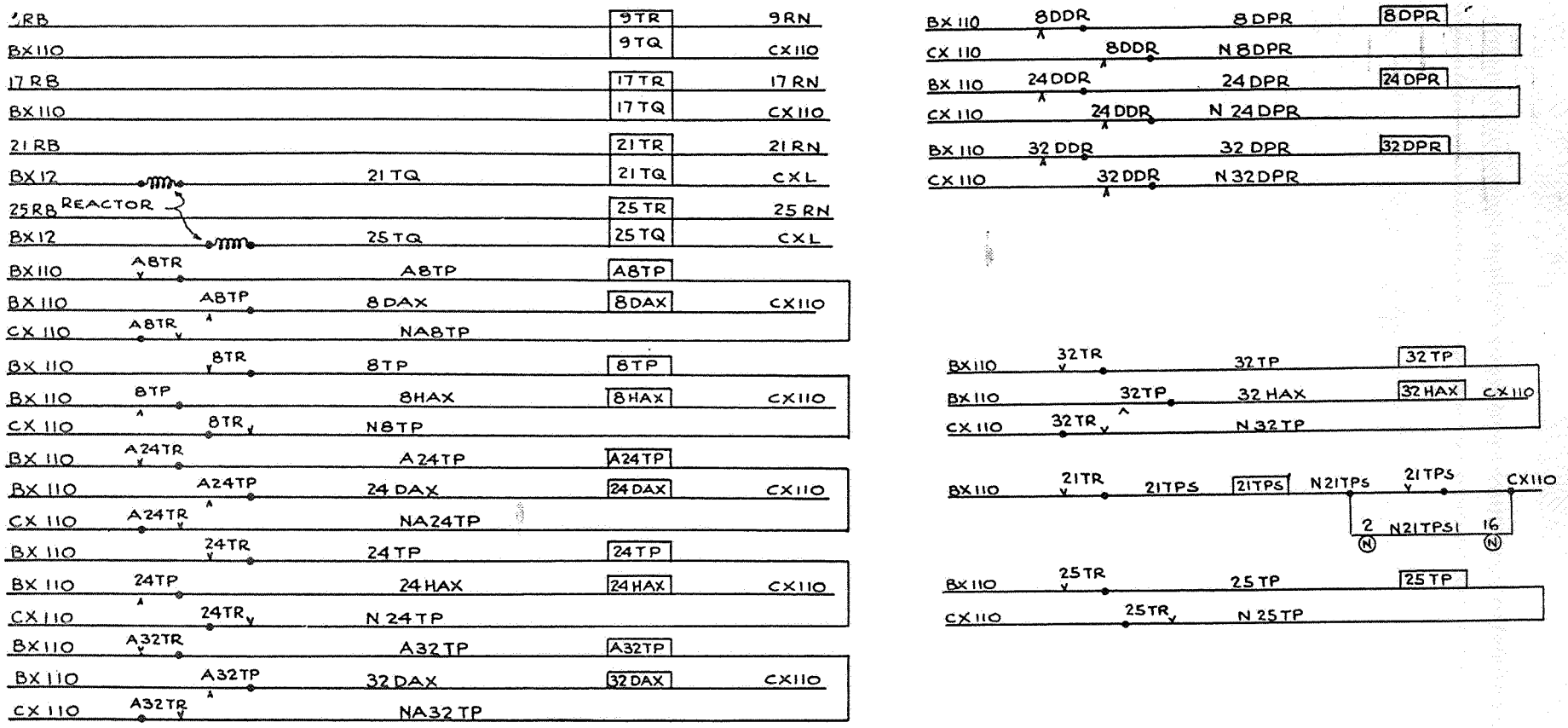


Fig. 16.
Track, Track Repeating Relay and Annunciator Circuits.

The control of annunciator 8HAX is as follows: BX110 through a back contact of relay 8TP, through coils of 8HAX, to CX110. This indicates the occupancy of track circuit between signal 8 and the approach signal. The control of annunciator 8DAX is from BX110, through a back contact of relay A8TP, through coils of 8DAX, to CX110. Relay A8TP is controlled through front contacts of A8TR which is the track circuit approaching the approach signal, to signal 8. Thus it will be noted that announcement is provided for the territory between the home signal and the track circuit approaching the distant signal.

Switch repeating relay circuits.

Figure 17 shows the WP or switch repeating relay circuits. In this case the WP relays are two-element three-position relays. The control of relay 30WP for crossover 25-29 is as follows: 30Q represents the local element of this relay and is energized by connecting one side of the coils to BX110 and the other side to CX110. The control of the line element of this relay in the normal position is from BX110, through a contact of the switch circuit controller on switch 29 closed when the switch is in the normal position, through a contact of the circuit controller on switch-and-lock movement 29, closed when the movement is locked in the normal position, through a contact of switch circuit controller on switch 25, closed when the switch is in the normal position, and through a contact of circuit controller on switch-and-lock movement 25, closed when the movement is locked in the normal position, through coils of relay, then through contacts on switch levers 29 and 25 closed from the normal to the normal indication position to insure that the levers correspond to the position of the switches, to CX110. The control of the line element for the reverse position is from BX110, through contacts on switch levers 25 and 29 closed from the reverse to the reverse indication position, through coils of relay 30WP thence through contact of the circuit controller on switch-and-lock movement 25 closed when the movement is locked in the reverse position, through a contact on switch circuit controller on switch 25, closed when the switch is in the reverse position through a contact on circuit controller on switch-and-lock movement 29 closed when the movement is locked in the reverse position, through contact of switch circuit controller on switch 29 closed when the switch is in the reverse position, to CX110. It will be noted that flow of current through the line side of relay 30WP for the reverse position of the switches is opposite in direction to that in which the current flowed for the normal position of the switches and causes the relay to assume its reverse position.

Switch indication circuits.

Figure 18 shows the switch indication circuits for the electric levers. The normal switch indication circuit for electric lever 30 is BX110 through a contact of relay 30WP closed in the normal position, through contacts on switch levers 25 and 29 closed in normal position, through contact on lever 30 closed in the normal indication position, through the coils of indication lock on lever 30, through latch contact on lever 30, to CX110. The reverse switch indication circuit for lever 30 is from BX110 through a reverse contact on relay 30WP, through contacts on levers 25 and 29 closed in the

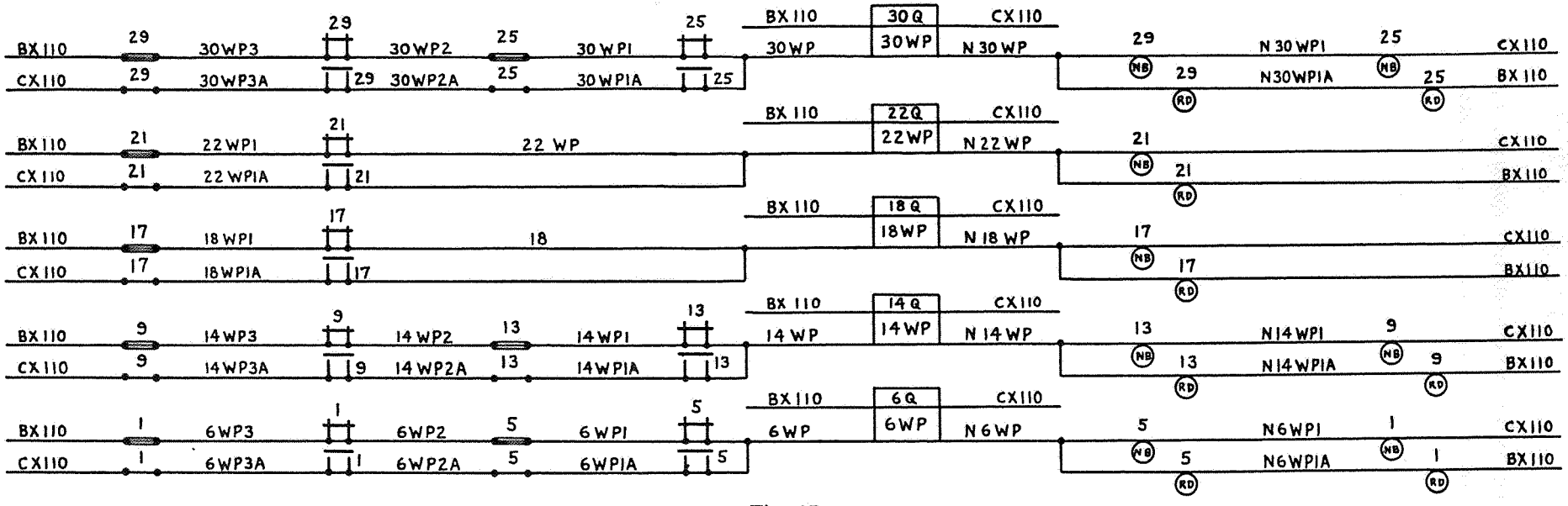


Fig. 17.
Switch Repeating Relay Circuits.

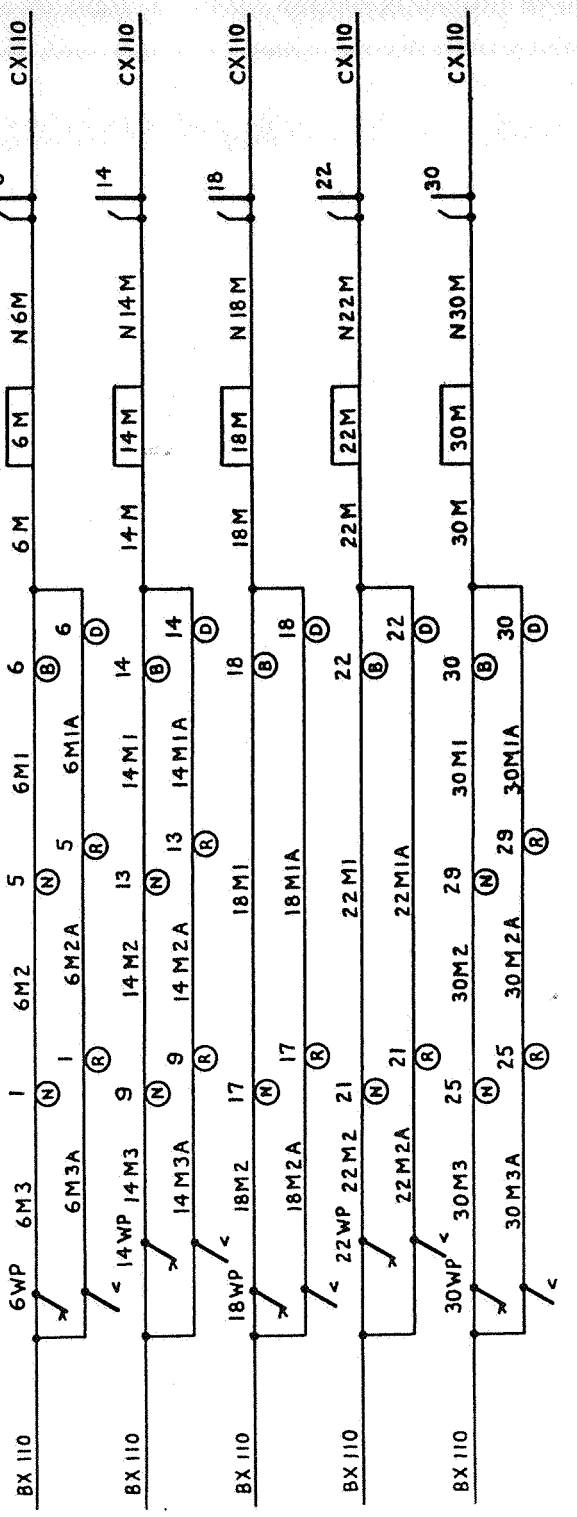


Fig. 18.
Switch Indication Circuits.

reverse position, through a contact on lever 30 closed in the reverse indication position, through the coils of indication lock on lever 30, thence through latch contact, to CX110. The purpose of the switch indication circuits is to insure that the switch has responded to the movement of its lever and that it is in the desired position and locked before the final movement of the lever can be made.

Electric switch lock circuits.

Figure 19 shows the electric switch lock circuits for the electric locks applied to the switch-and-lock movements installed on the switches. The purpose of these locks is described in Chapter XVII—Mechanical and Electro-Mechanical Interlocking. The circuit for the control of 30WL is BX110 through contact on lever 30 closed between the normal and reverse indication positions, to insure that the coils of the lock are de-energized when the lever is in normal or reverse position, through the coils of the electric switch lock, to CX110.

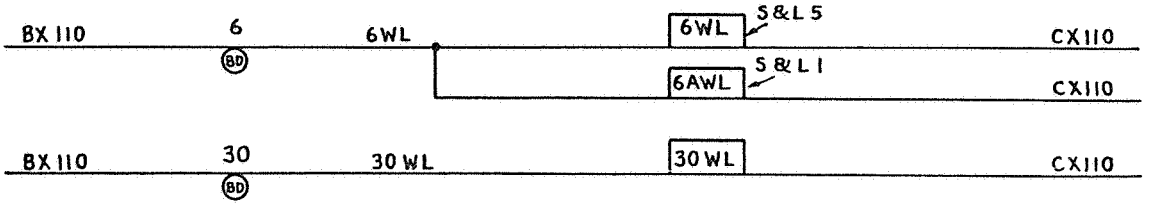


Fig. 19.
Electric Switch Lock Circuits.

Home or 45 degree signal circuits.

Figure 20 shows the home or 45 degree signal circuits. The circuit for the control of signal 8 for a movement from track 2 to track 4 is as follows: BX110 through contact on lever 28 closed in normal position, to insure that the lever controlling opposing movement is in the normal position, through contact on lever 30 closed in reverse position, through a contact of relay 30WP closed in reverse position, through contacts of relays 14WP and 6WP closed in normal position, through contacts on levers 14 and 6 closed in normal position, these to insure that the switches and levers are in proper position for desired route, through contact on lever 8 closed in reverse position to insure that the signal lever is fully reversed, through front contact of relay 8HS to insure that the signal stick relay is energized, through contact on lever 1 closed in normal position, through contact on lever 25 closed in reverse position to insure that these switch levers are in proper position for the particular movement desired, through back contact of relay 8AHR, to insure that relay for top arm is in the de-energized position, through coils of relay 8BHR, through contact on lever 8 closed in the reverse position to provide additional protection against crosses and grounds, to CX110.

Signal stick relay circuits.

Figure 21 shows signal stick relay circuits. The control of relay 8HS is as follows: BX110 through front contact of relay 21TPS, cut around by a contact on lever 6 closed in reverse position, or a contact on lever 30 closed in normal position, which insures that relay 8HS is de-energized when lever 6 is normal, lever 30 is reversed, and relay 21TPS is de-energized; through front contact of relays 9TR and 17TR, cut around by contact on lever 6 closed in normal position, which insures that relay 8HS is de-energized when lever 6 is reversed, and either relay 9TR or 17TR is de-energized, through front contact of relay 25TR, through coils of relay 8HS, through front contact of relay 8HS, to CX110. The control circuit of relay 8HS

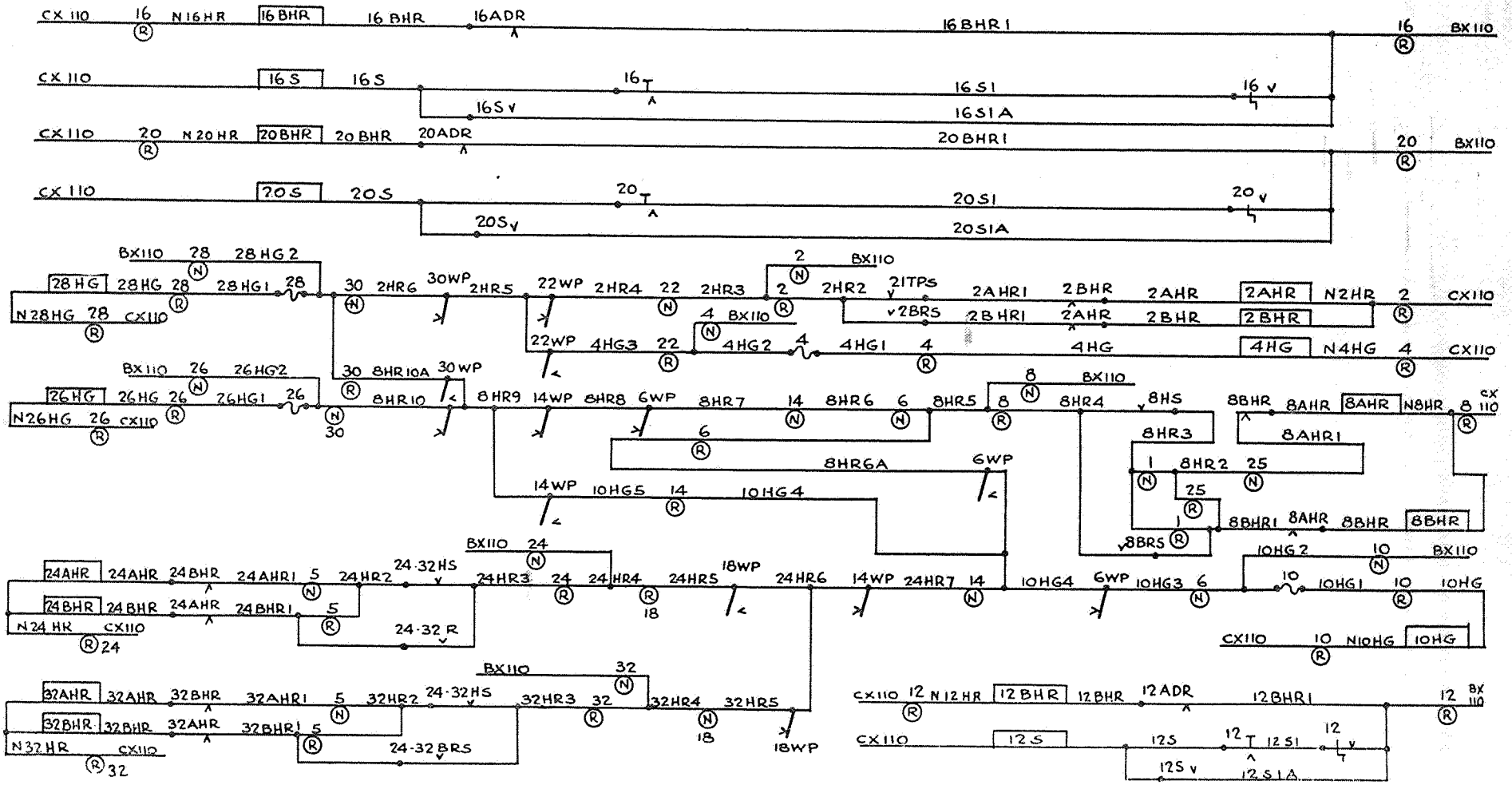


Fig. 20.
Home or 45 Degree Signal Circuits.

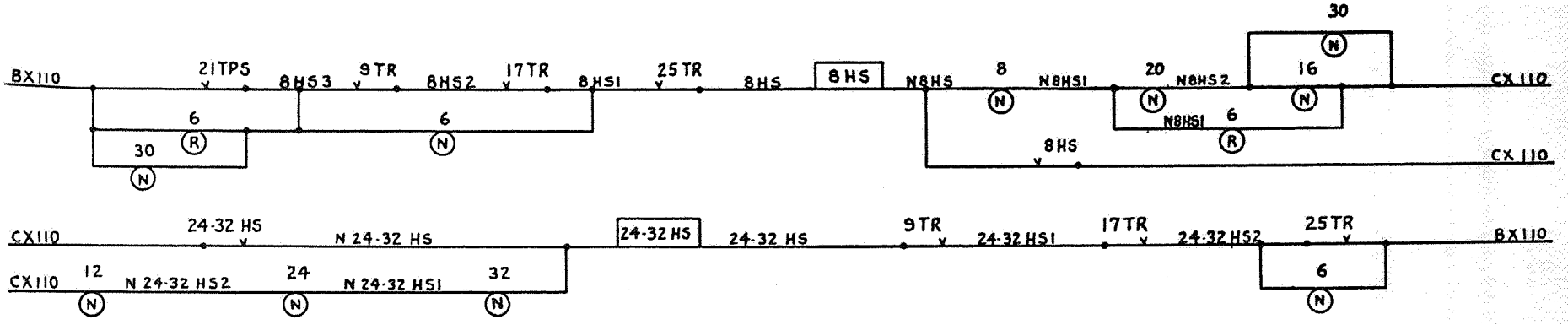


Fig. 21.
Signal Stick Relay Circuits.

passes through its own front contact to provide the stick feature. The purpose of the stick circuit is to insure that as a train passes the signal it will return to the stop position automatically and cannot again be cleared until the controlling relays have been energized and the levers controlling the signals governed by the stick relay are restored to the normal position. The restoring or pick-up circuit for relay 8HS after going through the coils of that relay goes through contacts on levers 8, 20 and 16 closed in the normal position, to CX110, but the circuit is cut around levers 20 and 16 when

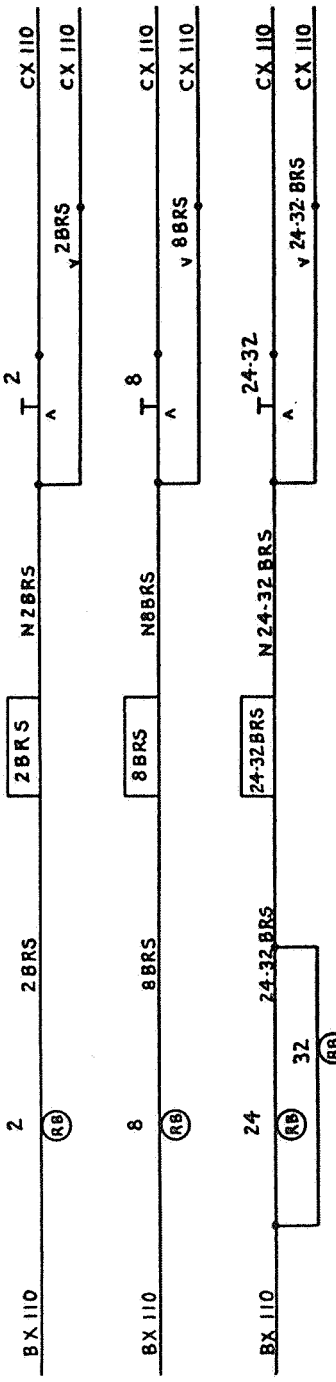


Fig. 22.
"Call-On" Relay Circuits.

lever 6 is reversed and is cut around lever 16 when lever 30 is normal. The circuit is carried through levers 16 and 20 normal, which levers control manual block signals, to insure that a proceed signal cannot be displayed by lever 8 without restoring lever 16 or 20 to its normal position. The signals are non-automatic and must be restored manually.

"Call-on" relay circuits.

Figure 22 shows "call-on" relay circuits. The control of "call-on" relay 8BRS for signal 8B is as follows: BX110 through contact on lever 8 closed from the normal indication to the reverse position to provide for proper advance switch locking protection, through coils of relay 8BRS, through normally open contact on push button, to CX110. When relay 8BRS has been energized by closing contact on push button, it remains energized by means of a circuit, through its own front contact, to CX110.

Referring to the home or 45 degree signal control circuit for signal 8, Fig. 20, it will be found that "call-on" relay 8BRS cuts around stick relay 8HS. This is done so that if desired, trains may follow into an occupied block in accordance with the rules which govern such operations. In addition, advantage is taken in case of track circuit or normal signal control failures, to permit trains to pass the signal.

90 degree signal circuits.

Figure 23 illustrates the 90 degree signal circuits. The 90 degree control circuit for signal 8A is as follows: BX110 through front contact of relay 20ADR to insure that signal 20A is in the proceed position, through front contact of relay 8AHR to insure that signal 8A is in the approach position, through the coils of relay 8DR, through front contacts on relays 8AHR and 20ADR to provide additional protection against crosses and grounds, to CX110. The necessity for signal 20A being in the proceed position is due to this signal being a manual block signal and a proceed indication on signal 8A is given only when the block signal indicates Proceed. The 90 degree control of signal 20A is as follows: BX110 through contact on lever 20 closed in the reverse position, through a normally closed contact on time release 20, through front contact of relay 20S, through coils of relay 20ADR, through contact on lever 20 closed in the reverse position, to CX110. It will be noted that before signal 20A can be displayed in the 90 degree position, it is necessary for relay 20S to be energized. Referring to Fig. 20, the control of relay 20S is as follows: BX110 through contact on lever 20 closed in the reverse position, through normally open contact on time release 20 and push button 20, through coils of relay 20S, to CX110. After relay 20S is energized, it will remain energized by means of a circuit through its own front contact and a contact on lever 20 closed in the reverse position, to BX110. It will be seen that in order to display a proceed block signal it is necessary for the operator not only to reverse the signal lever but also to operate a time release and push button simultaneously, which insures that the operator is alert before the signal is displayed. At points where non-interlocked switches are located in a track circuit controlling a signal, switch circuit controllers are connected to the switch points so that a movement of the switch from the normal position will cause the signal to assume its most restrictive indication. This is accomplished by breaking the control circuit for the signal through contacts in

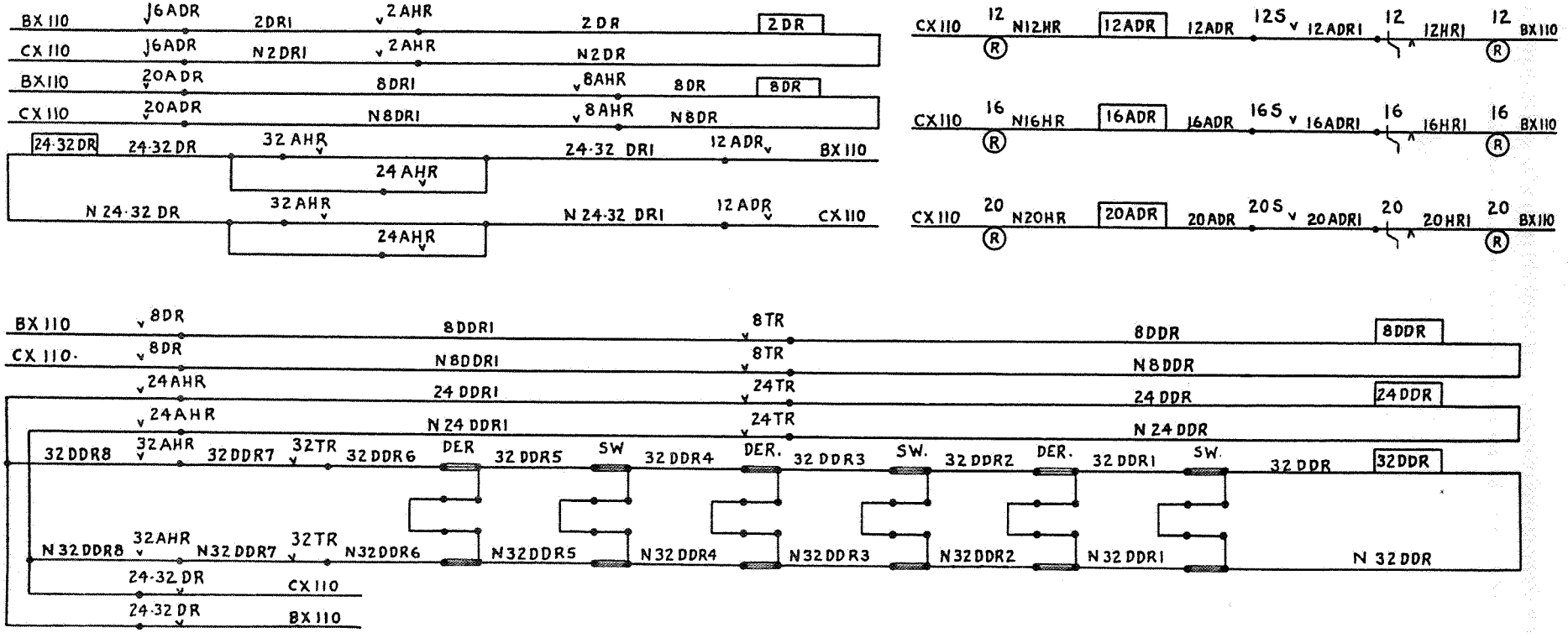


Fig. 23.
90 Degree Signal Circuits.

the switch circuit controller. Both sides of the circuit pass through contacts in the switch circuit controller to insure against crosses and grounds. In addition to this the relay coils are shunted through contacts in the switch circuit controller closed with the switch in reverse position, as shown in circuit for 32DDR, Fig. 23.

Signal lighting circuits.

Figure 24 shows typical signal lighting circuits for color light signals. The circuit for the top arm of a signal is as follows: BX110 through back contact of relay AHR to insure that the home control relay is in the de-energized position, to primary of transformer located in case of signal unit, to CX110. The 12-volt secondary of transformer is connected to the red light. BX110 through front contact of relay AHR to insure that the home control relay is energized, through back contact of relay DR to insure that distant signal control relay is de-energized, to primary of transformer controlling yellow light, to CX110, which displays the Approach indication. BX110 through front contacts of relays AHR and DR to insure that the home and distant signal control relays are energized, to primary of transformer controlling green light, to CX110, which displays the Proceed indication.

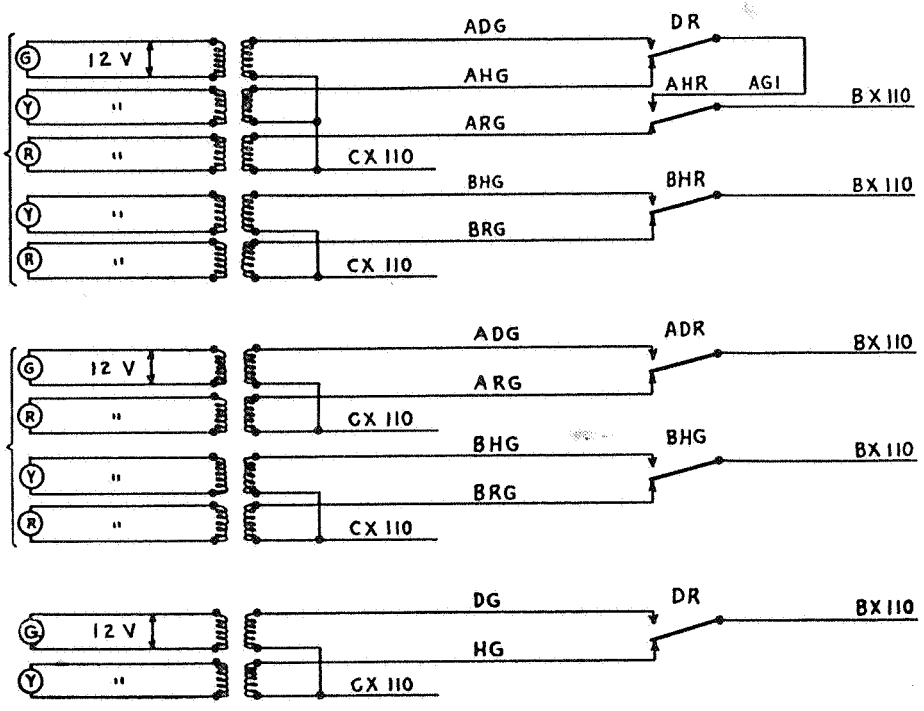


Fig. 24.
Typical Signal Lighting Circuits.

Dwarf signal lighting circuit.

Figure 25 illustrates the typical arrangement of circuits for lighting dwarf signals.

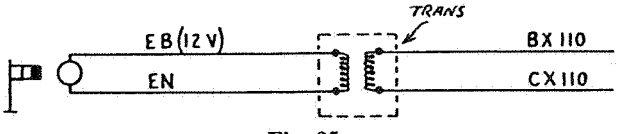


Fig. 25.
Typical Dwarf Signal Lighting Circuit.

Signal indication lock circuits.

Figures 26 and 27 illustrate the electric signal indication lock circuits. The circuit for lock 8 is as follows: BX110 through front contact of relay 8DPR to insure that the distant signal is in the approach position, through back contacts of relays 8DR, 8AHR, 8BHR to insure that the control relays of signal 8 are de-energized, through contact on lever 8 closed in the normal indication position so that the indication magnet will only be energized with the lever at the indication position, through front contacts of relays 8TP and A8TP which provide for the approach locking, through coils of indication magnet 8M, through latch contact on lever 8 which is a battery energy saving device, through back contacts of relays 8BHR, 8AHR, 8DR and front contact of relay 8DPR to provide additional protection against crosses and grounds, to CX110.

This portion of the circuit permits the restoring of signal lever 8 to the normal position after the signal has been cleared but no movement has been made through the interlocking and when the track circuits approaching the home and distant signals are unoccupied. Relays 8TP and A8TP provide approach locking for signal lever 8, therefore, if either track circuit 8TR or A8TR is occupied, the signal lever cannot be restored without the operation of the time release which is explained later. The circuit through relays 8TP and A8TP is cut around by means of a circuit through back contacts of relays 8HS and 8BRS; this provides for the restoration of signal 8 to the normal position, after train has passed signal 8, track circuit 8TR is occupied, and the "call-on" relay is de-energized. An additional cut around circuit is provided to restore signal lever 8 to the normal position in case track circuit 8TR or A8TR is occupied but no movement made past signal 8 which had been cleared for a train movement and the signal restored to the stop position. This circuit goes through a normally closed contact on time release 8 and a front contact on relay 8LS. This relay is used in connection with circuits having a time release designed without latch provided to keep the slow release in a wound position. With the type of release specified in this case the release is normally run down. In using the release, it is wound up closing a normally open contact which energizes relay 8LS which remains energized due to completing circuit through its own front contact. The release is then allowed to run down, being adjusted to consume the required time, until the normally closed contact is closed at which time lock on lever 8 is energized, allowing the lever to be restored to normal position. This circuit is provided to prevent the changing of a route after a proceed distant signal has been accepted until a predetermined time has lapsed. The time setting of the releases is determined on the basis of 30 seconds for each 1000 feet between the distant and home signals, a time interval of not less than 10 seconds being used for slow-speed signals.

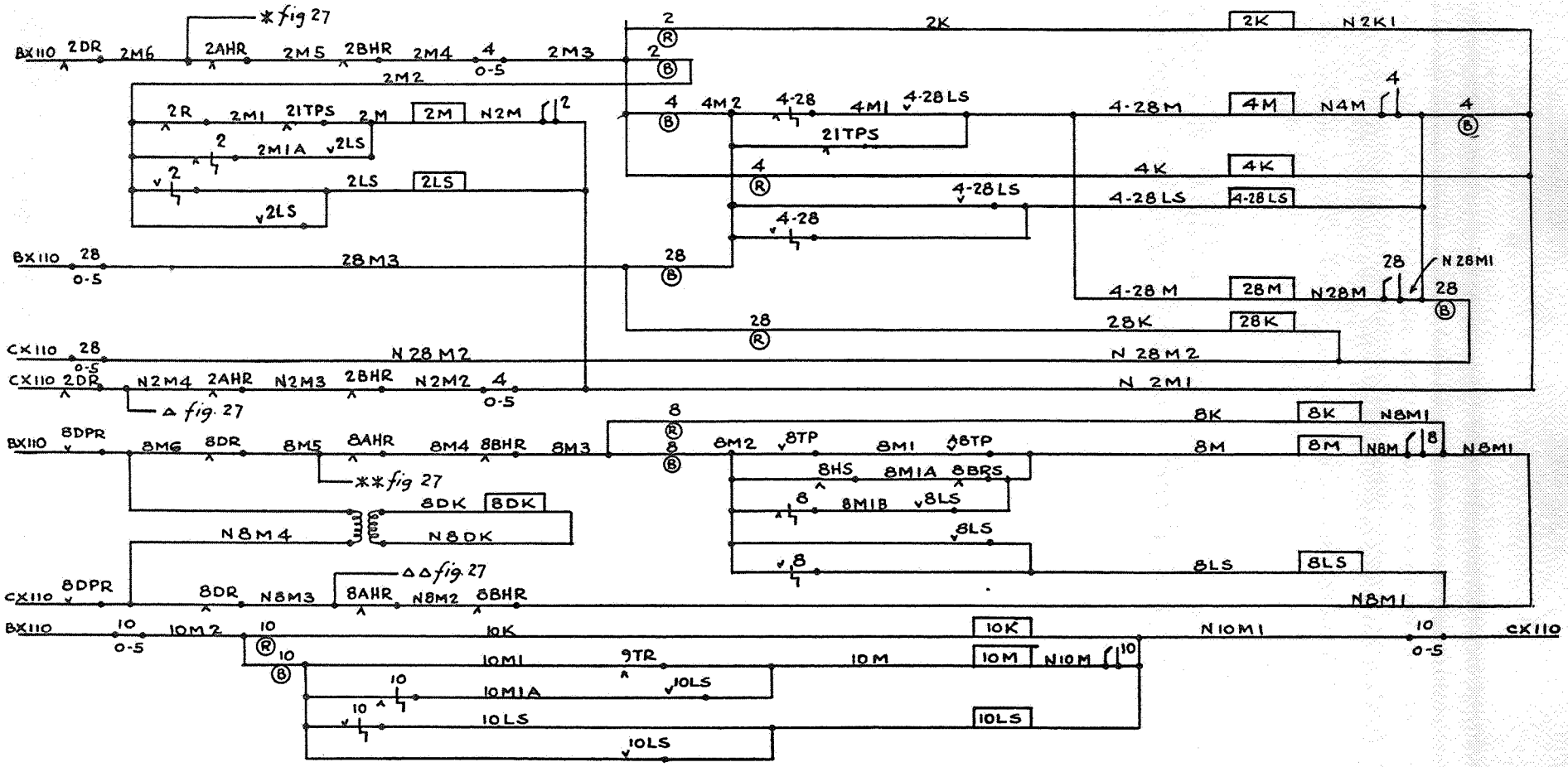


Fig. 26.
Signal Indication Lock Circuits.

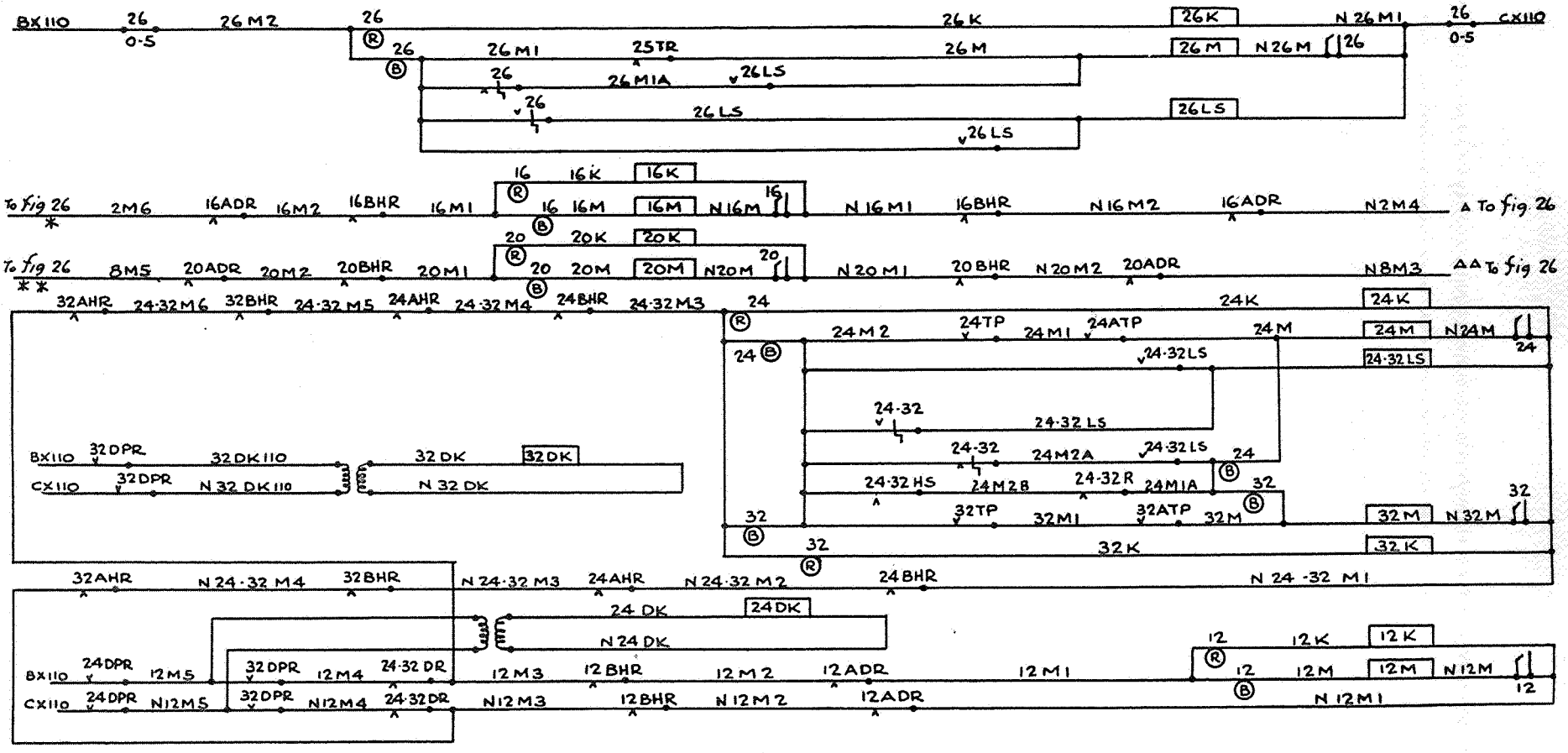


Fig. 27.
Signal Indication Lock Circuits.

In a number of instances where light signals are in service an indicating light of a flash type is provided to inform the operator that the signal is displaying a Proceed indication. Referring to signal lock circuit for lever 8 it will be noted that a circuit is tapped off between relay 8BHR and contact on lever 8, through a contact on lever 8 closed in the reverse position, to the control terminals of an indicator or light, 8K. From the opposite control terminal the circuit returns to the signal lock circuit at the lever latch contact. If the signal operates when the lever is manipulated, a flash of the light will be displayed. If the signal does not operate the light will continue to burn, indicating to the operator that something is wrong with the signal or controlling apparatus. An additional indicating light is furnished to inform the operator that the relay controlling the distant signal has returned to the de-energized position. This circuit is shown in multiple at relay 8DPR which controls the primary of a transformer. The secondary of this transformer supplies current to a 10-volt lamp mounted on the track model board, from which point of vantage the operator can note the indication.

Electric switch lever locking circuits.

Electric switch lever locking circuits as covered in this portion of the chapter are subdivided into what is known as electric route locking and electric section locking, the control circuits for which are illustrated in Figs. 28 and 29. Electric route locking provides a means of protection by which an operator is prevented from changing a route for a train for which a signal has been displayed and accepted. Referring to Fig. 28, the electric route locking circuit for electric lever 14 which is the lever locking switches 9 and 13 for a movement past signal 28 in a westwardly direction, is as follows: BX110 through front contact of relay 21TR, which insures that with the route set up relay 14WS will be de-energized when levers 28 and 29 are reversed and track relay 21TR is de-energized, through the coils of relay 14WS, to CX110. A stick circuit is provided on this relay through its own front contact by taking BX110 through contacts on lever 28 or 29 closed in the normal position.

In electric section locking, illustrated in Fig. 29, it will be noted that the electric lever controlling a switch is locked not only while a movement is being made over the track circuit in which the switch is located, but is locked in advance as soon as a train passes the signal displayed for that route. Electric route locking provides advance locking for the switch whereas electric section locking provides locking for both the track circuits in advance and the track circuit in which the movement is being made. (The various types of electric locking are defined in Chapter XIV—Definitions.) The control circuit for locks 6 and 14 is as follows: BX110 through front contacts of relays 25TR and 9TR which insures that the levers will be locked when these track relays are de-energized, through front contacts of relays 6WS and 14WS which insures that the levers will be locked when the train passes the signal displayed for the respective route, through coils of lock, through latch contact which is a battery energy saving device, to CX110. In multiple with this lock circuit is an indication lever light circuit which lights a light under the electric lever when the track circuits involved are unoccupied or the electric route locking relays are energized. This light

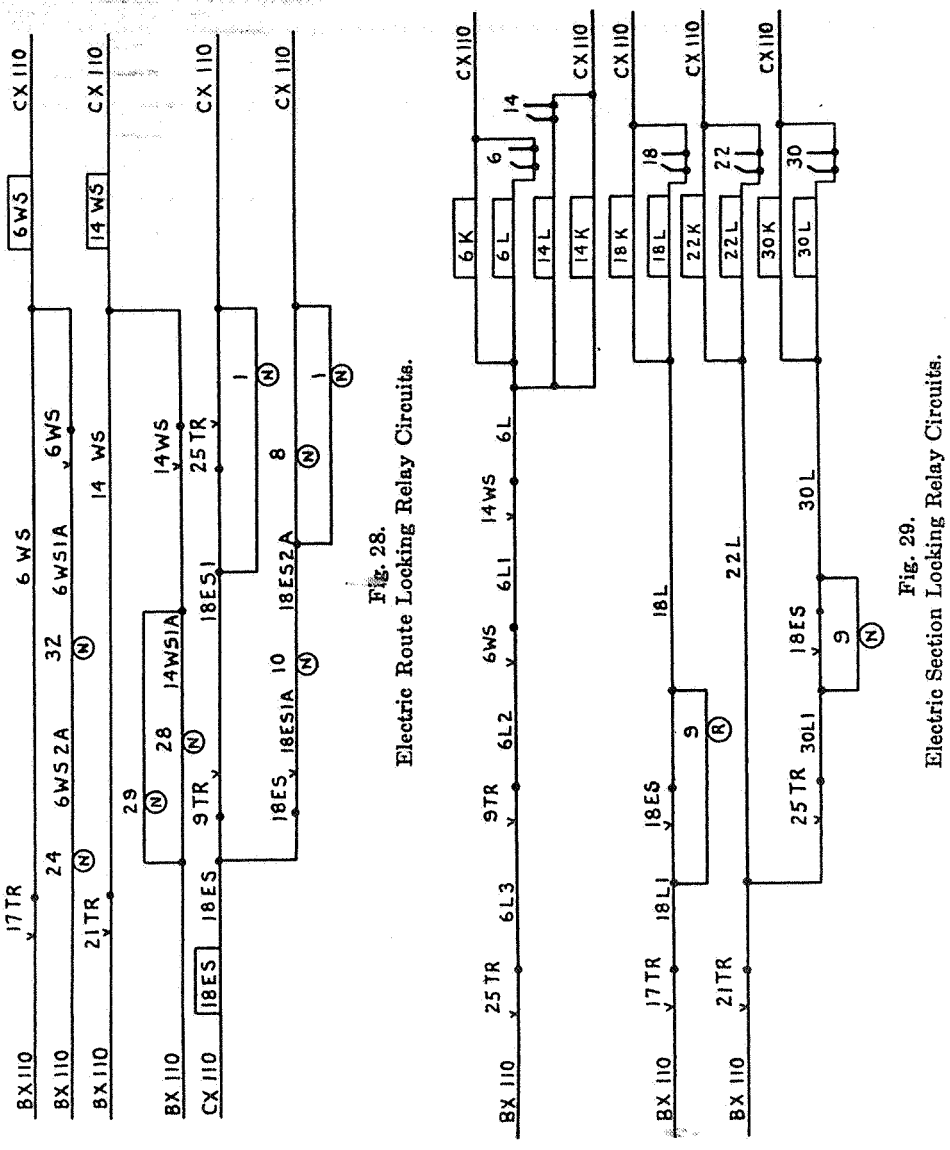


Fig. 28.
Electric Route Locking Relay Circuits.

Fig. 29.
Electric Section Locking Relay Circuits.

circuit taps off the lock circuit after going through relay 14WS, to the light, to CX110.

Track model transformer circuit.

Figure 30 shows the circuit for the transformer furnishing power for the track model. BX110 through a fuse to the primary side of the track model transformer, through the coils of the transformer, through a fuse, to CX110. From the secondary side of the transformer BXL and CXL are taken to the lights on the board at a low voltage.

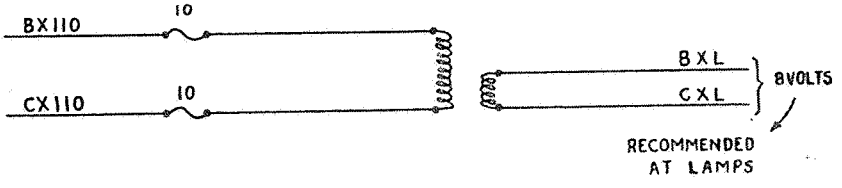


Fig. 30.
Track Model Transformer Circuit.

Track model light circuits.

Figure 31 shows the track model lights for the various track and track repeating relays. The control circuit for 9TK is as follows: BXL through a back contact of relay 9TR; the light is normally out as 9TR is normally energized. When 9TR is de-energized the current will pass through the back contact to the lamp, to CXL.

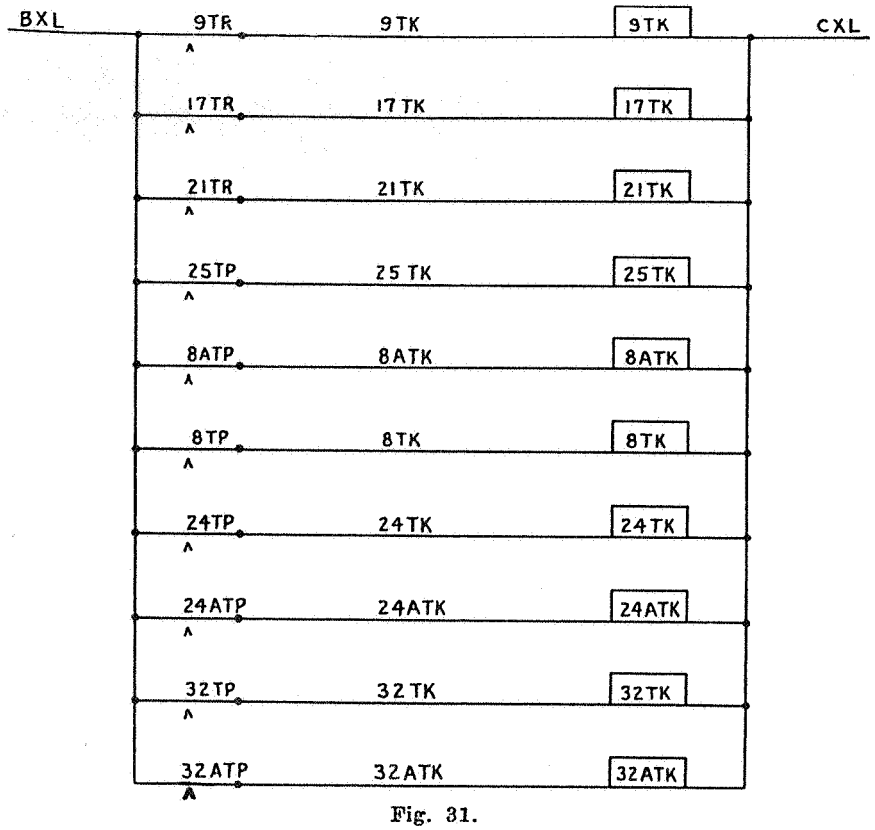


Fig. 31.
Track Model Light Circuits.

Signal lever light circuits.

Figure 32 shows the circuits for the signal lever lights. In this case the lamps are 110-volt. The control circuit for 2K is as follows: BX110 through a front contact of relay 21TPS so that an indication will be received when relay 21TPS is de-energized as relay 21TPS must be energized to display other than the "call-on" signal, to the lamp on lever 2, to CX110.

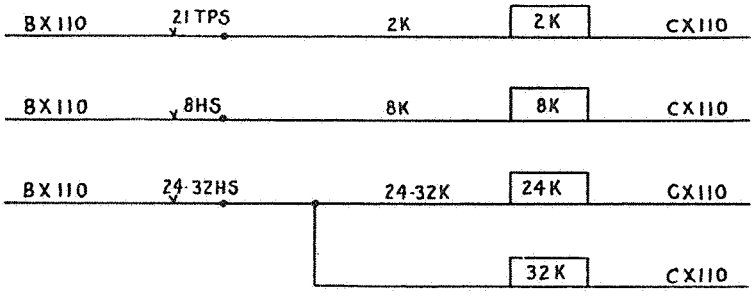


Fig. 32.
Signal Lever Light Circuits.

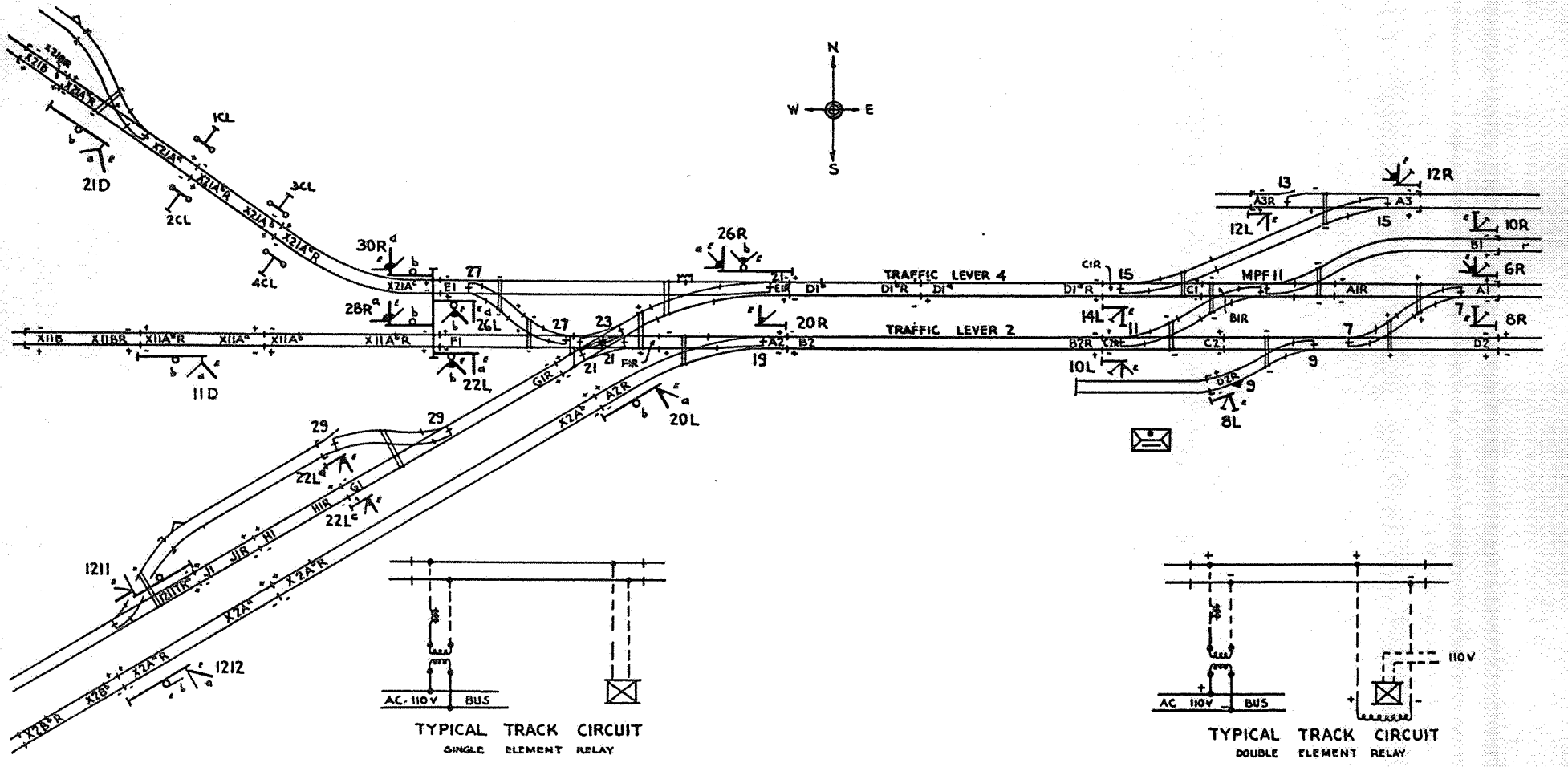


Fig. 33.
Track and Signal Layout.

Electro-Pneumatic Interlocking

Track and signal layout.

Figure 33 shows the track and signal layout of an electro-pneumatic interlocking with position light type signals. The track circuits are of the alternating current type, and the control machine is described in Chapter XVIII—Electro-Pneumatic Interlocking. Direct current is used for the control of all circuits except those for the signals, machine levers and track diagram lights.

In the previous descriptions in this chapter, the circuits are shown in Signal Section, A.A.R., nomenclature. The circuits for the electro-pneumatic interlocking are presented in written circuit form as used by several railroads and the nomenclature is as follows:

Track Circuits

Each track circuit is numbered according to the number of the track in which it is located, the number preceded by a letter according to its location from the first home signal.

Track circuits outside of interlocking limits approaching the home signal controlling the normal direction of traffic are lettered "X." This is followed by the number of the tracks and the letters "A," "B," etc., depending upon the location from the first home signal.

Instruments Designated According to the Number Assigned the Track

Approach relays 2P — 21P
P = Approach relay.
Where a conflict in the numbering of the tracks arises, the approach relay is numbered according to the track sections controlling it.

Track indicating relays 1A — 2C
A, C = first, third, etc., track sections from first home signal.
W added = West.
E added = East.

Track relays A1 — B2 — G1 — $X2A^{b}$ — X11B — take the same designation as the track section to which they are connected.

Repeating relays A1M — D2M — $20L^{a}HM$
A1, D2, $20L^{a}H$ = Instrument repeated.
M = Repeating relay.

Slow-acting relays $X2A^{a}SA$
$X2A^{a}$ = Relay in connection with which the slow-acting relay is used.
SA = Slow-acting relay.

Indication lights 2PEL — B1EL — E2MEL
2P, B1, E2M = Instrument that light repeats.
EL = Indication light.

Clear control relays for distant signals 2DJ
D = Distant.
J = Clear control relay.

Instruments Designated According to Lever Number

Home, 45 degree or permissive control relays 10RH—26R^{b}H^a—26R^{b}H^b
10R, 26R^b = Signal controlled.
H = Home, 45 degree or permissive aspect control relay.
H^a, H^b = Home, 45 degree and permissive aspect control relays respectively, when both aspects are on the same signal arm.

Clear control relays for home signals 12RJ — 30R^{a}J
12R, 30R^a = Signal controlled.
J = Clear control relay.

Control relays for marker lights on home signals 20L^{b}N — 22L^{b}N
20L^b, 22L^b = Signal controlled.
N = Marker light control relay.

Indication lights 7EL — 30REL
7, 30R = Lever repeated.
EL = Indication light.

Time releases 20SR — 22SR
20, 22 = Signal controlled.
SR = Slow release.

Locks 8K — 14K — 28K
K = Lock.

Switch repeating relays 9SS — 15SS
SS = Switch repeating relay.

Route locking relays 9E — 23W
E = East.
W = West.

Lever repeating relay 21NM — 29NM
N = Normal.
M = Repeating.

Track, signal, lever repeating and approach relay circuits.

Figure 34 shows the repeating relay circuits for the various track relays. The control of repeating relay A1M is as follows: positive battery (M^1) through a front contact of track relay A1, the relay for which a repeating relay is required, through the coils of repeating relay A1M, through a front contact of track relay A1 to provide additional protection against crosses and grounds, to negative battery (M^1).

The circuit for signal control repeating relay 26R^{a}HM is as follows: positive battery (H^b) through a front contact of relay 26R^{a}H, as relay 26R^{a}H is the relay to be repeated, through the coils of relay 26R^{a}HM, to negative battery (H^b). Repeating relays for contacts on the signal levers have also been provided. The circuit for lever repeating relay for lever 21 is as follows: positive battery (M^1) through a contact on lever 21 closed in the normal and normal indication position, through the coils of relay 21NM, to negative battery (M^1).

At this interlocking a visual approach annunciator is used. By referring to Fig. 34, the control circuit for approach relay 21P is as follows: positive

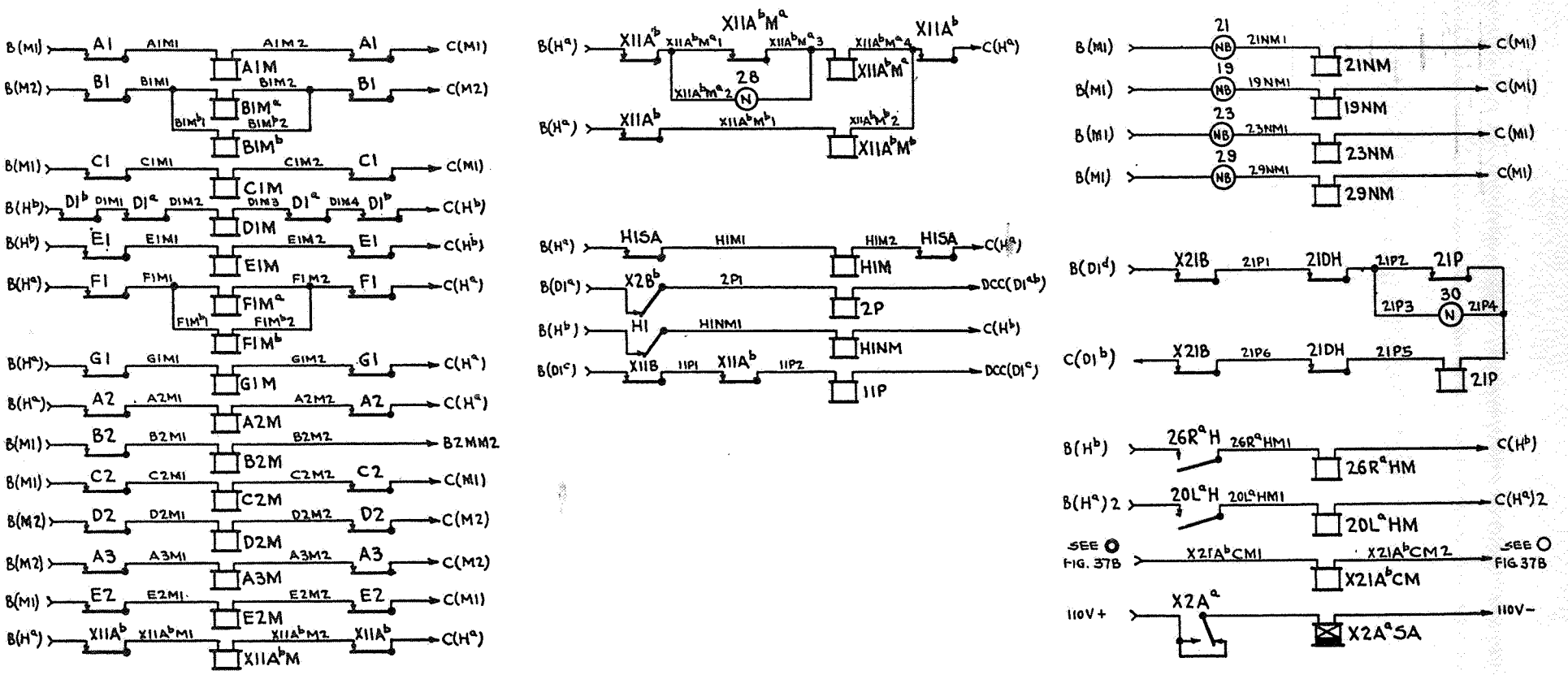


Fig. 34.
Track, Signal Lever Repeating and Approach Relay Circuits.

battery ($D1^d$) through a front contact of track relay X21B, the track circuit approaching distant signal 21D, through front contact of relay 21DH, a relay controlled through front contacts of relays $X21A^c$, $X21A^b$ and $X21A^a$, track relays between distant signal 21D and home signal 26L, in order that a train on any of the above track circuits will de-energize relay 21P, through a front contact of relay 21P, cut around by a contact on signal lever 30 closed in the normal position to provide the stick circuit for a movement past signal 30 as this portion of the railroad is operated as single-track, movements over which are governed by signal 30L, the stick circuit requiring the operator to restore lever 30 after each train movement, through the coils of relay 21P, through front contacts of relays 21DH and X21B, to provide additional protection against grounds and crosses, to negative battery ($D1^d$). A circuit controlling a light giving a visual indication for approaching trains on this track is controlled through a front contact of relay 21P and will be explained later.

Switch repeating relay and switch indication lock circuits.

Figure 35 shows typical switch repeating relay (SS) and switch indication lock circuits for the turnouts and crossovers of this interlocking. The purpose of illustrating this circuit is to show the control of the SS relay; the switch control circuit is explained in Chapter XVIII—Electro-Pneumatic Interlocking. By referring to Fig. 35 it will be seen that the SS relay control circuit for the A1 switch-and-lock movement is a polarized circuit. Consider the SS relay control circuit for the A1 mechanism as shown for the crossover. Positive battery (M^1) is connected to terminal 15 of the switch indication contact box, over a multiple tie to terminal 1, through a contact closed in the normal position, to terminal 2 on one end of the crossover, over wire 1SS1, to terminal 1 of the indication box on the opposite end of the crossover. From terminal 1 through contact closed in the normal position, to terminal 2 over wire 1SS to the SS relay, through the coils of the SS relay over wire N1SS, to terminal 8 of indication box, through a contact closed in the normal position, to terminal 7, from terminal 7 over wire N1SS1 to terminal 8 on indication box on opposite end of crossover, through contact closed in the normal position, to terminal 7, and from terminal 7 to negative battery (M^1). This SS circuit is for the crossover in the normal position. If the contacts are assumed to be in the opposite position and the circuit traced as before, the SS circuit for the reverse position of the crossover can be readily ascertained.

The indication lock circuit is also shown in Fig. 35. It will be noted that three lock magnets are shown: the normal and reverse indication magnets and the electric switch locking magnet. The circuit for the electric switch locking magnet will be explained later.

In Fig. 35 the circuit for the normal indication magnet control circuit is as follows: positive battery (M^1) through a front and a polar contact of the SS relay, closed in the normal position, over wire INK1 to a contact closed in the normal indication position on the quick switch roller of the switch lever controlling the movement, from the quick switch contact to the normal indication magnet, to negative battery (M^1). The operation of the quick switch is explained in detail in Chapter XVIII—Electro-

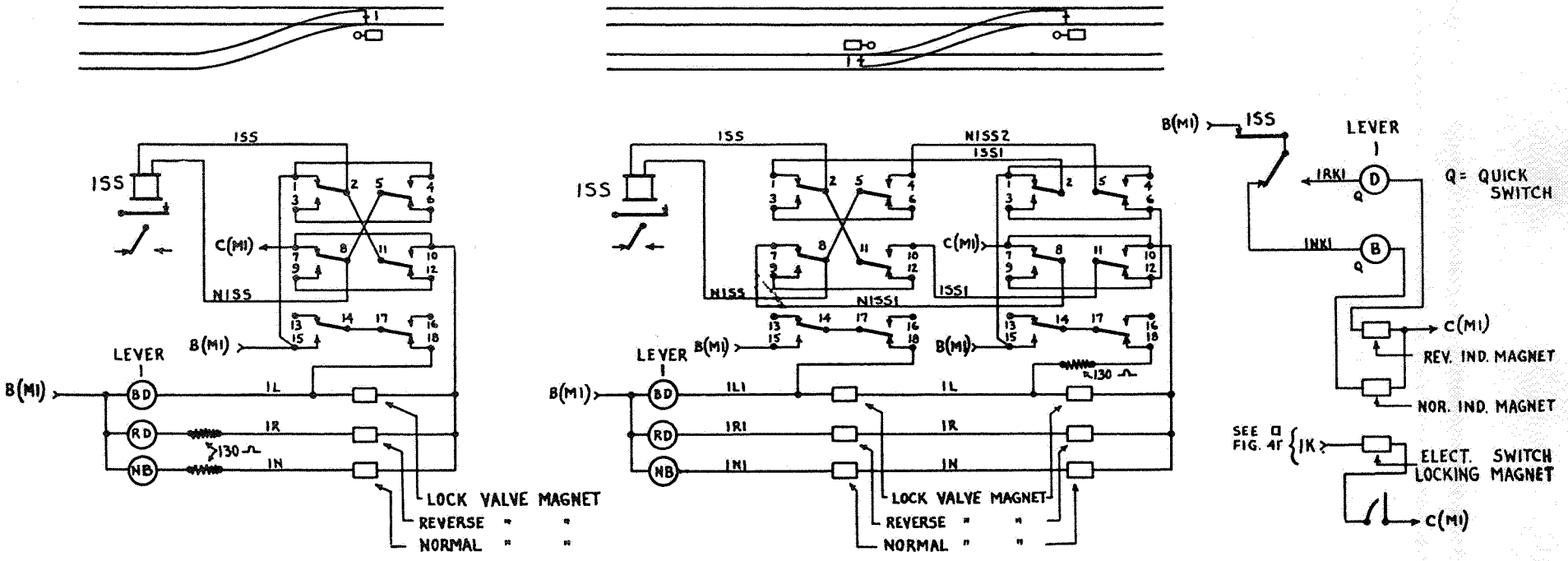


Fig. 35.
Typical Switch Repeating Relay and Switch Indication Lock Circuits.

Pneumatic Interlocking. The reverse indication circuit is similar to the normal indication circuit except that the SS relay polar contact will be in the reverse position, thus the reverse indication magnet receives its energy over wire IRK1 through a quick switch roller contact closed in the reverse indication position.

Track indicating relay circuits.

Referring to Fig. 36, the control circuits for the various track indicating relays are shown. The control circuit for track indicating relay 1EE is as follows: positive battery (M^1) through a front contact of relay E1M, track repeating relay for track circuit E1 so that relay 1EE will be de-energized with track circuit E1 occupied, through a front contact of relay 1F cut around when lever 27 is normal so that a movement over track circuit F1 will de-energize relay 1EE when lever 27 is reversed, through a front contact of relay 15W cut around when lever 27 is reversed, to insure that relay 1EE is de-energized, when crossover 27 is normal, with any portion of the track between signal 14L and the east end of the interlocking on the westward track occupied, through a front contact of relay D1M, repeating relay for track circuits $D1^a$ and $D1^b$ cut around when lever 27 is reversed to insure that relay 1EE is de-energized with any portion of the track between signals 26R and 14L occupied when crossover 27 is normal, through a contact on lever 26 closed in the normal and to the right position to necessitate the restoring of lever 26 to the normal position to energize relay 1EE, which will be found necessary in a later explanation, before signal 26L can display a Proceed indication for a following train movement, through the coils of relay 1EE, to negative battery (M^1). On relay D1M it will be seen that an additional circuit is tapped off going through a front contact of relay 1EE and tapped on to the wire going to the coils of relay 1EE. This circuit provides what is known as the "stick circuit." If it were not for this stick circuit, when lever 26 is operated to the left position, relay 1EE would de-energize. However, with the stick circuit, once relay 1EE is energized through the closed contact on lever 26 it will remain energized until such time as one of the track circuits, involved in the control of the signal displayed for a train movement, is occupied. It will be noted by referring to Fig. 33 that with crossover 27 reversed relays D1M and 15W are not involved in such a movement and with crossover 27 normal, relay 1F is not involved, thus the circuits are cut around these relays as shown in Fig. 36. The track indicating relay is utilized to obtain the semi-automatic operation of home interlocking signals, or in other words it requires the operator to restore to normal and then reverse the lever controlling the signal involved before the signal can display other than the Stop indication. Relay 1EE is the track indicating relay for a movement with the current of traffic for which signal 26L is cleared.

Home or 45 degree signal circuits.

It will be observed that the interlocking is practically divided into two parts with two tracks connecting the two portions. The one portion is entirely within yard limits and the movements in this territory are controlled by means of dwarf signals. The other portion is outside yard limits

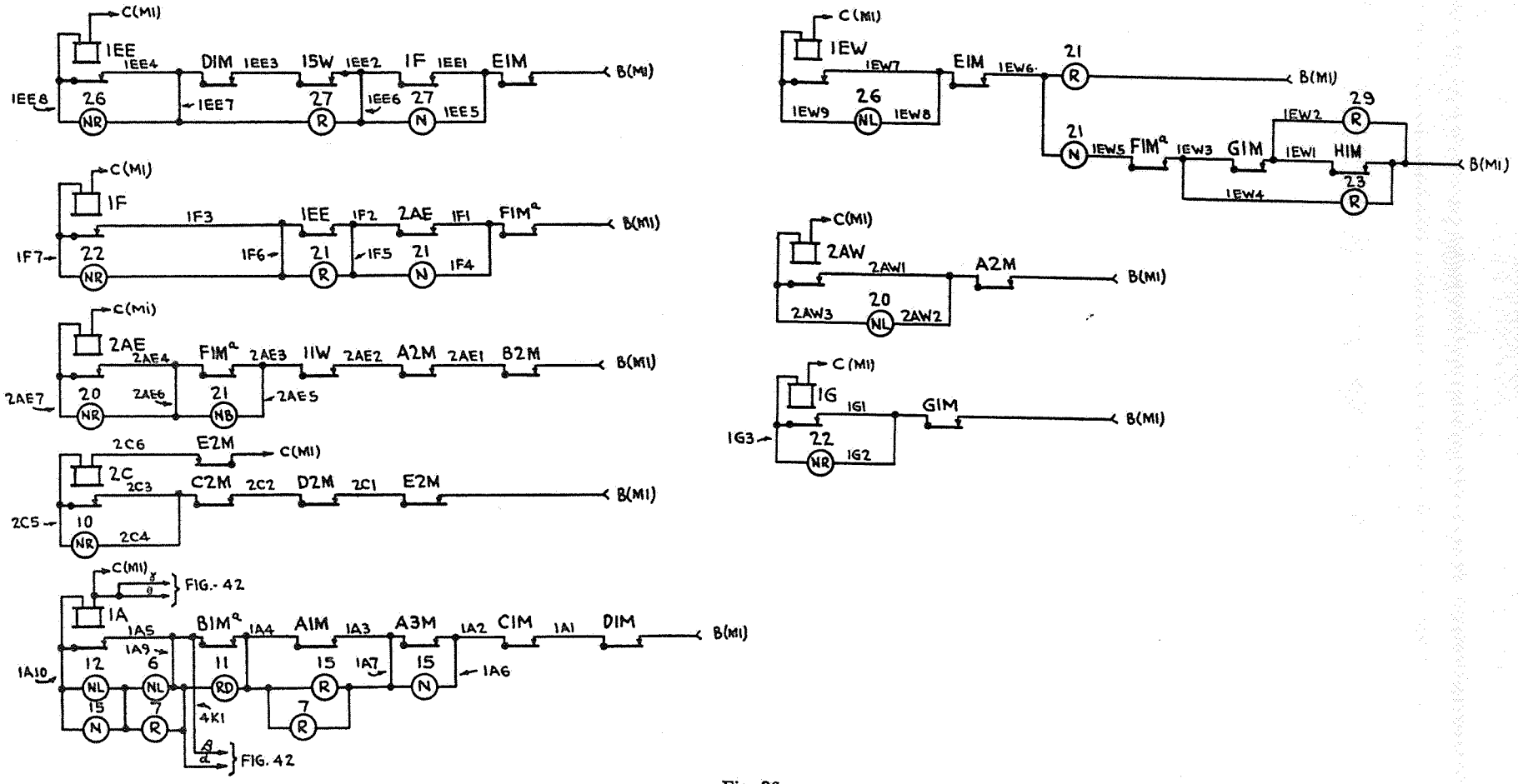


Fig. 36.
Track Indicating Relay Circuits.

and for this reason high signals are installed for movements with the current of traffic. Several dwarf signals have been installed displaying four aspects in order to provide maximum information for movements with the current of traffic.

In Figs. 37a and 37b the home or 45 degree signal circuits are shown.

Signal 26R controls movements to all tracks except reverse movements on track 2. The control circuit for a movement to track 1 is as follows (See Fig. 37b): positive battery (M^2) through a contact on lever 22 closed in the normal and to the reverse position to the right, so that signal lever 22 cannot be operated for an opposing movement to the movement controlled by signal 26R, through a contact on switch lever 29 closed in the normal position as lever 29 must be normal for the movement under consideration, through a closed normal polar and front contact of SS relay for switch 29 which insures that switch 29 is in agreement with the position of lever 29, through a contact on switch lever 23 closed in the normal position, as lever 23 must be normal for this movement, through a closed normal polar and front contact of SS relay for switch 23, for the reason mentioned for switch 29, through a contact on switch lever 21 closed in the normal position as lever 21 must be normal for this movement (See Fig. 37a), through a closed normal polar and front contact of SS relay for switch 21, through a normally closed contact of slow release 26, to insure that the signal control circuit is opened thus de-energizing the signal control relay when it becomes necessary to take a signal away from a train for which a route has been set up and a signal displayed after the train has possibly accepted a Proceed indication on the distant signal, through a front contact of track indicating relay 1EW to insure that the track circuits over which signal 26R governs are unoccupied and that the operator has restored signal lever 26R to normal position before operating the lever for a second movement, through contacts on switch levers 21, 23 and 29 closed in the normal position, as these levers must be normal for the movement, through a contact on signal lever 26 closed in the reverse position to the right as the signal involved is displayed when the signal lever is operated to the right position, through the coils of relay $26R^aH$, the control relay for signal involved, through a contact on signal lever 26 closed in the reverse position to the right and through contacts on switch levers 29, 23 and 21 closed in the normal position, through a front contact of relay 1EW to provide additional protection against crosses and grounds, to negative battery (M^2). It no doubt has been seen that the control circuit just explained was taken through three sets of contacts on switch levers 29, 23 and 21 closed in the normal position. The circuit has been so designed to insure that the switch selection has been obtained on these switch levers for all movements in which they are involved and it will be found that by this arrangement the switch selection is obtained for all moves with the least field work.

The control circuits for signal $26R^a$ also provide the "call-on" signal feature for which the stop and proceed signal is used as explained in Chapter II—Symbols, Aspects and Indications. By referring to Fig. 37a for the control of relay $26R^bN$, the control relay for the "call-on" signal, the circuit will be found to be the same as the control circuit for relay $26R^aH$ up to the point where the control of relay $26R^aH$ passes through the closed contact of slow release 26. At this point the control of relay $26R^aH$ goes

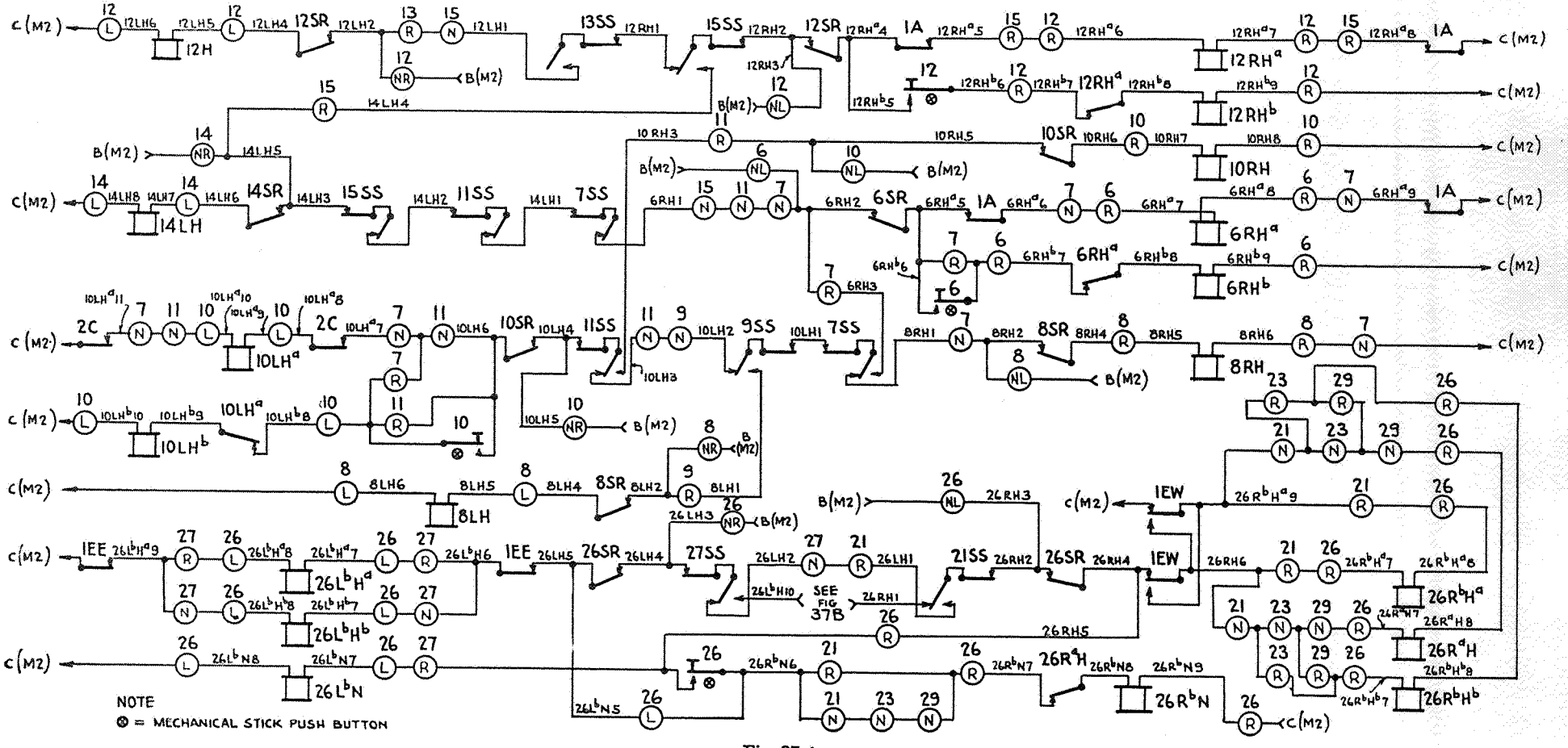


Fig. 37a:
Home or 45 Degree Signal Circuits

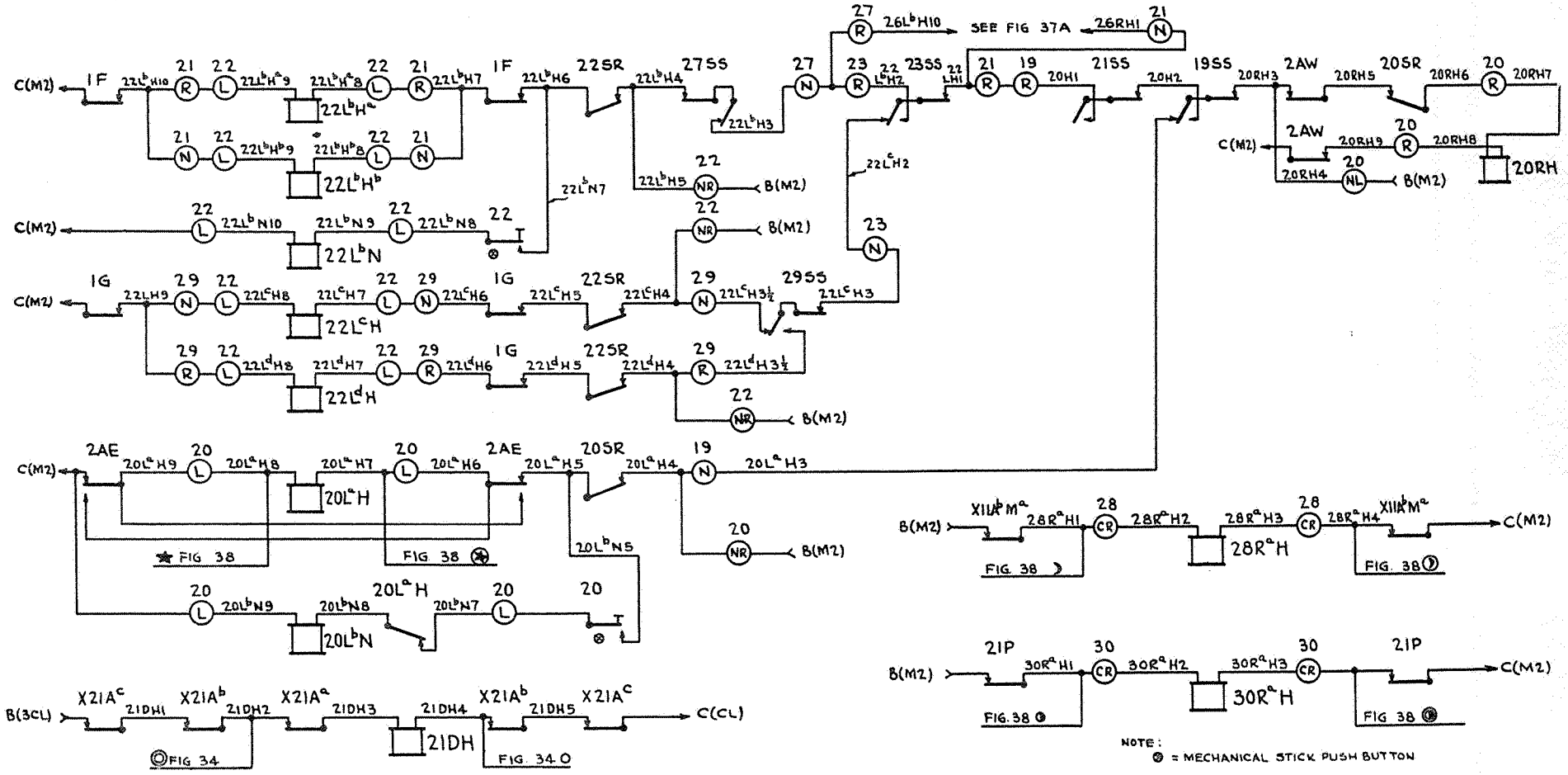


Fig. 37b.
Home or 45 Degree Signal Circuits.

to a front contact of relay 1EW. Tapped to this wire is a wire which goes to a contact on signal lever 26 closed in the reverse position to the right, to insure that the signal lever is in this position before the "call-on" indication is given, through a normally open contact of push button 26 so that the control of the "call-on" relay is normally opened and only closed by a distinctive movement on the part of the leverman, through contacts on switch levers 21, 23 and 29 closed in the normal position, through a contact on signal lever 26 closed in the reverse position to the right, through a back contact of relay $26R^aH$ so that the "call-on" indication cannot be given if the relay controlling the top arm is energized, through the coils of relay $26R^bN$, to a contact on signal lever 26 closed in the reverse position to the right, to provide additional protection against crosses and grounds, to negative battery (M^2). A circuit through a contact on switch lever 21 closed in the reverse position cuts around the normal contacts on levers 21, 23 and 29 as the "call-on" signal is effective for movements over switch 21 normal and reverse.

90 degree signal circuits.

The 90 degree signal circuits are shown in Fig. 38. The 90 degree control circuit for signal $26R^a$ is as follows: positive battery (H^a) through a closed polar contact of track relay H1 closed in the normal position, or the designated polar position of the relay for the 90 degree position of the signal controlled, which insures that the signal will not be displayed in the 90 degree position when track circuit H1 is occupied, through a front contact of relay $26R^aH$, the control relay for the 45 degree position of signal $26R^a$ to provide for the 45 degree relay being energized before the 90 degree relay will energize, through the coils of relay $26R^aJ$. through a closed polar contact of track relay H1 closed in the normal position to provide additional protection against crosses and grounds, to negative battery (H^a). It will be noted that the 90 degree position of signal $26R^a$ is for a movement to track 1 as this movement is considered the straight track movement, the bottom arm of signal $26R^a$ controlling movements to signals 28 and $30R^a$. The 90 degree control circuit is through a contact of track relay H1 only, as the control of track relay H1 is governed over contacts on track relay J1, obviating the necessity of the 90 degree circuit being taken through both track relays.

Signal lighting circuits.

The lighting circuits for the various signals are shown in Fig. 39. A circuit for one arm of each signal only is shown. Referring to "A" of Fig 39, the lighting circuit for the top arm of signal $26R^a$ is as follows: ACB12 through a back contact of relay $26R^aH$ over wire $26R^aS$, to the stop position lights of signal "A," to ACC12. When signal "A" is at the 45 degree position ACB12 goes through a front contact of relay $26R^aH$, through a back contact of relay $26R^aJ$, over wire $26R^aH$, to the 45 degree position of signal "A," to ACC12. The 90 degree or clear control of signal "A," is ACB12, through a front contact of relay $26R^aH$, through a front contact of relay $26R^aJ$, over wire $26R^aJ$, to the 90 degree or clear lights of signal "A," to ACC12. It will be noted that in the circuits just explained two lights

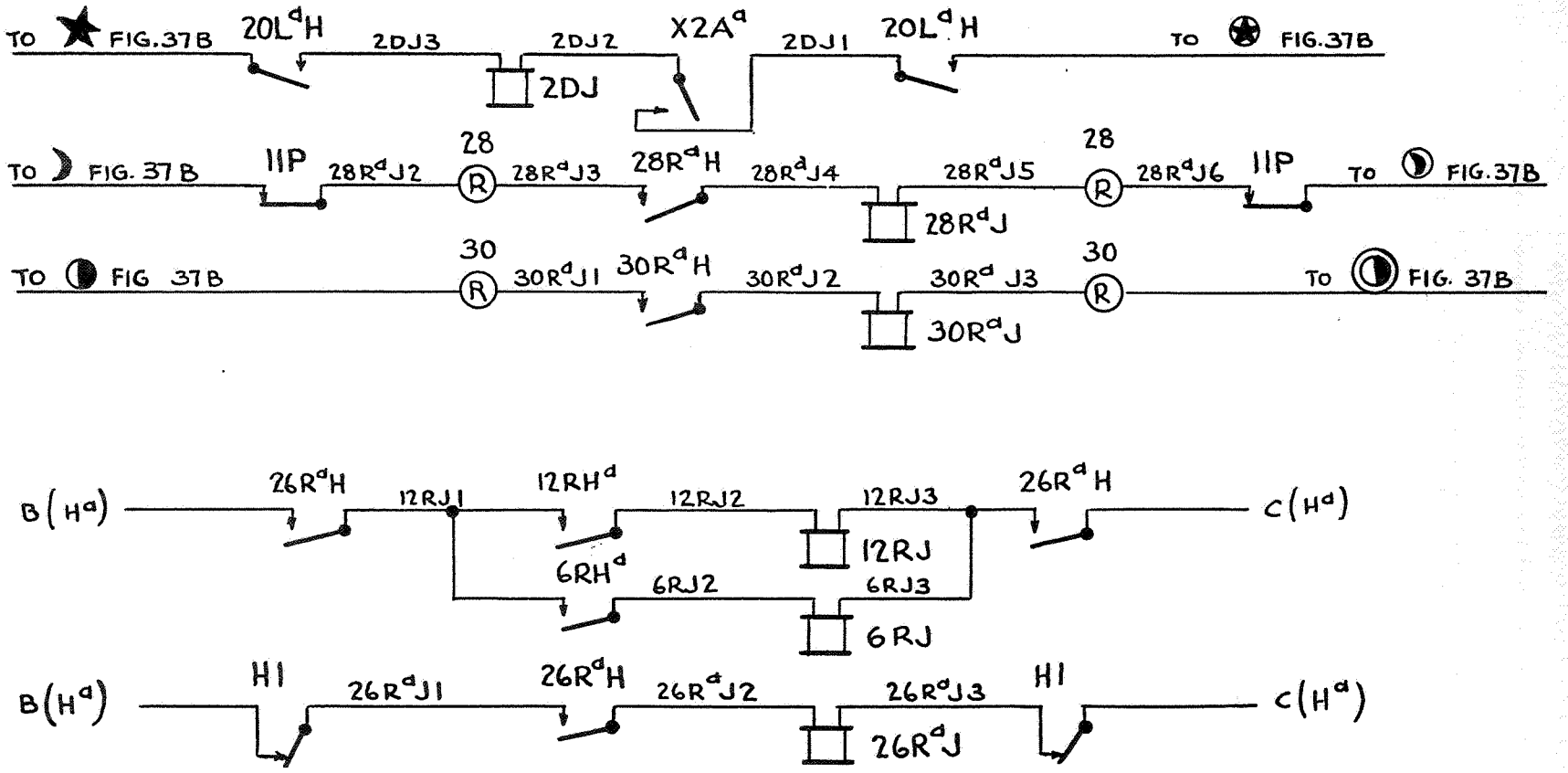
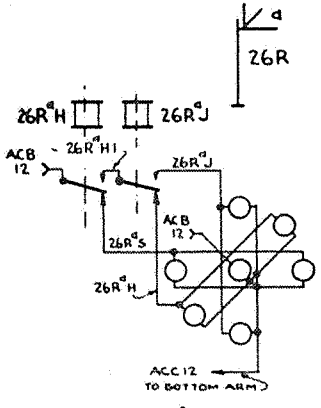
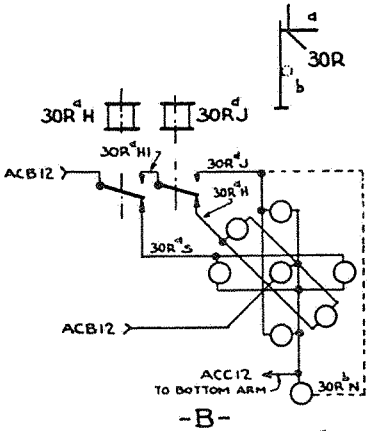


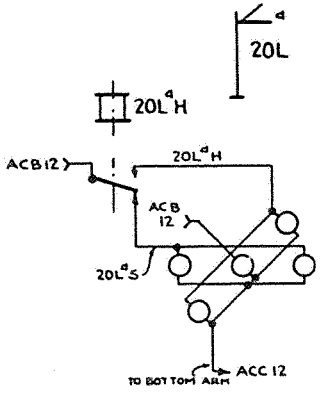
Fig. 38.
90 Degree Signal Circuits.



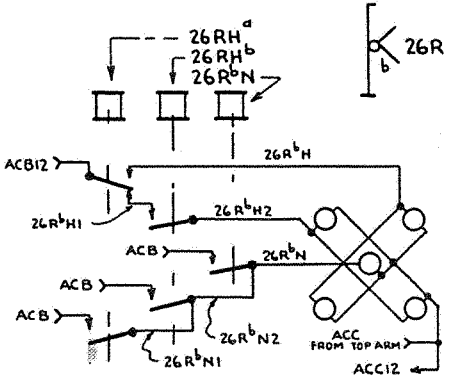
-A-
AS APPLIED TO SIG. 26R^a



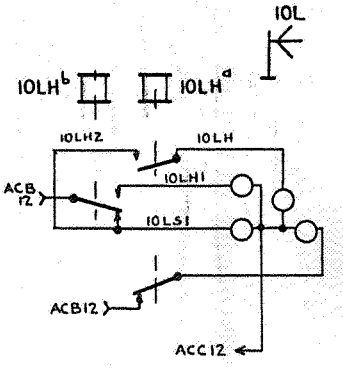
-B-
AS APPLIED TO SIG. 30R^a



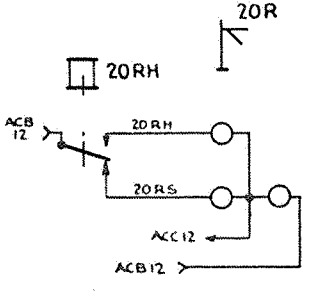
-C-
AS APPLIED TO SIG. 20L^a



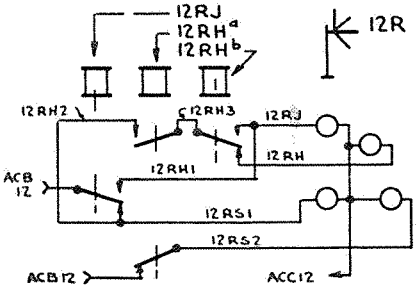
-D-
AS APPLIED TO SIG. 26R^b



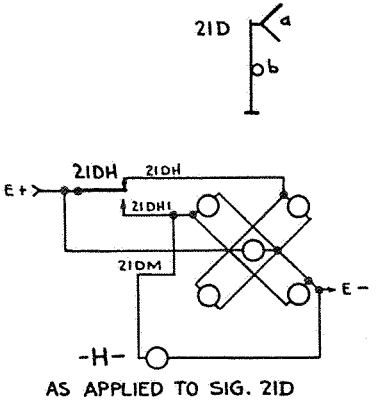
-E-
AS APPLIED TO SIG. 10L



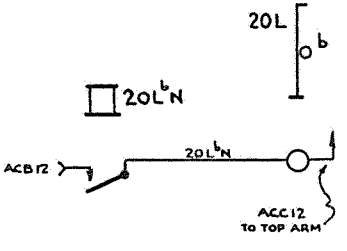
-F-
AS APPLIED TO SIG. 20R



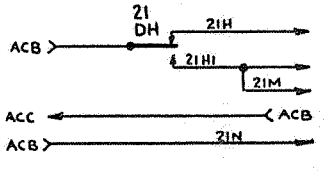
-G-
AS APPLIED TO SIG 12R



-H-
AS APPLIED TO SIG. 21D



-J-
AS APPLIED TO SIG. 20L^b



-K-

Fig. 39.
Signal Lighting Circuits.

only are controlled through the relay contacts, the control of the middle or neutral light is direct from ACB12 to the middle light, then to ACC12.

To provide the maximum time in which the signals are lighted slow drop-away relays are used for bridging the contacts of the alternating current track circuit relays. If it were not for the slow drop-away relay the signal lights would not be displayed during the changing of the track relay contacts; with the slow drop-away relay the lights will remain lighted in one position until such time as the track relay has reversed.

Signal indication lock circuits.

The signal indication lock circuits are shown in Fig. 40. The indication lock circuit for signal 26 is as follows: positive battery (H^b) through a back contact of relays $26L^bN$, $26L^bH^b$, $26L^bH^a$, $26R^aJ$, $26R^bN$, $26R^bH^b$, $26R^bH^a$, $26R^aH$, $26R^aHM$, 12RJ and 6RJ to insure that control relays of signal 26 are de-energized and that the 90 degree control relays for the dwarf signals leading to $26R^a$ are de-energized through contact on lever 26 closed at the indication and to the reverse position to the left so that the indication magnet will only be energized with the lever in these positions, through a front contact of relay 21P which provides for the approach locking, through an additional contact on lever 26 closed at the indication and to the reverse position to the left, to provide a separation of the lock circuit for lever 26 when in the reverse position to the right, through a contact on lever 26 closed in the indication position to the left and until just before the left position is reached so that the indication lock on lever 26 will be de-energized when the lever is in the left position, through the coils of the lock, through a contact on lever 26 closed in the indication and the reverse position to the left, to provide additional protection against crosses and grounds, to negative battery (H^b). This circuit provides for the restoring of signal lever 26 to the normal position providing no movement has been made through the interlocking and that the track circuits approaching the signals are unoccupied. The circuit through a front contact of relay 21P and a contact on lever 26 closed in the left indication and the reverse position to the left, is cut around by means of a circuit through a back contact of relay 1EE, the track indicating relay, and a normally closed contact of push button 26 to provide for restoring of lever 26 after a movement has been made through the interlocking, the push button contact to provide approach locking for "call-on" signal. This portion of the circuit provides the signal indication locking for lever 26 when operated to the reverse position to the left. A further cut around circuit is provided for lever 26 when operated to the reverse position to the right; after the lock circuit passes through the back contact of relay 6RJ the cut around circuit passes through a contact on lever 26 closed in the reverse and the indication position to the right, through a back contact of relay 1EW, the track indicating relay for a movement in the westwardly direction, through push button 26 closed in the normal position, through a contact on lever 26 closed at the indication and to just before the reverse position to the right, to open the lock circuit when the lever is in the reverse position to the right, through the coils of the lock magnet, through a contact on lever 26 closed in the reverse position and the indication position to the right, to provide protection against crosses and grounds, to negative battery (H^b).

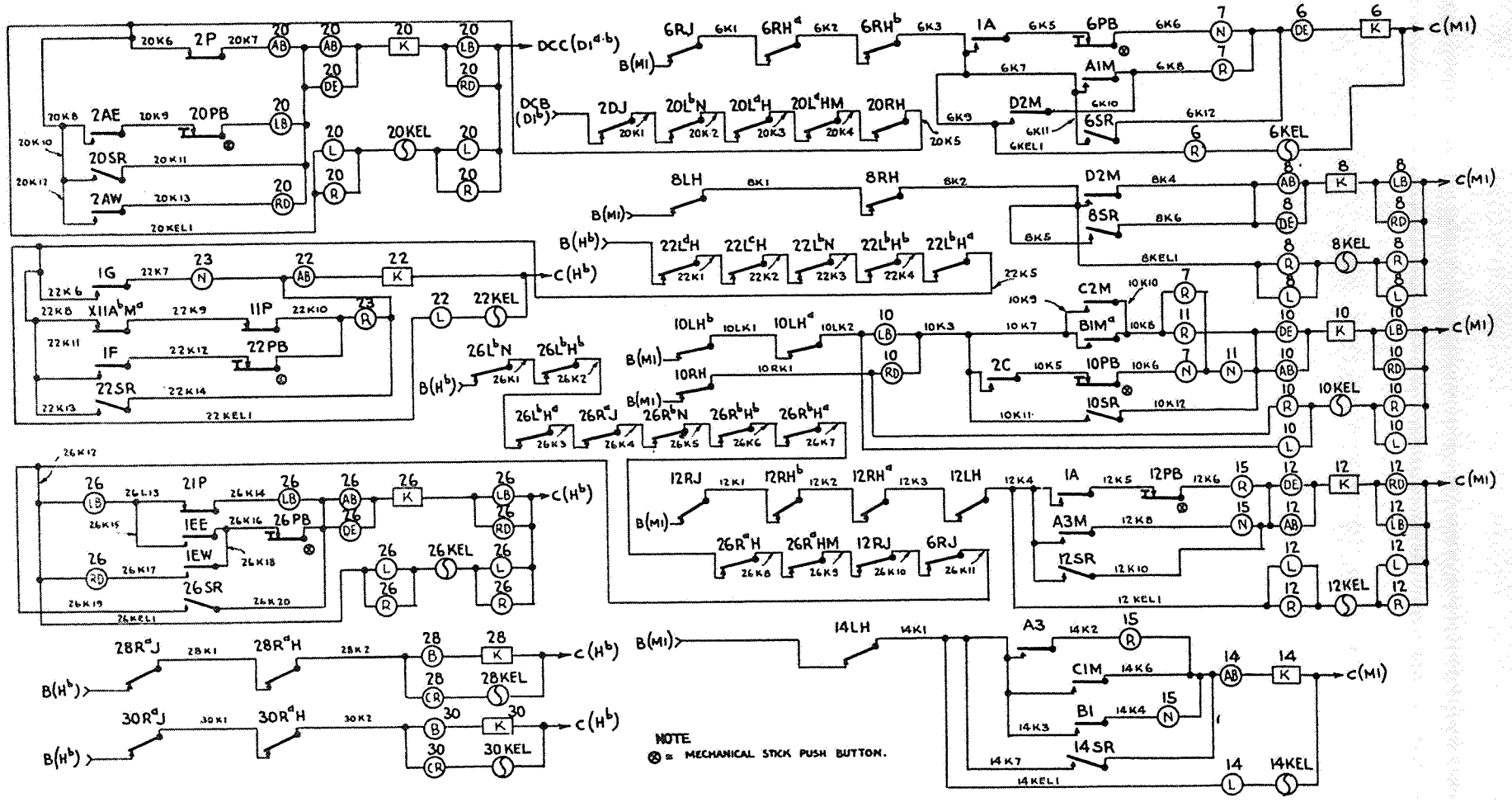


Fig. 40.
Signal Indication Lock Circuits.

A circuit is provided through a reverse contact on slow release 26 cutting around the circuits beginning at the right of 6RJ to the left of 26AB and 26DE to provide for the release of the signal lever providing the approach relay circuit is de-energized and that no movement has been made past signal 26, thus de-energizing track indicating relay and to also provide time locking on lever 26 should it be decided to change an existing route for which a signal has been displayed. The time release used in this instance is provided with a latch and is normally wound up, therefore the reverse contact is shown open.

To provide a means of notifying the operator that the signal has assumed an aspect other than Stop, a circuit tapped off the lock circuit has been provided as follows: from the contact on lever 26 closed in the reverse position to the right and to the indication point, through a contact on lever 26 closed in the reverse position to the left in one instance and to the reverse position to the right in the other instance, to lamp 26KEL on lever 26. It will be noted that at the time lever 26 is operated either to the left or right position until such time as the control relay involved energizes, a light will be displayed at lever 26. This will inform the operator that certain operations have taken place. The circuit is continued to negative battery (H^b), through contacts on lever 26, closed in the reverse position to the right or to the left, as the case may be, to provide protection against crosses and grounds. The signal indication lock circuit is provided to prevent the operator from restoring the signal lever to its normal position unless the signals or relays involved have assumed their proper position.

Electric switch lever locking circuits.

The electric switch lever locking is similar to the locking provided for the electro-mechanical machine. Figure 41 shows the circuits for the switch locking and also provides for route locking through the medium of the various route locking relays. The control circuit for switch lock 7 is as follows: positive battery (M^1) through a front contact of relay D2M, the repeating relay for track circuit D2 in which switch 7 occurs. This prevents switch lever 7 being reversed with track circuit D2 occupied, through a front contact of route locking relay 9E which provides for locking switch 7 over track circuit C2 with switch 11 normal so that for a movement over switch 7 with switch 11 normal the switch lever lock prevents the operation of switch lever 7 with track circuit C2 occupied, through a front contact of route locking relay 11E which provides for locking switch 7 over track circuits C1 and B1 with switch 15 normal so that with a movement over switch 7 with switch 15 normal the switch lever lock prevents the operation of lever 7 with track circuits C1 and B1 occupied, through a front contact of track repeating relay A1M as track circuit A1 is the track circuit in which one end of crossover 7 is located and with track circuit A1 occupied switch lever 7 cannot be operated, through a front contact of track repeating relay $B1M^a$ cut around when lever 11 is reversed so that a movement over track circuit B1 will de-energize electric switch lock 7 when lever 11 is normal. From this point the circuit is continued in Fig. 35 which shows it through the lock magnet coils, through lever latch contact on switch lever, to negative battery (M^1). To the right of contact at relay $B1M^a$ an additional circuit is provided through a front contact of track repeating relay $B1M^a$,

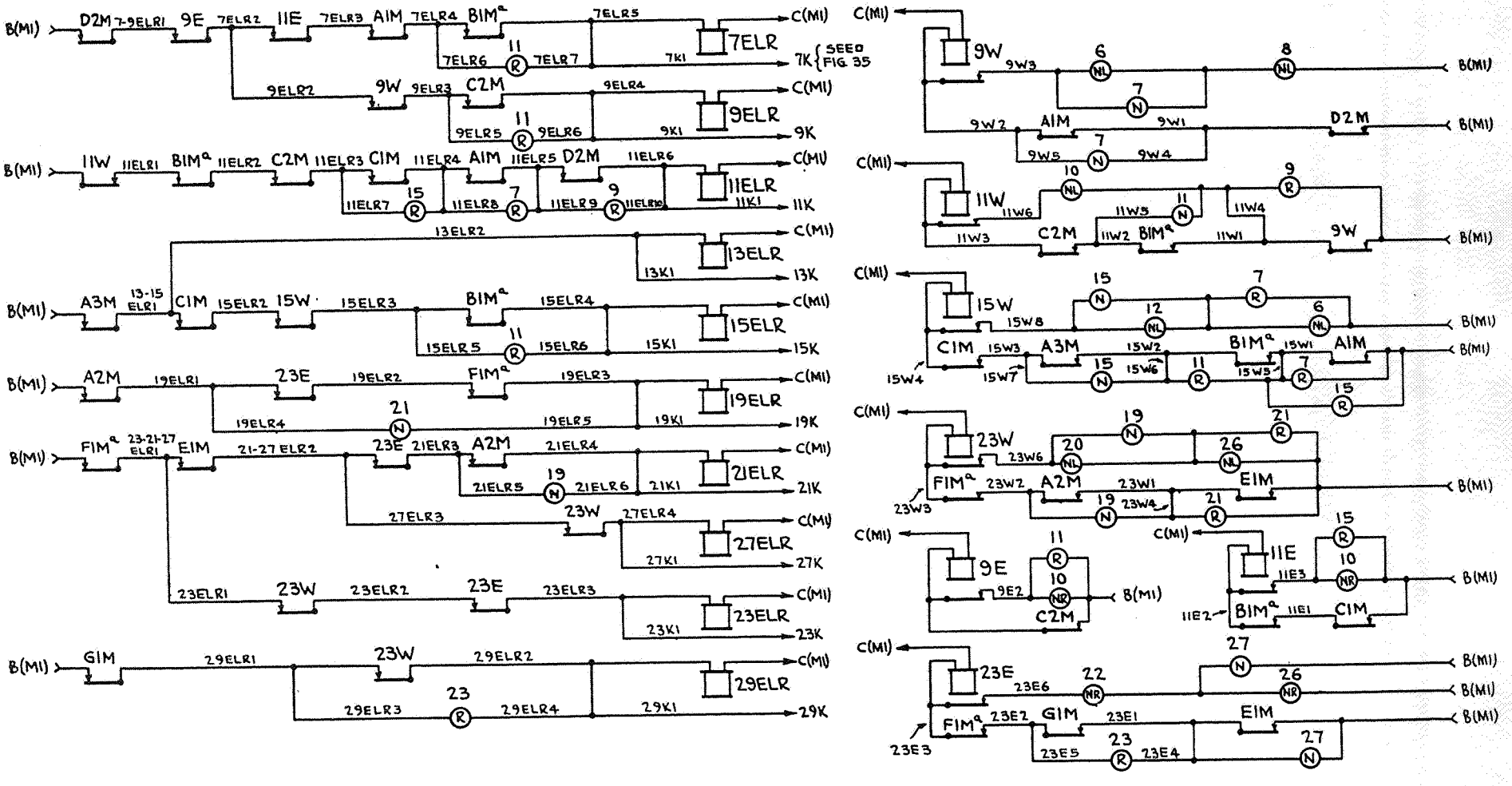


Fig. 41.
Electric Switch Lever Locking Circuits.

through the coils of relay 7ELR, lever light relay, to negative battery (M^1). The purpose of this relay will be explained later. Mention was made of route locking relays 9E and 11E and in order to make clear the locking provided by these relays, the control circuit as shown in Fig. 41 is as follows: positive battery (M^1) through a front contact of repeating relay C2M, track repeating relay for track circuit C2, through the coils of relay 9E, to negative battery (M^1); thus it will be noted that with relay 9E de-energized it will remain de-energized with track circuit C2 occupied. However, if relay 9E is energized and switch lever 11 is in the reverse position relay 9E will remain energized through its own contact with track circuit C2 occupied, for the reason that with switch 11 reversed for an eastward movement, switch 9 is not affected. It will also be noted that once relay 9E is energized it will remain energized with track circuit C2 occupied, through its own front contact, through a contact of signal lever 10 closed in the normal and to the reverse position to the right as signal 10 when operated to the reverse position to the left is semi-automatic with switch 11 reversed. The contact on lever 11 closed in the reverse position cutting around the contact on signal lever 10 closed in the normal and in the reverse position to the right, is provided so that with track circuit C2 occupied relay 9E will not be affected.

Traffic locking circuits.

In order to operate the double track in both directions between the two portions of the interlocking, traffic locking is installed. By referring to Fig. 42 the control circuit for traffic lock 2, on the westward track, is as follows: positive battery (M^1) through a front contact of track relays A2M, B2M and C2M to prevent the operation of traffic lever 2 with any of these track circuits occupied, through a front contact of relay D2M cut around by switch lever 9 reverse, through contact on relay $B1M^b$, cut around by a contact on lever 11 closed in the normal position, through contact on A1M, E1M, $F1M^b$ and G1M, cut around by contacts on levers 7 and 21 closed in the normal position or levers 11 reverse and 19 normal. Relay E1M is further cut around when lever 27 is normal. Thus the control circuit is taken over the various routes for which traffic locking is provided. The circuit then continues through coils of electric lock 2K, through latch contact on lever 2, to negative battery (M^1). The traffic locking is not affected, when track circuit D2 is occupied, with switch 9 reversed, track circuit B1 occupied with switch 11 normal, track circuit E1 occupied with switch 27 normal, nor with track circuits A1, E1, F1 and G1 occupied when switches 7 and 21 are in the normal position, or switches 11 reverse and 19 normal. The traffic locking in this instance is made necessary, as the tracks beyond signals 30R and 28R are operated as single tracks and at the same time trains may move east on both tracks simultaneously. With traffic locking, a movement eastward over the normally westward track between signals 6R and 26R is permissible.

Indicating light circuits.

Operating information is conveyed to the operator by means of a light mounted on the machine just beneath the lever. When the lever may be operated the lamp is lighted; when the lever may not be operated the light

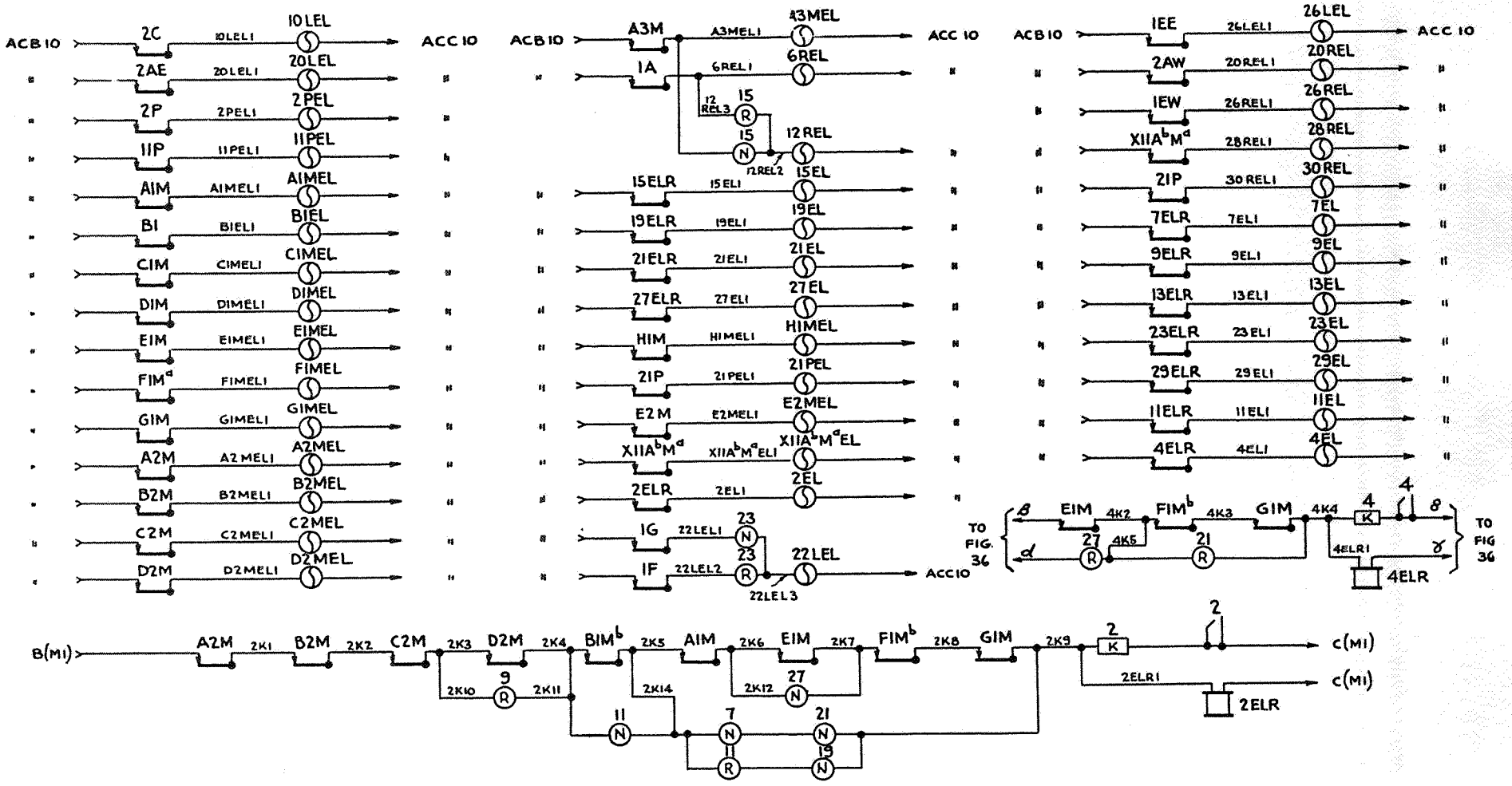


Fig. 42.
Traffic Locking Circuits.

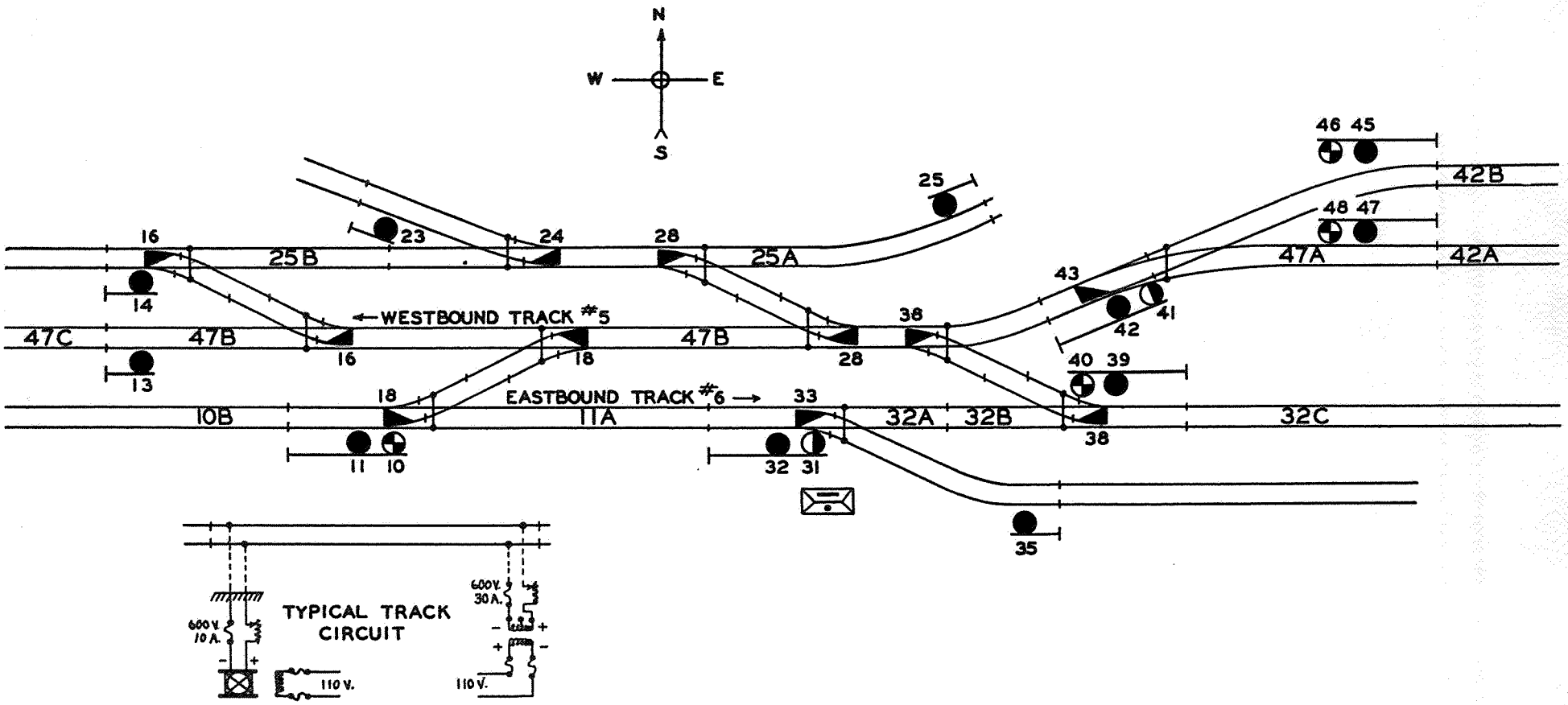


Fig. 43.
Track and Signal Layout.

is not displayed. The same information is given regarding the track circuits, the approach circuits and certain signal circuits. Referring to Fig. 42, the control circuits for the various lights will be found; the control circuit for 21PEL and the approach light for approach relay 21 is as follows: ACB10 through a front contact of relay 21P to a light on the model board designated as 21PEL, to ACC10. These approach lights, as well as the signal and track circuit lights are mounted on the model board directly above the machine.

Protection against foreign electric current.

Throughout the explanation reference has been made to several different batteries: namely, M^1, M^2, H^a, H^b. In order to provide so far as possible protection against foreign electric current from crosses and grounds these various batteries have been established. Battery M^1 has been provided to control all apparatus within the interlocking station, battery M^2 to control all apparatus the circuits of which start at the interlocking station, and the controlled apparatus located outside, batteries H^a and H^b located at the home signal bridges controlling the apparatus at this point. A battery $D1^b$ has been provided at the distant signal for a standby service and also for the control of circuits starting from this point.

Electric Interlocking

Track and signal layout.

The track and signal layout for this interlocking is shown in Fig. 43. Color light signals of the searchlight type are used, the switches are operated electrically, and the track circuits are of the alternating current type.

In order that the circuits in this portion of the chapter can be understood, certain wire designations follow and symbols are shown in Figs. 44 and 45.

Designation of Wires

15—Light signal control wire.
17—Light signal control wire.
23—Home relay, positive control wire.
24—Home relay, negative control wire (two-wire circuit).
31—Switch relay, (three-position) positive control wire.
32—Switch relay, (three-position) negative control wire.
53—Approach relay, positive control wire.
54—Approach indicator, positive control wire.
62—Track indicator, positive control wire.
63—Signal repeater relay, (red position) positive control wire.
64—Signal indicator, positive control wire.
94—Secondary relay, (repeating signal mechanism or signal operating relay only) positive control wire.
95—Secondary relay, positive control wire.
96—Secondary relay, negative control wire.
97—Stick relay, positive pick-up control wire.

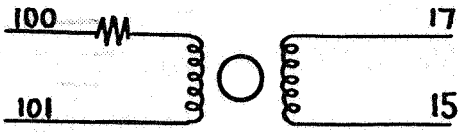
98—Stick relay, positive stick-up control wire.
100—Low-volt battery, negative wire.
101—Low-volt battery, positive wire.
110—110-volt, a.c. wire.
111—110-volt a.c. wire.
200—Low-volt signal lighting wire, negative when d.c.
201—Low-volt signal lighting wire, positive when d.c.
203—Power-off relay control wire.
207—Approach bell, positive control wire.
300—Chart and lever light wire, negative when d.c.
301—Chart and lever light wire, positive when d.c.

COLOR	LEVER CONTROL		AUTO-MATIC	INOP-ERATIVE
	NON AUTO-MATIC	SEMI AUTO-MATIC		
RED AND YELLOW				
RED AND GREEN				
RED - YELLOW AND GREEN				
RED				

Fig. 44.
Light Signal Symbols for Layout Shown in Fig. 43.

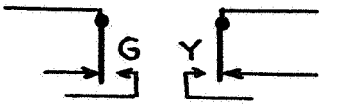
Track and signal repeating relay and annunciator circuits.

The track repeating relay circuits are shown in Fig. 46a. The circuit for relay 32B-95 is as follows: positive battery 101A through a fixed resistance of 300 ohms to provide a means of regulating the voltage, through a front contact of track relay 32B, relay to be repeated, through the coils of track repeating relay, through a front contact of track relay 32B, to negative battery 100A. In some instances two track relays are repeated instead of one which is done to save relays where the circuit design will permit. In some instances, as in the case of track repeating relay 47CD-95, the repeating relay is made slow drop-away so that the signal will remain lighted when relay 47CD is pole-changing, such relay being a polarized relay for 47C and 47D track relays for the track circuits in advance of the interlocking; this arrangement has been provided so that the third position of the home signal may be displayed to govern movements into this territory.



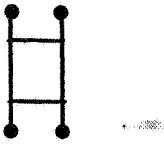
THREE POSITION - RED-YELLOW-GREEN

COLOR LIGHT SIGNAL WIRING

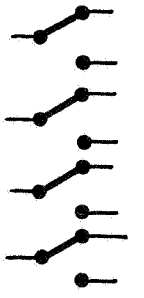


SHOWN DEENERGIZED

CONTACTS OPERATED BY SIGNAL MECHANISM



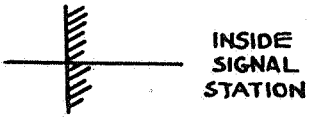
RECTIFIER



NORMAL POSITION

ELECTRIC LIGHT

SWITCH CIRCUIT CONTROLLER CONTACTS



SIGNAL STATION LINES

TO SECOND

CLOCK WORK RELEASE

NORMALLY CLOSED

NORMALLY OPEN

CIRCUIT CONTROLLER CONTACT ON INTER-LOCKING MACHINE

Fig. 45.

Miscellaneous Symbols Used in Figs. 46a to 52, Inclusive.

The signal repeating relay circuits are also shown in Fig. 46a. The control circuit for signal repeating relay 10-11-63 is as follows: positive battery 101C through contacts on the operating mechanism of signal 10 closed when the signal displays a Stop indication, through contacts on the operating mechanism of signal 11 closed when the signal displays a Stop indication, as the signals are to be repeated when displaying this indication, through a voltage regulating resistance of 300 ohms, through the coils of the signal repeating relay, to negative battery 100C.

Some of the signals at this plant are approach lighted and the others continuously lighted. The approach lighting relay is also utilized for approach annunciator and approach locking. Referring to Fig. 46b, the control circuit for approach lighting relay 41-95 for signal 41 is as follows: positive battery 101B through a voltage regulating resistance of 400 ohms, through a front contact of track repeating relay 25A-95A, cut around by contact on switch lever 28 closed when lever is normal, so that with switch lever 28 normal, signal 41 is not affected by movement over track circuit 25A, through a front contact of approach relay 31-95 so that with a movement east on track 6 signal 41 will be lighted, through a front contact of track repeating relay 47B-95B, so that signal 41 will remain lighted with track circuit 47B occupied, through the coils of relay 41-95, to negative battery 100B. The lighting circuit for this signal will be explained later.

The approach annunciator bell EW-207 for track 6 is shown in Fig. 46b. The control circuit is as follows: positive battery 101 through a voltage regulating resistance of 100 ohms, through a back contact of approach relay 6-53 as bell rings only with relay 6-53 de-energized, through a back contact of stick relay EW-207-97, bell release relay explained later; through the coils of bell, to negative battery 100. It will be noted that the approach bell will continue to ring as long as relay 6-53 is de-energized. However, a bell releasing relay EW-207-97 is provided and the control circuit for same is as follows: positive battery 101 through a voltage regulating resistance of 400 ohms, through a back contact of approach relay 6-53 for track 6 provided to keep relay EW-207-97 energized, over the stick circuit with relay 6-53 de-energized after push button has been operated, through open push button contact, through coils of relay, to negative battery 100. The open push button contact is cut around by means of a circuit through a front contact of relay EW-207-97 to provide the stick feature for the relay after it has been energized.

Switch repeating relay circuits.

Figure 47 shows the switch repeating relay circuits. The control for switch repeating relay 16-31 is as follows: positive battery 101C through a voltage regulating resistance of 300 ohms, through a contact in switch-and-lock movement on the west end of crossover 16 closed when the crossover is normal, over wire 16-31-A to a contact in switch-and-lock movement on the east end of crossover 16 closed when the crossover is in the normal position, over wire 16-31 to and through the coils of relay 16, over wire 16-32 to a contact in switch-and-lock movement on east end of crossover closed when the crossover is normal, over wire 16-32-A to contact in switch-and-lock movement on west end of crossover closed when the crossover is normal, to negative battery 100C. An additional circuit is provided through the switch-

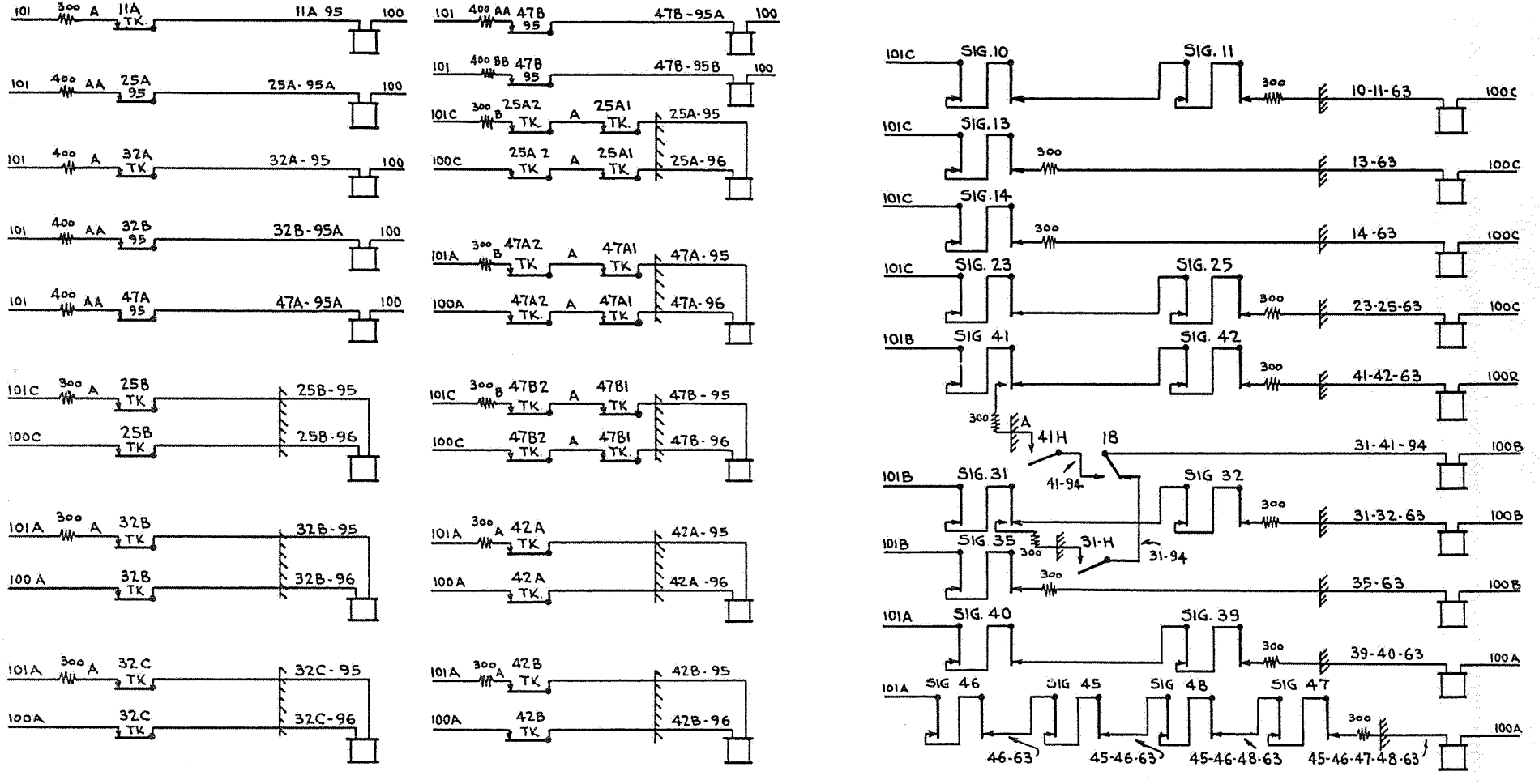


Fig. 46a.
Track and Signal Repeating Relay Circuits.

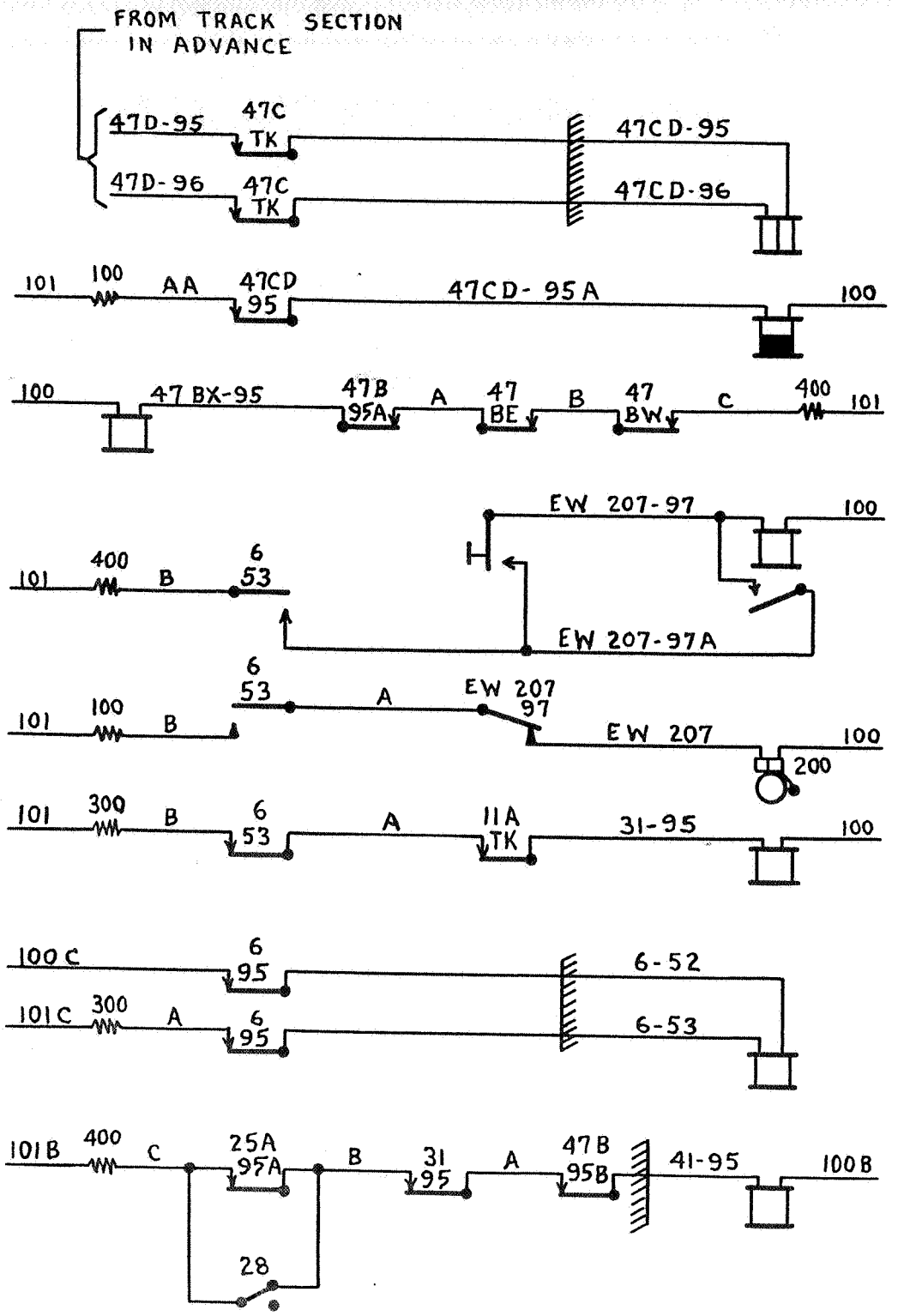


Fig. 46b.
Annunciator, Approach Lighting, and Bell Stick Circuits.

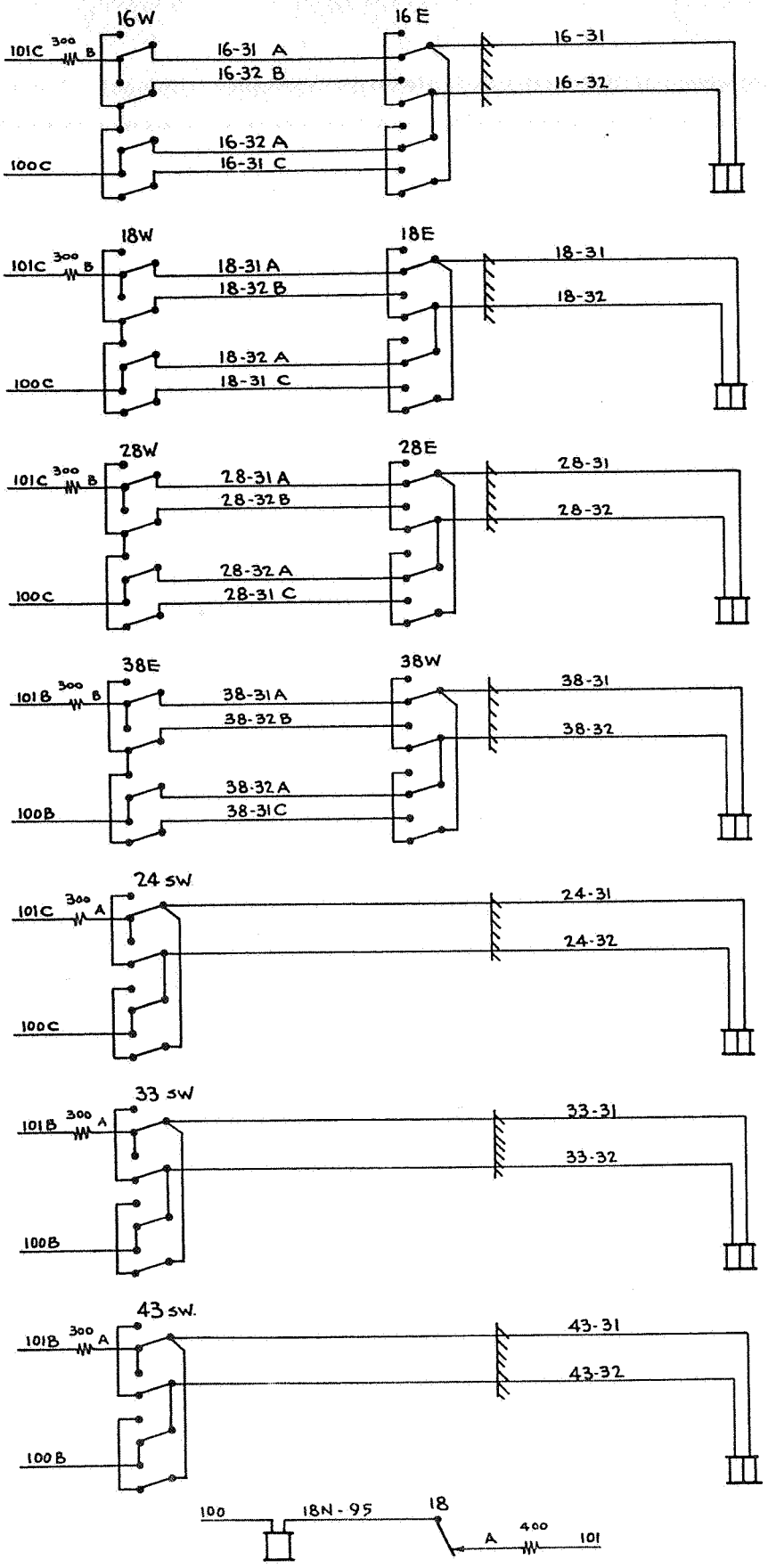


Fig. 47.
Switch Repeating Relay Circuits.

and-lock movement when the crossover is reverse and also that the direction of flow of current will be opposite, when the switch is reverse, to the direction of flow of current when the switch is normal. This circuit is provided to control a polarized relay so that a positive operation of the relay is necessary for each position of the switch movement. It will be noted that while the switch is moving from normal to reverse position, or vice versa, a shunt is placed across the coils of the relay to further insure that it will remain de-energized.

Stick relay, switch lock relay and switch lock circuits.

The stick relay, switch lock relay and switch lock circuits are shown in Fig. 48. The control circuit for stick relay 11AE-97 is as follows: positive battery 101 through a voltage regulating resistance of 400 ohms, through contacts of time releases on levers 10 and 11, provided so that relay 11AE-97 will not energize thereby releasing switch locking until after a 10-second period has elapsed after lever is placed in normal position, through a front contact of signal repeating relay 10-11-63 so that with relay 10-11-63 de-energized switches affected by relay 11AE-97 will be locked, through a front contact of relay 11A-95, track repeating relay for track circuit 11A, so that with track circuit 11A occupied with signal 10 or 11 displaying a Proceed indication relay 11AE-97 will be de-energized, through the coils of the relay, to negative battery 100. An additional circuit, cutting around the front contacts of relays 10-11-63 and 11A-95 through a front contact of relay 11AE-97, is provided to make the relay stick so that it will remain energized when track circuit 11A is occupied by a movement governed other than by signal 10 or 11. The stick relay is somewhat similar to what is commonly known as a route locking relay and is utilized for practically the same purpose.

The switch locking relay circuit for relay 18L-2-95 is as follows: positive battery 101 through a voltage regulating resistance of 400 ohms, through a front contact of repeating relay 47BX-95, repeating stick relay for track circuit 47B east and west and for repeating relay 47B-95-A, which is done to provide sufficient relay contacts, through a front contact of stick relay 32A-W as locking relay 18L-2-95 must be de-energized for any movement over track circuit 32-A, through a front contact of stick relay 11AE, to provide time locking on switch 18, as electric locks are not provided on signal levers which allows the signal lever to be restored to its normal position at once, releasing mechanical locking permitting the movement of lever 18 if the time locking was not provided, through a front contact of track repeating relay 11A-95 to provide electric switch locking for switch 18 as track circuit 11A is the track circuit in which switch 18 is located, through the coils of relay 18L-2-95, to negative battery 100.

The circuit for electric lock L18 on lever 18 is as follows: positive battery 101 through a voltage regulating resistance of 1 ohm, through a front contact of lock relay L-2-95 as lever 18 must be locked when lock relay L-2-95 is de-energized, through an open latch contact on lever 18 provided as a battery energy saving device, through the coils of electric lock 18, to negative battery 100.

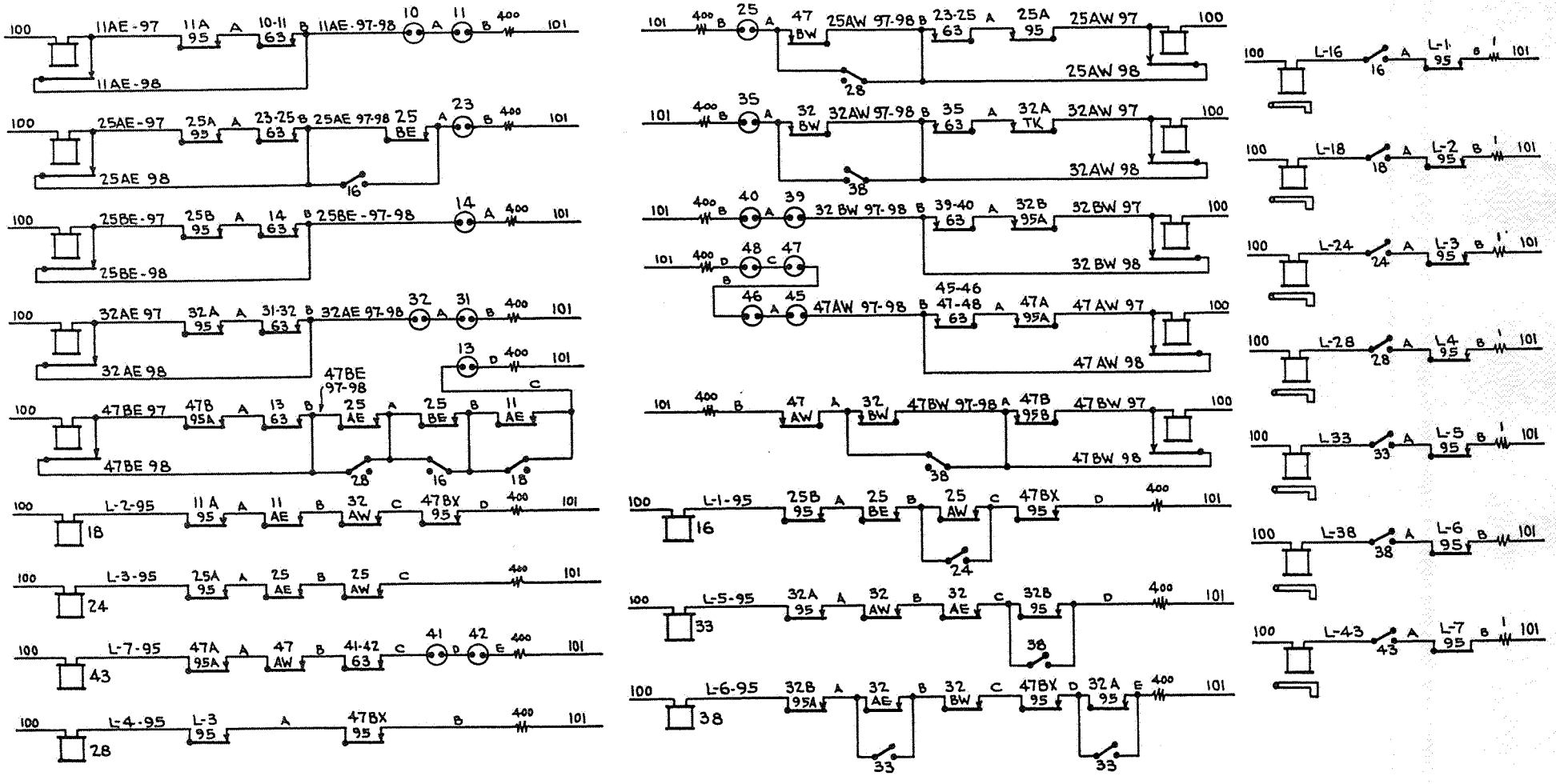


Fig. 48.
Stick Relay, Switch Lock Relay and Switch Lock Circuits.

Home or 45 degree signal circuits.

The home or 45 degree signal circuits are shown in Fig. 49. The circuit for signal control relay 10H is as follows: positive battery 101 through a voltage regulating resistance of 400 ohms, through a contact on switch lever 18 in normal position, through a polar contact of SS relay 18 in normal position and a front contact of repeating relay 18N-95, repeating relay for normal position of SS relay 18 as crossover 18 must be normal for this movement, through a front contact of track relay 11A, as signal 10 must not give Proceed indication with this track circuit occupied, through a contact on signal lever 10 closed when the lever is reversed, through the coils of home relay 10H, signal control relay, through a contact on signal lever 10 closed when the lever is reversed, to negative battery 100. The front contact of repeating relay 18-N-95 is cut around by a front contact of track repeating relay 47B-95, as home relay 10H must be de-energized with track circuit 47B occupied when crossover 18 is reversed. An additional circuit is provided between contacts on lever 10 so that coils of home relay 10H are shunted when lever 10 is normal.

The home relay circuit for signal 10 with crossover 18 reversed is as follows: positive battery 101 through a voltage regulating resistance of 400 ohms, through a front contact of relay 47AW; through a contact on switch lever 38 closed when lever is in the normal position, through polar contacts of switch repeating relays 38 and 28 closed in the normal position as these switches must be normal for this movement, through a contact on switch lever 28 closed when lever is in the normal position, through a polar contact of switch repeating relay 18 closed in reverse position as switch 18 must be reversed for this movement, through a contact on switch lever 18 closed when lever 18 is reversed for reason previously stated, through polar contact of switch repeating relay 38 closed in normal position, through a polar contact of switch repeating relay 18 closed in reverse position, through a front contact of track repeating relay 47B-95 as home relay 10H must be de-energized with track circuit 47B occupied and thence to relay 10H as previously explained.

Signal mechanism operating circuits.

Figure 50 shows the signal mechanism operating circuits. The circuit for signal 10 is as follows: positive battery 101 through a voltage regulating resistance of 200 ohms, through a contact on signal lever 10 closed when lever is reversed, through a back contact of signal repeating relay 31-41-94, as the Proceed indication of signal 10 depends upon the indications given by signals 31 and 41, (with these signals indicating Stop, signal 10 will give an Approach indication, and with either signal 31 or 41 giving an Approach indication signal 10 will give a Proceed indication), through a front contact of home relay 10H as this relay must be energized before mechanism will operate, through the coils of signal mechanism, through a front contact of relay 10H, through a back contact of relay 31-41-94, through contact on signal lever 10 closed when the lever is reversed, to negative battery 100. Relay 31-41-94 energized causes the flow of current to change direction. This is done so that the operating mechanism will change its direction of motion. In one case when the flow of current is from M to L the operating mecha-

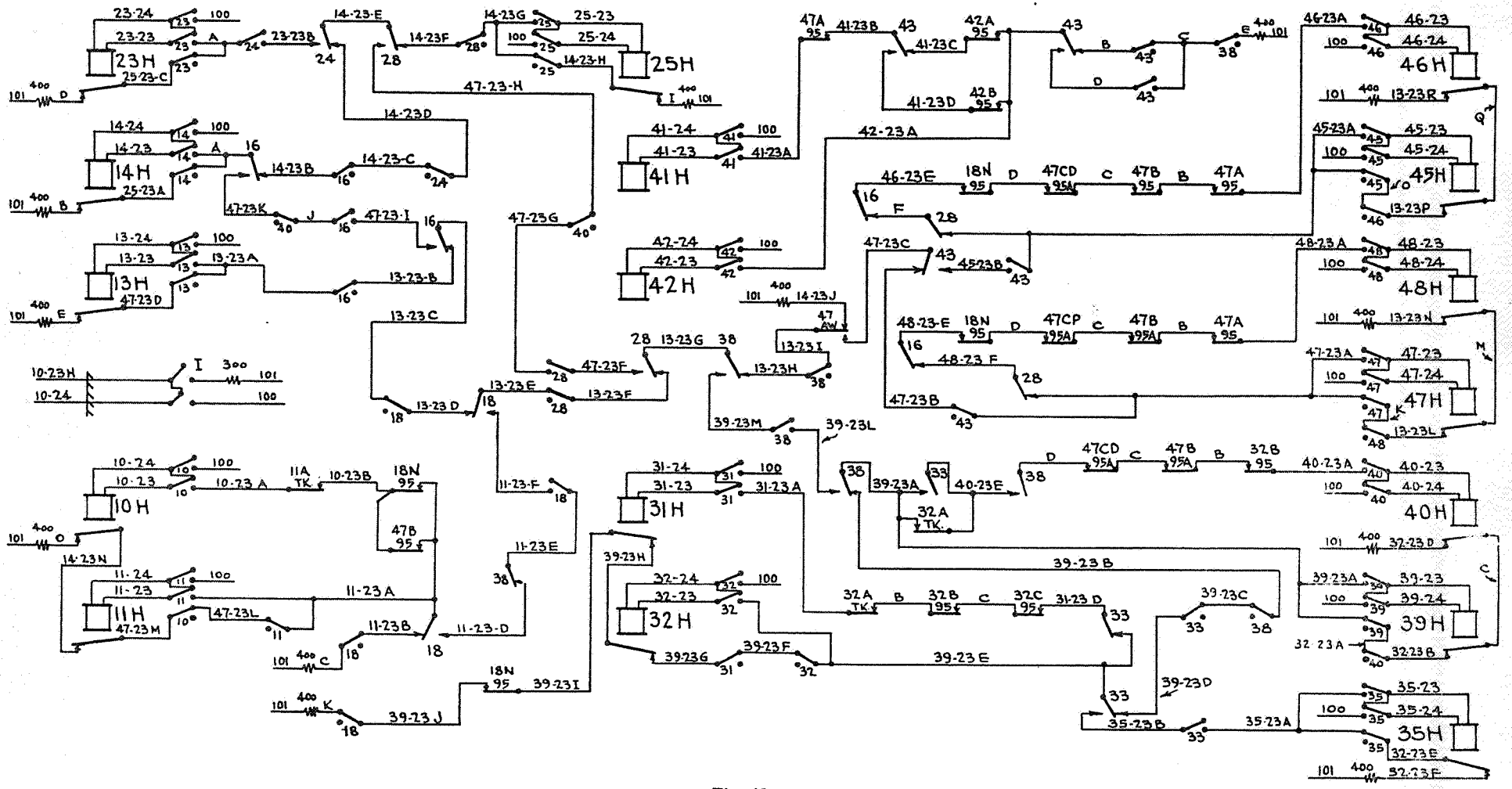


Fig. 49.
Home or 45 Degree Signal Circuits.

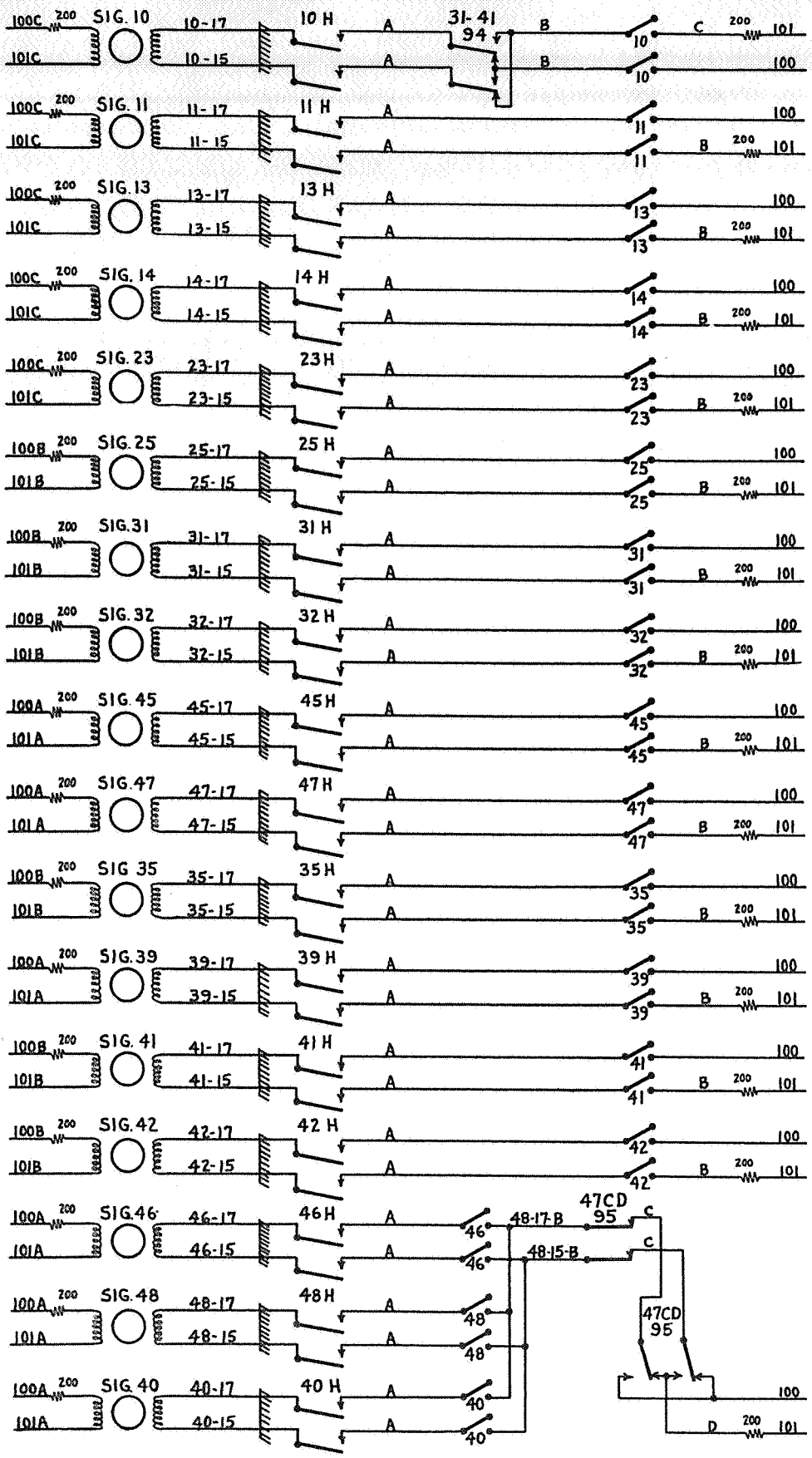


Fig. 50.
Signal Mechanism Operating Circuits.

nism will cause the signal to give an Approach indication; when the flow of current is from L to M the operating mechanism will cause the signal to give a Proceed indication. This portion of the operating mechanism is known as the armature. The circuit for the field portion of the operating mechanism is as follows: positive battery 101C through the field coils of operating mechanism, through a voltage regulating resistance of 200 ohms, to negative battery 100C.

Signal lighting circuits.

The signal lighting circuits are shown in Fig. 51. The circuit for signal 10 is as follows: alternating current C-201-A of approximately 10.5 volts through a front contact of power transfer relay, through a back contact of approach relay 6-95 to the lamps on signals 11 and 10, through the lamps, through a front contact of power transfer relay to alternating current C-200-A. The power transfer relay is used to change from alternating to direct current for lighting the signals in event of alternating current power failure. The power transfer relay is connected direct to the secondary of the lighting transformer. The direct current is taken from a storage battery floated across a rectifier.

Model board and lever light circuits.

The model board and lever light circuits are shown in Fig. 52. The control circuit for lever lights 10 and 11 is as follows: positive battery 301 through a back contact of signal repeating relay 10-11-63, through a contact on signal lever 11 closed when the lever is normal, through lever lamp for signal 10, to negative battery 300.

The lever light circuit for switch lever 18 is as follows: positive battery 301 through a front contact of lock relay L-2-95 so that with lock relay L-2-95 de-energized light on lever 18 will be out; through lamp on lever 18, to negative battery 300.

Electric switch machine circuits.

The electric switch machines operate and lock the switch by means of a switch-and-lock movement driven by a series-wound direct current motor. Three wires are used for its control: one for the normal operation (NW), one for the reverse operation (RW) and one for individual switch return wire (CW). These same wires are also used for indication purposes, the normal control wire being used for the reverse indication and the reverse control for the normal indication, the return wire being used in both indication circuits.

Typical operating, indication and cross-protection circuits for a switch are shown in Fig. 52a. When a switch is to be operated from the normal to the reverse position, the first movement of the lever is to the reverse indication position and permits current to flow in the circuit as follows: positive battery 110V from the operating bus through a 15-ampere fuse, through the safety magnet coils S located on the interlocking machine and arranged so that the same armature is actuated by both the safety and indication magnets in opposite directions, (the safety magnet when energized holds the armature so that it cannot be drawn toward the indication magnet, which

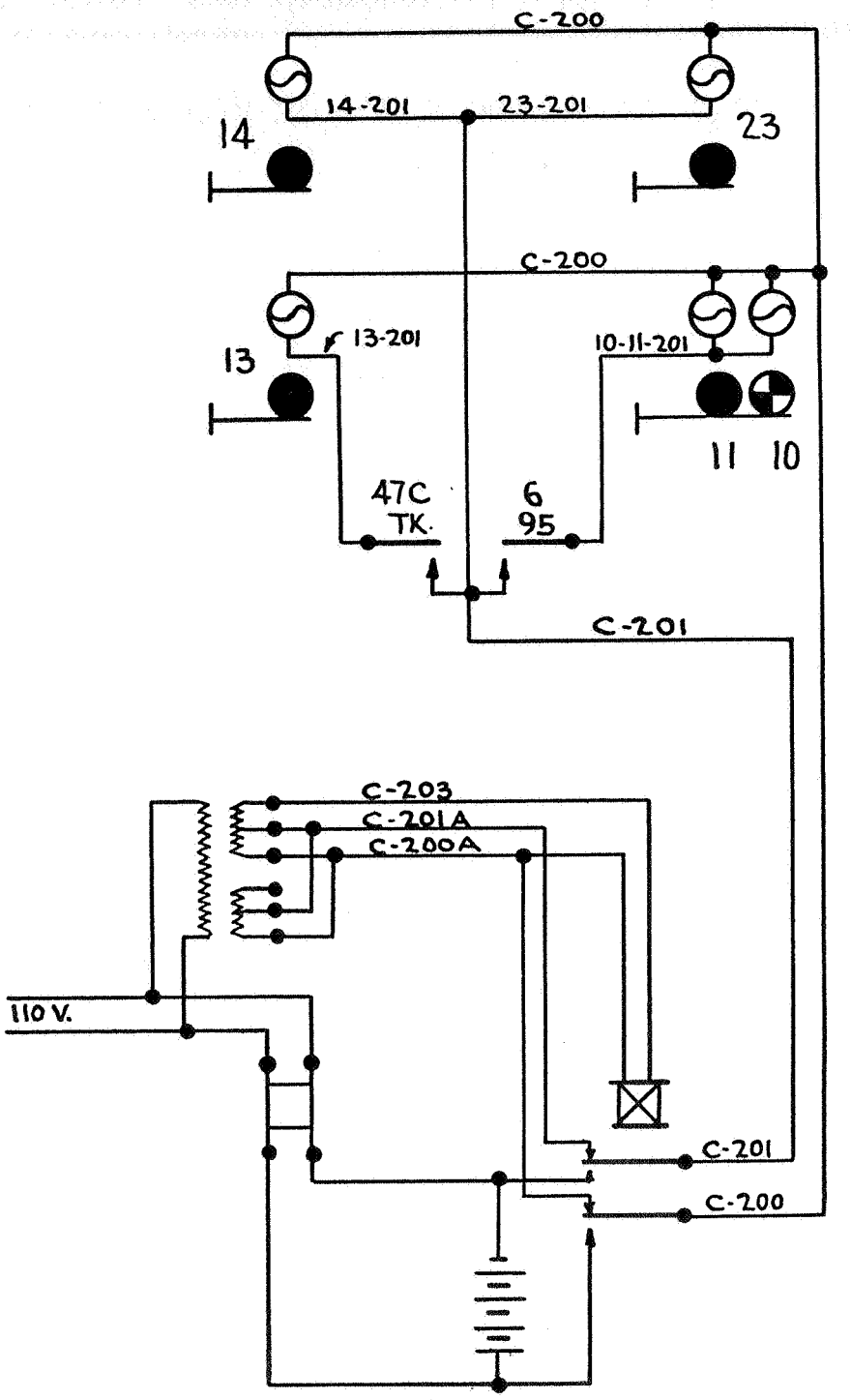


Fig. 51.
Signal Lighting Circuits.

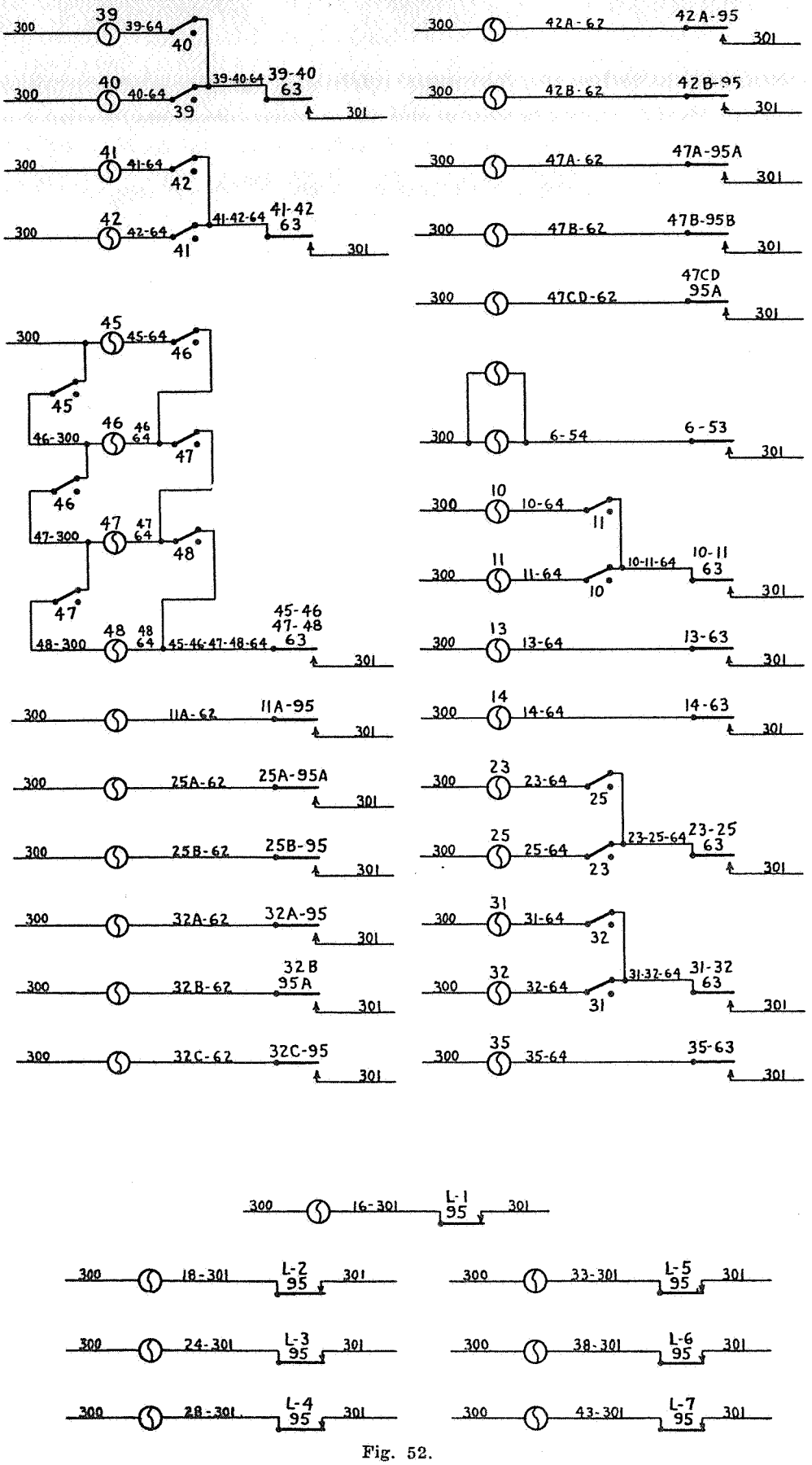
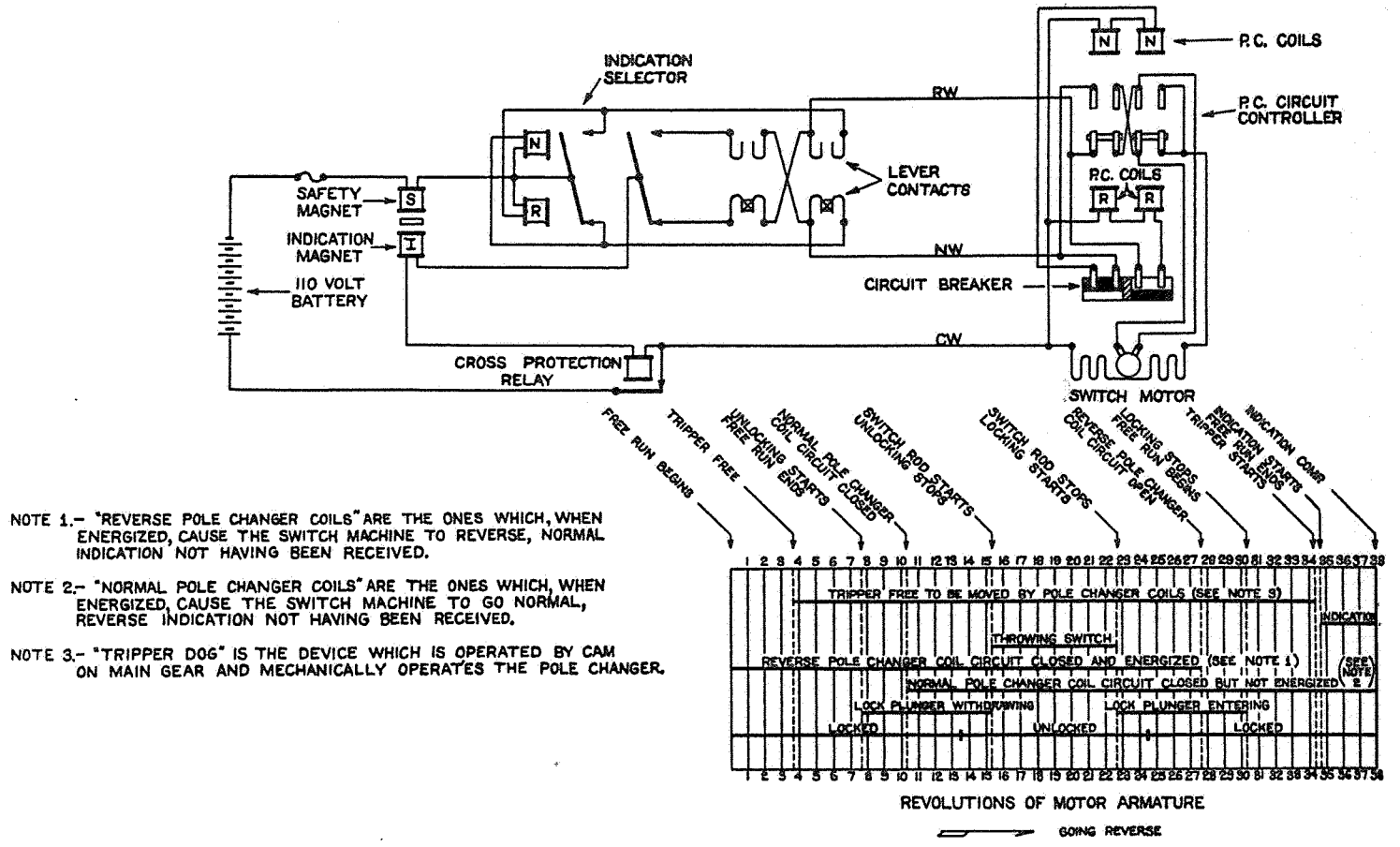


Fig. 52.
Model Board and Lever Light Circuits.



NOTE 1.– "REVERSE POLE CHANGER COILS" ARE THE ONES WHICH, WHEN ENERGIZED, CAUSE THE SWITCH MACHINE TO REVERSE, NORMAL INDICATION NOT HAVING BEEN RECEIVED.

NOTE 2.– "NORMAL POLE CHANGER COILS" ARE THE ONES WHICH, WHEN ENERGIZED, CAUSE THE SWITCH MACHINE TO GO NORMAL, REVERSE INDICATION NOT HAVING BEEN RECEIVED.

NOTE 3.– "TRIPPER DOG" IS THE DEVICE WHICH IS OPERATED BY CAM ON MAIN GEAR AND MECHANICALLY OPERATES THE POLE CHANGER.

Fig. 52a.
Typical Electric Switch Machine Circuits.

movement is necessary to obtain an indication, until the safety magnet becomes de-energized, which occurs when the switch has completed its movement; this guards against the possibility of a premature indication even if the indication magnet becomes improperly energized), through the reverse indication selector coils, (located on the interlocking machine and which actuate an armature through which the normal and reverse indication circuits are controlled, also a second armature through which the coils of the indication selector are shunted out after these coils have operated the selector armature to the reverse operating position. The shunting out of the selector coils reduces the resistance of the circuit so that sufficient current will flow to operate the switch motor), through a contact actuated by the lever, closed when lever is in the reverse indication and reverse positions, to obtain lever control of the switch; then on the RW or reverse operating wire through a contact on the pole changer circuit controller in the switch machine, closed when the switch machine is normal; through the armature windings of the motor, through another contact on the pole changer circuit controller closed when the switch machine is normal, through the field windings of the motor to the CW wire, through a closed contact on the cross-protection relay, to negative 110-volt battery.

The pole changer circuit controller in the switch machine is operated normally through mechanical connections known as tripper dogs, by the movement of the switch machine, contacts closed when the switch machine is normal will remain closed until the switch has completed its movement and is locked in the reverse position at which point an escapement is provided in the machine which causes the pole changer to operate to the reverse position and thus opens the reverse operating circuit and de-energizes the safety magnet on the interlocking machine. This escapement also provides for a free run of the motor after the pole changer has operated. This free run of the motor generates a dynamic current for the indication circuit which is closed at this time and dynamic current flows as follows: from the positive motor brush, through a contact on the pole changer closed when switch is reversed and locked, through the motor fields to the CW wire to the interlocking station, through the cross-protection relay, through the indication magnet, through a contact on the indication selector closed when the lever is in the reverse indication and reverse position, through a contact on the lever closed when the lever is in the reverse indication and reverse position, to the NW wire to the switch machine, through a closed contact on the pole changer circuit controller, to the negative motor brush. This energizes the indication magnet which attracts its armature thus releasing the indication mechanism of the lever permitting its movement to the reverse position. This closed circuit also provides dynamic braking of the motor thereby relieving strain on mechanism parts which would otherwise occur due to abrupt stopping of the motor at the limit of its travel.

Provision is also made for operating the pole changer in the switch machine electrically when the machine is in midstroke. Pole changer magnet coils and a separate circuit controller are provided for this purpose in the switch machine.

The circuit controller is mechanically operated from the locking bridle, the movement of which also disconnects the mechanical connection to the pole changer when the switch starts to unlock and closes contacts through

which the pole changer coils are controlled. The circuit for the control of the pole changer magnet is as follows: positive battery from the reverse operating RW wire through contacts of the circuit controller closed except when the switch machine is in the fully locked position, through the pole changer coils to the CW wire and negative battery.

The electrical operation of the pole changer is provided to cause the switch machine to assume the position corresponding with the position of the lever in case the lever is operated to its opposite position before the switch machine has completed its movement.

The cross-protection relay is of the polar type, its contacts are held closed by permanent magnets and all normal currents pass through the coils of this relay in the direction tending to maintain the contacts closed, but all currents which may be applied to the operating wires through any other channel, such as crosses or grounds, must pass through the coils in the opposite direction which will cause its contacts to open, which in turn will cut power off that switch. The relay may be manually reset but only after the condition which caused it to open has been removed.

Referring again to Fig. 52a and assuming a cross exists between the normal NW and reverse RW operating wires when the lever is in the normal position, the circuit which will cause the cross-protection relay to open is as follows: positive battery through the cross from the NW to the RW wires, through a closed contact on the lever, through a closed contact on indication selector, through the indication magnets, through the coils of cross-protection relay in the reverse direction, through a closed contact on the cross-protection relay, to negative battery.

The operation of a switch from the reverse to the normal position is accomplished in the same manner.

Figure 52a also shows a tabular form from which the cycle of movement may be readily determined based on the number of revolutions of the switch motor armature. This form, together with notes 1, 2 and 3, is self-explanatory. The cycle of movement for a switch operating normal is in the same order as operating reverse.

As the interlocking just described includes circuits applicable only to a certain type of electric interlocking, the following description of another type is included in order to provide the student with information pertaining to the circuit arrangement for such an installation.

Track and signal layout.

The track and signal layout is shown in Fig. 52b. The signals are of the semaphore, searchlight and color light type, the switches are operated electrically.

The track circuits are direct current and it will be noted that storage batteries are used, the batteries being charged through a rectifier connected to a transformer fed from a 110-volt 60-cycle source of energy. Figure 52c shows the track circuits approaching the interlocking. It also shows the typical interlocking track circuits as well as those entering into the control of trap circuit 23TS shown in Fig. 52d.

Track repeater, approach, trap circuit and annunciator relay circuits.

Figure 52d shows the track repeater, approach, trap circuit and annun-

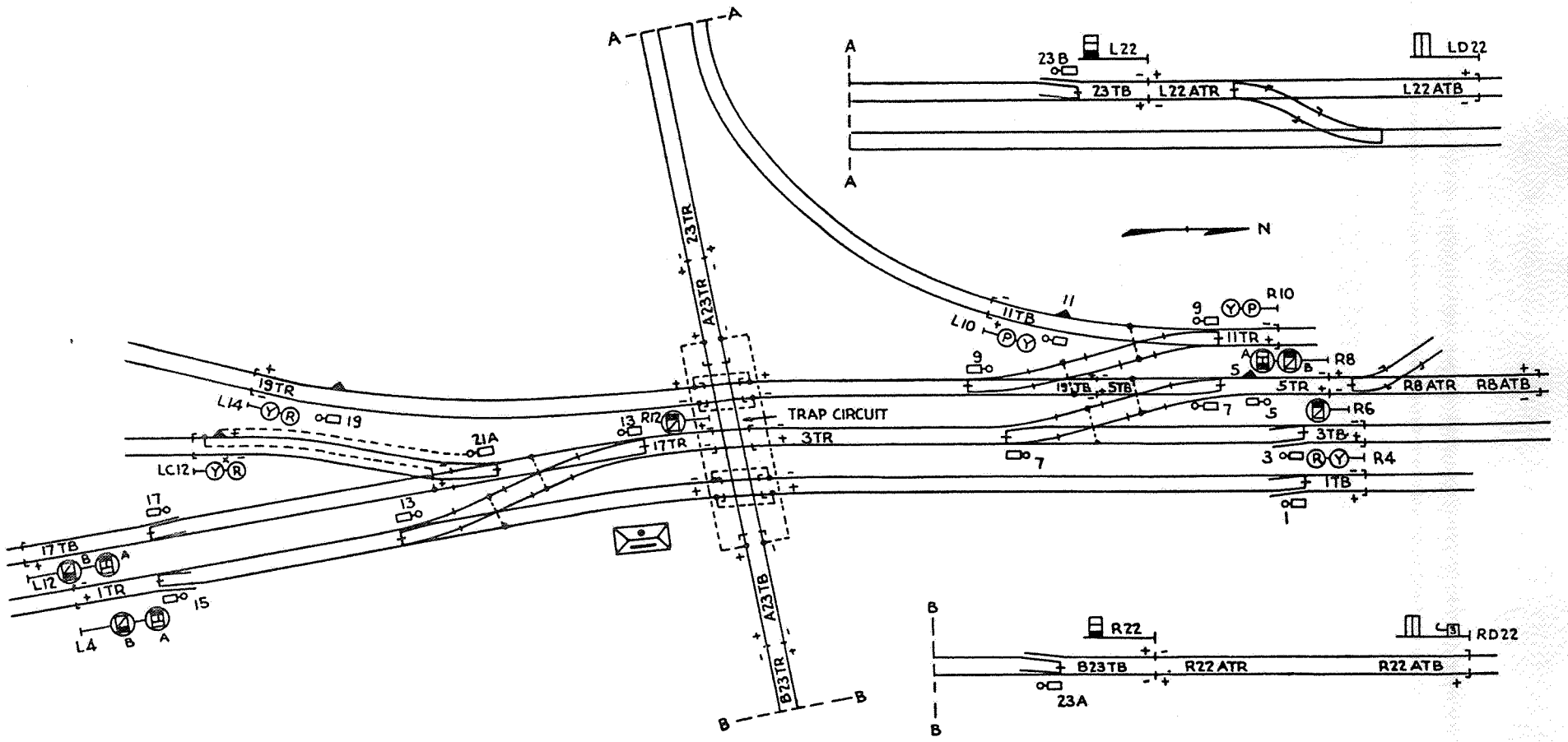


Fig. 52b.
Track and Signal Layout.

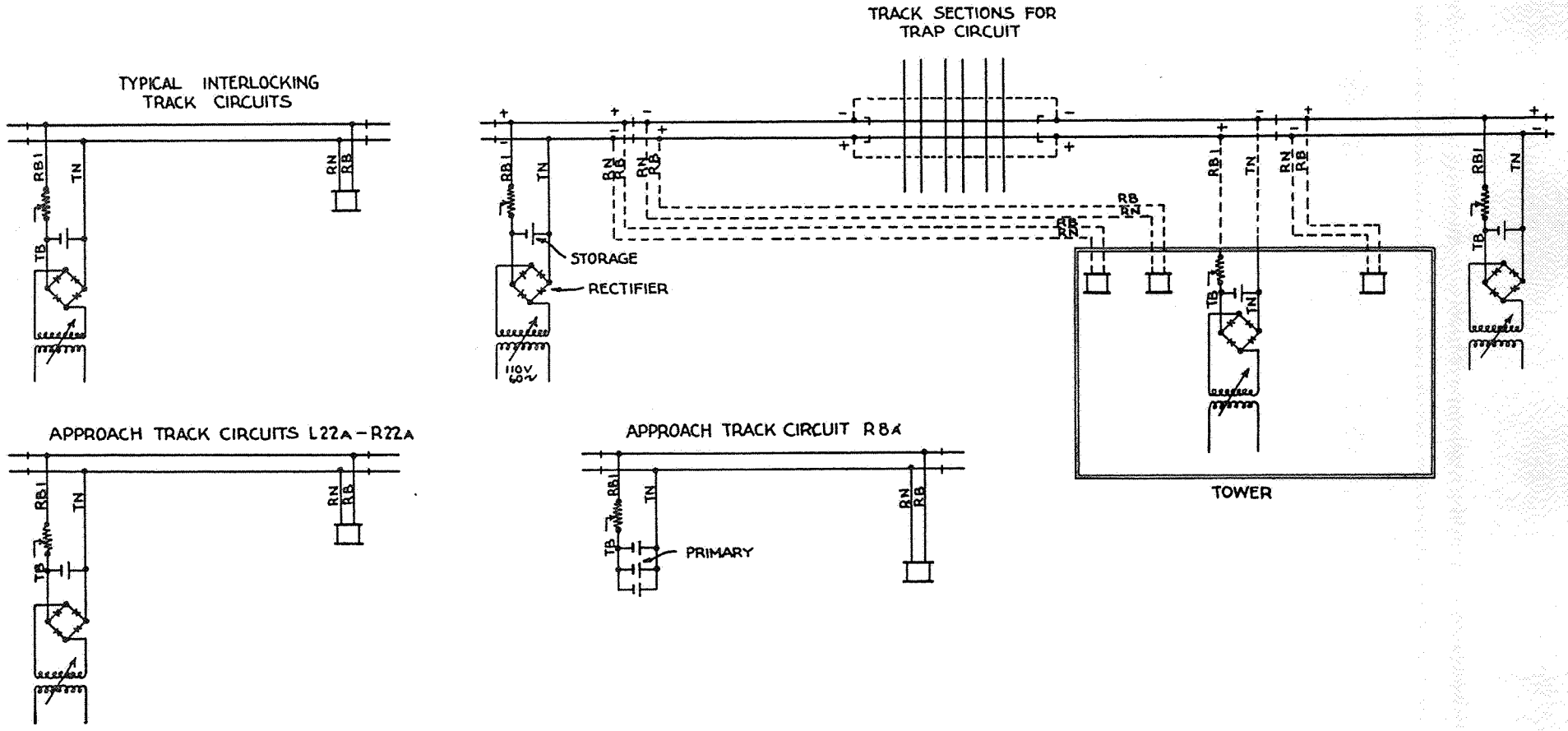


Fig. 52c.
Track Circuits.

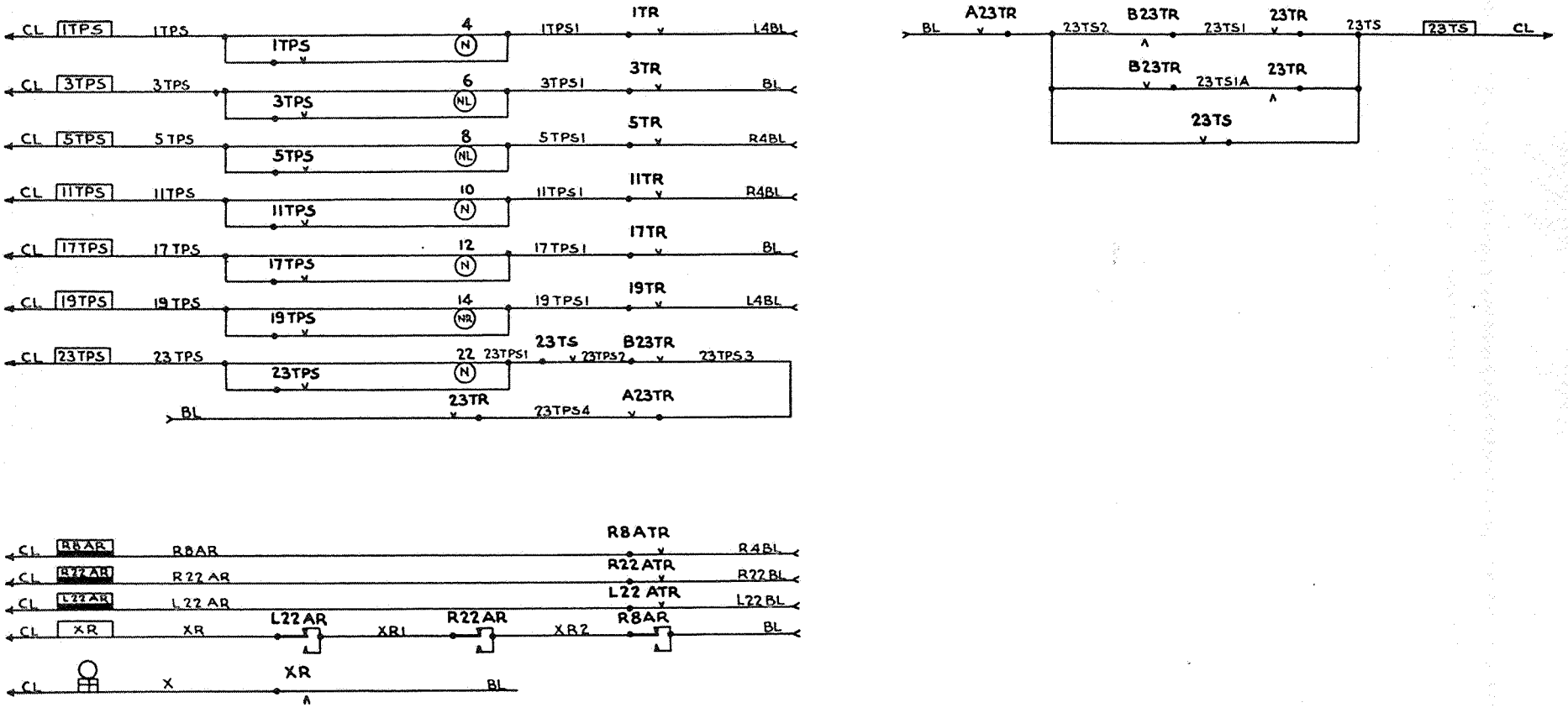


Fig. 52d
Track Repeater, Approach, Trap Circuit and Annunciator Relay Circuits.

ciator relay circuits. The circuit for track repeater relay 1TPS is as follows: positive battery L4BL through a front contact of track relay 1TR, the track relay to be repeated; through a contact on lever 4 closed when the lever is in the normal position, through the coils of relay 1TPS, to negative battery CL. Before the circuit goes through the contact on lever 4 an additional circuit is tapped off going through a front contact of relay 1TPS; this circuit provides the stick feature to relay 1TPS required later in the signal circuit to enforce the operator to restore signal lever 4 to the normal position after a train movement has been made by signal 4 as explained later. The other track repeater relay circuits are the same except in the case of relay 23TPS. The circuit for this relay takes in all track sections between signals L22 and R22; the principle of the circuit, however, is the same as the semi-automatic feature of the signals involved extends throughout these limits.

The circuit for approach relay R8AR is as follows: positive battery R4BL through a front contact of track relay R8ATR, the track relay for the circuit in the rear of signal L22; through the coils of relay R8AR to negative battery CL.

The circuit for annunciator relay XR is as follows: positive battery BL through front and back contacts of approach relays R8AR, R22AR and L22AR, through coils of relay to negative battery CL. One bell is used for announcement on all tracks, and with any of the approach relay track circuits occupied the bell will ring. Front and back contacts are provided to make the bell single-stroke for if it were not for this arrangement the bell would ring continuously while the train occupies the approach relay track circuit. It will be noted that relay XR is only de-energized during the time the various approach relays are opening.

The circuit for annunciator bell is as follows: positive battery BL through a back contact of relay XR, through the coil of the bell to negative battery CL.

The trap circuit is also shown in Fig. 52d and the pick-up circuits are as follows: positive battery BL through a front contact of relay A23TR, through a back contact of relay B23TR, through a front contact of relay 23TR, through the coils of the trap circuit relay 23TS to negative battery CL, or positive battery BL through a front contact of relay A23TR, through a front contact of relay B23TR, through a back contact of relay 23TR, through coils of relay 23TS, to negative battery CL. The stick circuit is as follows: positive battery BL through a front contact of relay A23TR, through a front contact of relay 23TS, through coils of relay 23TS, to negative battery CL. It will be noted that as soon as relay A23TR is de-energized relay 23TS is de-energized and will remain de-energized as long as relay A23TR is de-energized and relay 23TS will not be energized again until a movement in either direction is made over track circuits B23T and 23T. This portion of the circuit is to insure that the trap circuit relay remains de-energized during the movement over the crossing. After a movement has been made over the crossing and track circuit 23T is occupied, relay B23TR will then energize and with relay 23TR de-energized relay 23TS energizes and remains energized through the front contact of relay A23TR and its own front contact.

Mention has been made of various batteries in the foregoing explanation and additional batteries will be referred to later. To be able to better

understand the arrangement of batteries at this interlocking, the power distribution is shown in Fig. 52e. The power circuits including the power transfer relays, switches and rectifiers as shown may be easily followed.

KR relay, switch indication lock and indicating light circuits.

The KR relay circuits are shown in Fig. 52f, these relays being polarized and used as switch repeating relays. The circuits are typical for the switches as shown. The KR relay circuit shown for the crossovers is as follows: positive battery BL through a contact in Type "F" controller and through a contact in circuit controller of switch machine closed when the Type "F" controller and switch machine are normal on one end to insure the controller and switch machine are in proper position with respect to the switch on the ground; through a contact in the Type "F" controller and the circuit controller of switch machine on the other end closed when the Type "F" controller and switch machine are normal for the reason previously stated, through the coils of relay KR, through contacts of circuit controller of switch machine on each end closed when the machine is in the normal position to insure against crosses and grounds, to negative battery CL.

In the Type "F" controller a reverse contact is utilized to shunt the coils of KR relay prior to the unlocking of the switch machine which further insures the de-energizing of KR relay during each movement. As soon as the switch starts to unlock the shunt circuit is transferred to contacts in the circuit controller of the switch machine which are closed until the switch machine is locked in the opposite position.

In the circuit just explained it will be noted that positive current flows over wire KR to the relay with the switch normal. When the switch is reversed the contacts of the Type "F" controller and circuit controller in switch machine change position at which time positive current will flow over wire NKR, through the coils of the relay. This change in the direction of the flow of current causes the KR relay to operate in such a manner that its polar contacts will close in the opposite position from which they closed in the original operation. The reason for this change is to provide what is known as polarized switch indication, which means that with the switch normal the normal polar contacts on the KR relay will be closed and with the switch reversed the reverse polar contacts will be closed.

The indication lock circuit is also shown in Fig. 52f and is as follows: positive battery BL through a contact on the switch lever closed from the reverse indication point to the reverse position; through a front neutral and a reverse polar contact of the KR relay, through a contact on the switch lever closed from the normal to the reverse indication position; through the coils of reverse indication magnet, to negative battery CL. The indication lock circuit for the switch moving normal is the same except that the movement of the lever is in the opposite direction and the contacts on the switch lever and KR relay closed accordingly.

A light is provided on the machine to indicate when the KR relay is de-energized. The circuit is shown in Fig. 52f and is as follows: positive battery BL through a contact on switch lever closed from the normal to the normal indication position; through a back contact of the KR relay; through a limiting resistance of 30 ohms, to limit voltage at the lamp; through the

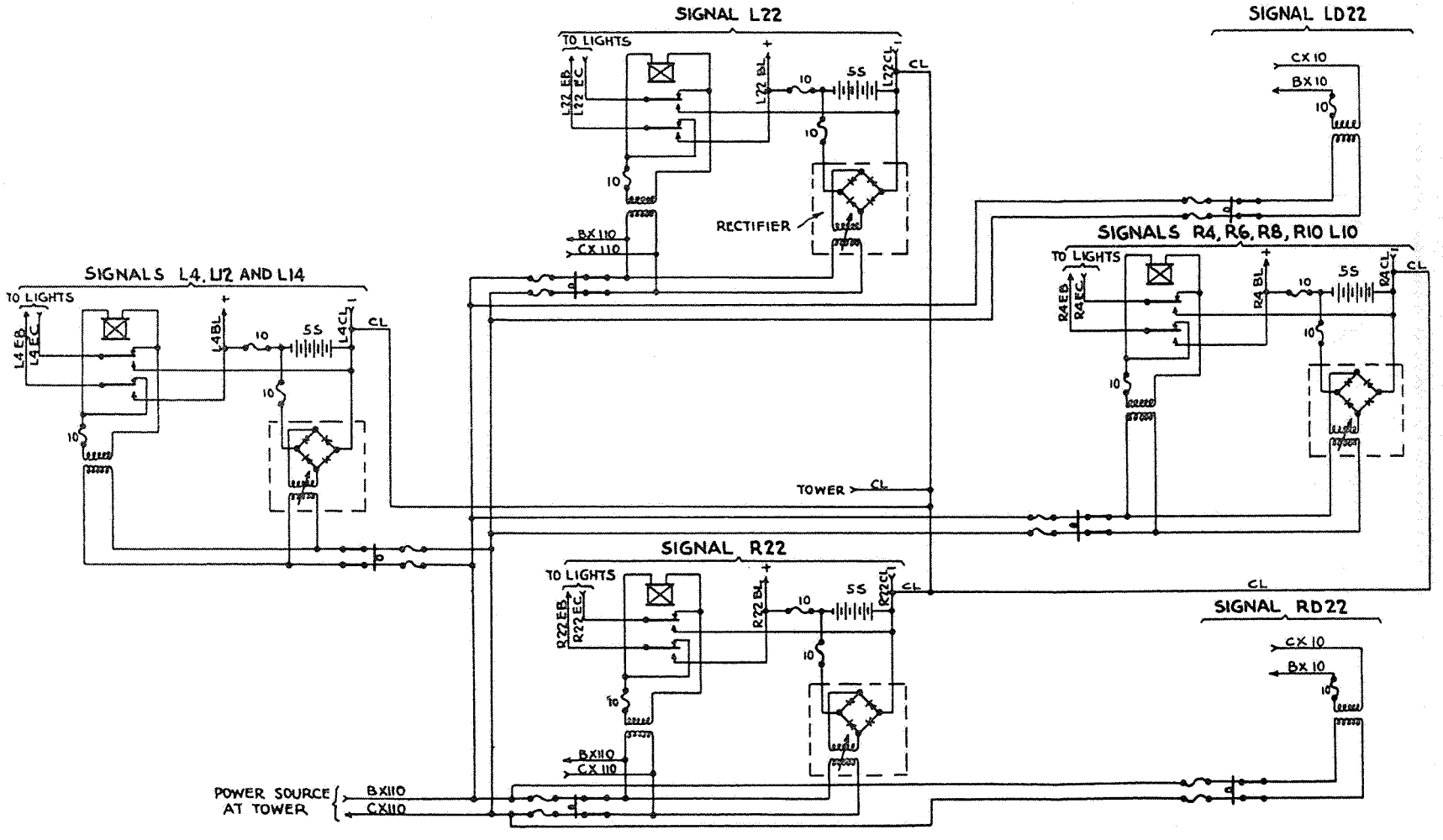
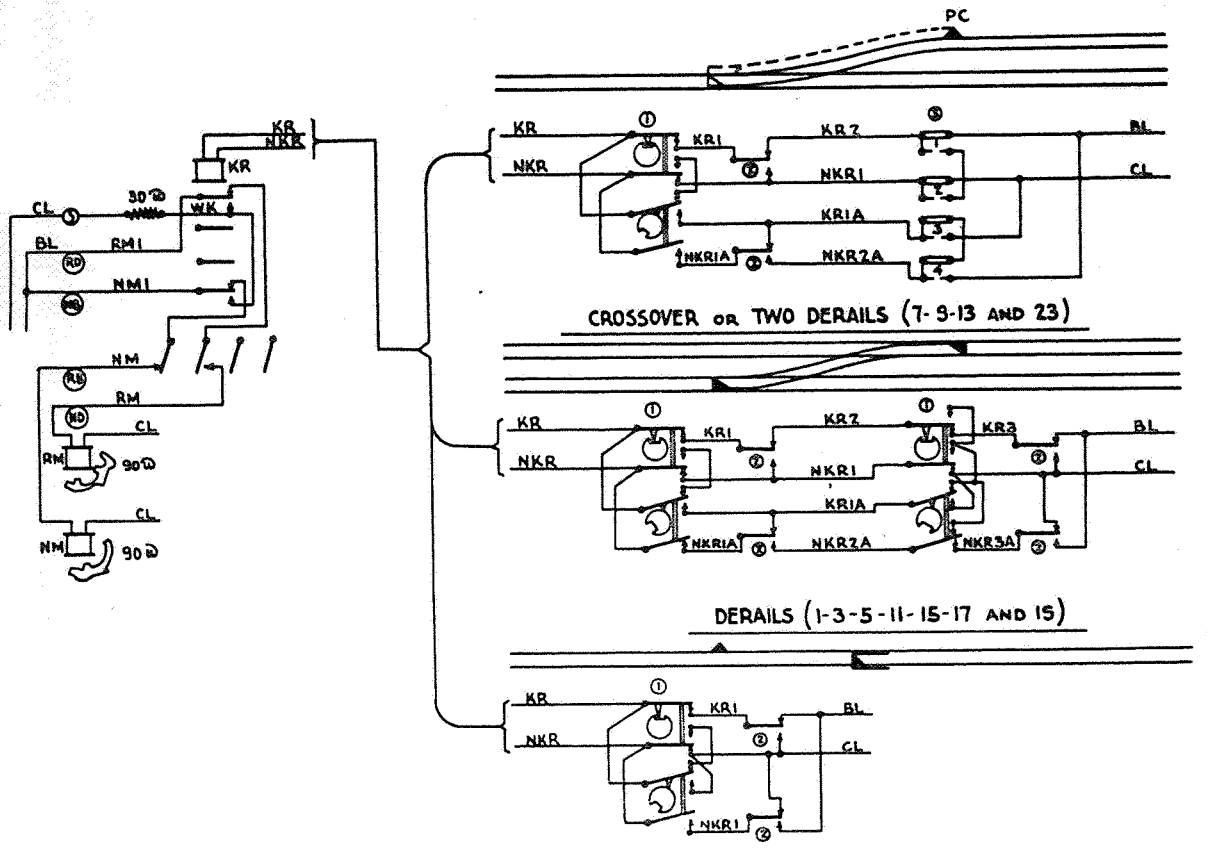


Fig. 52e.
Power Distribution Diagram(in the Field).



① = INDICATION CIRCUIT CONTROLLER ON SWITCH MACHINE.
② = CONTACTS ON TYPE "F" CONTROLLER
③ = SWITCH CIRCUIT CONTROLLER CONNECTED TO DERAIL

Fig. 52f.
KR Relay, Switch Indication Lock and Indicating Light Circuits.

filament of the lamp to negative battery CL. A similar circuit is shown for the control of the light with the lever between the reverse and the reverse indication position.

Home signal circuits.

The home signal circuits are shown in Fig. 52g, sheets 1 and 2. The circuit for signal LB4 over switch 13 reverse is as follows (See sheet 2): positive battery BL through a contact on lever 4 closed from the normal to the left position as the opposing signal for this movement is with lever 4 to the right; through a contact on lever 1 closed when the lever is reverse, as the lever must be reverse; through a contact on lever 13 closed when the lever is reverse as lever 13 must be reverse; through neutral front and reverse polar contacts of KR relays 1, 13 and 15, as these derails and crossover must be reverse and locked before the signal can display a Proceed indication; through a contact on lever 15 closed in the reverse position as the lever must be reverse; through a contact on lever 13 closed when the lever is in the reverse position for the reason as stated previously; through a contact on lever 4 closed when the lever is in the left position as lever 4 controls the signal involved for this movement and the lever must be to the left to display the Proceed indication; through the operating coils of signal LB4; through a contact on lever 4 closed in the left position to insure against crosses and grounds, to negative battery CL.

The circuit for signal LA4 over crossovers 13 and 7 normal is as follows (See sheet 2): positive battery BL through a contact on lever 8 closed from the normal to the left position as lever 8 must be normal; through a contact on lever 5 closed in the reverse position as lever 5 must be reverse; through a front neutral and reverse polar contact of KR relay 5 as derail 5 must be reversed and locked; through a front neutral and normal polar contact of KR relay 7 as crossover 7 must be normal and locked; through a contact on lever 7 closed in the normal position as lever 7 must be normal; through a contact on lever 12 closed from the normal to the left position as lever 12 must be normal; through a front neutral and normal polar contact of KR relay 13 as crossover 13 must be normal and locked; through a contact on lever 13 closed in the normal position as lever 13 must be normal; through a front neutral and reverse polar contact of KR relay 15 as derail 15 must be reversed and locked; through a contact on lever 15 closed when the lever is reverse; through contacts on levers 7 and 13 closed in the normal position as these levers must be normal; through a front contact of track repeating stick relays 1TPS and 5TPS to provide track circuit protection and also the semi-automatic feature for signal LA4 which requires the operator to restore the signal lever after each movement through the interlocking before a signal to proceed can be again displayed for a following train; through front contacts of track relays 3 and 17TR to provide continuous track circuit protection, through a contact on signal lever 4 closed in the left position; through a front contact of signal repeating relay LB4RGP; through operating coils of signal LA4; through a contact on signal lever 4, closed in the left position to insure against crosses and grounds, to negative battery CL.

A calling-on signal is also provided on signal L4 for the route just outlined. This circuit is tapped off the last one described after the circuit passes through a contact on lever 15 closed when lever 15 is reverse, the

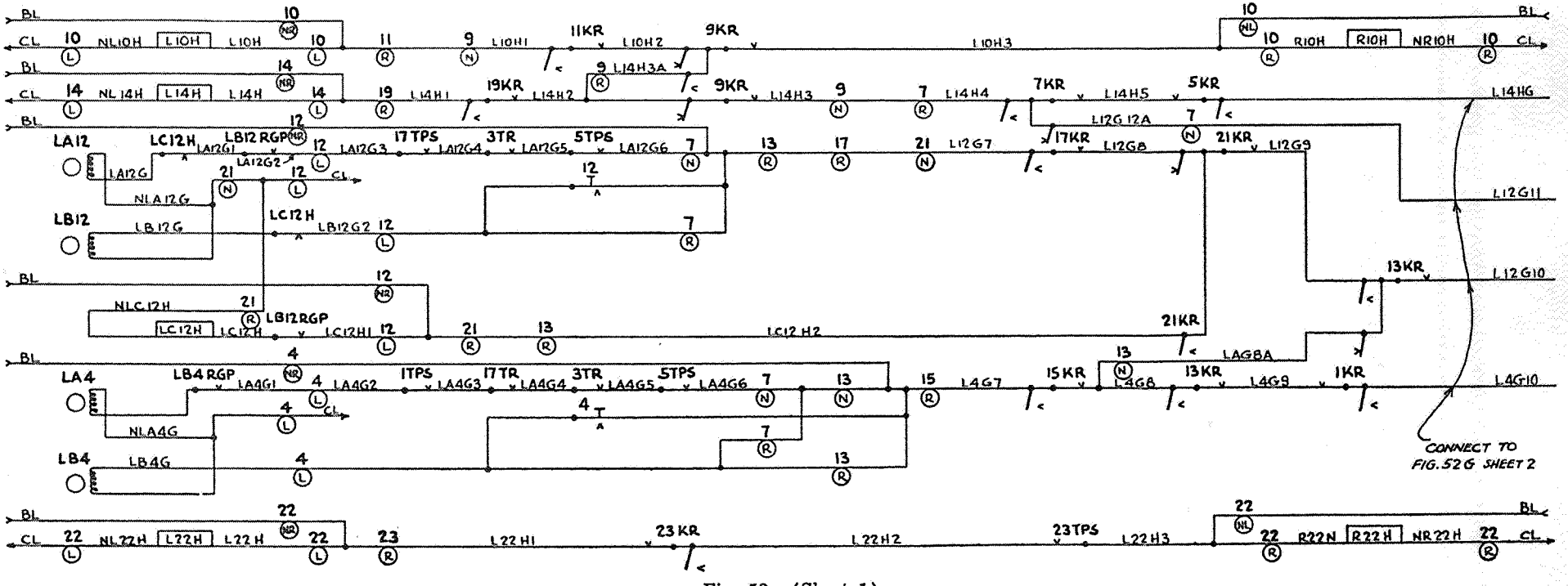


Fig. 52g (Sheet 1).
Home Signal Circuits.

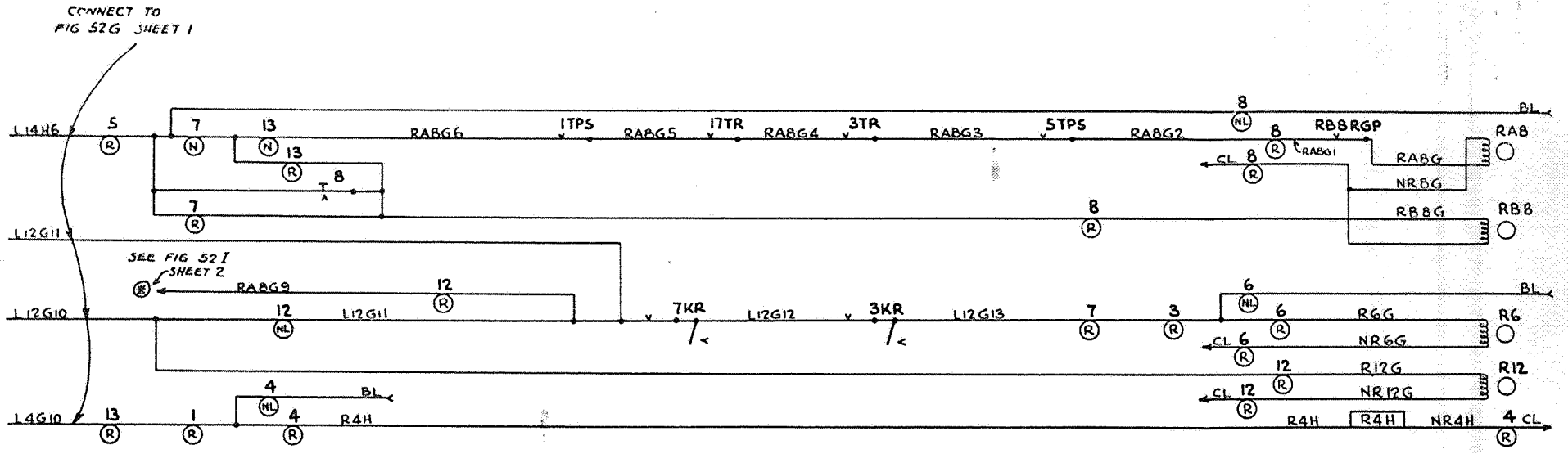


Fig. 52g (Sheet 2).
Home Signal Circuits.

circuit passing through push button 4 to a contact on lever 4 closed when the lever is to the left, through the operating coils of signal LB4; through a contact on lever 4 closed when the lever is in the left position, to negative battery CL. From this circuit it will be noted that with a train occupying any track circuit between signals L4 and R8 a following move can be made by operating push button 4 with lever 4 to the left.

Local signal wiring.

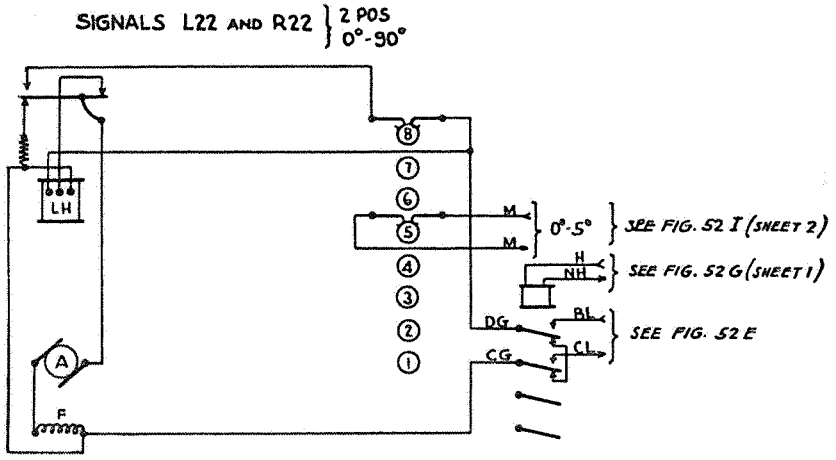
Figure 52h shows the local signal wiring for all signals including lighting, mechanism operating and lock circuit control.

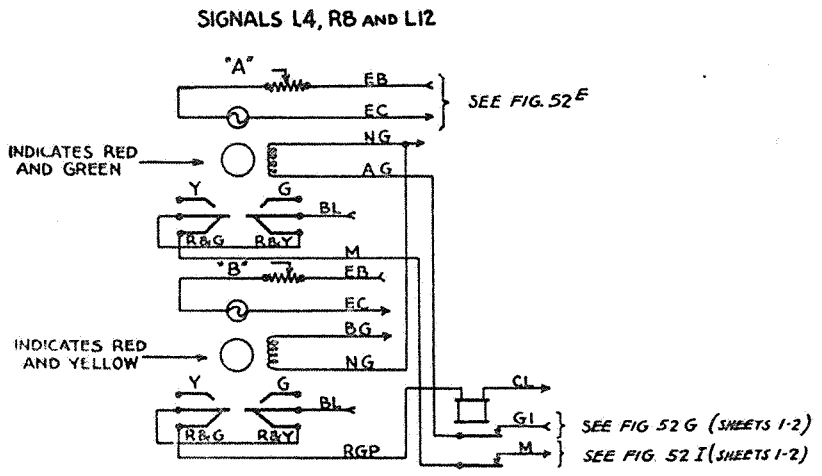
The mechanism operating circuit for semaphore type signals L22 and R22 is as follows: after relay H is energized from circuits as shown in Fig. 52g (sheet 1), positive battery BL through a front contact of the H relay; through the low-resistance winding on signal slot; through a slot contact closed when slot de-energized; through resistance; through front contact of H relay to negative battery CL. After motor slot energizes a tap from positive battery is taken through a contact on circuit controller of mechanism closed when the mechanism is at stop and until it reaches about 89 degrees; through a contact closed when the slot is energized; through the armature of motor; through field winding of motor, through front contact of H relay to negative battery CL. The slot magnet in the mechanism has two windings, one a low-resistance winding used to energize the slot and the other a high-resistance winding used to keep the slot energized while operating and to hold the signal in proceed position. A resistance is provided to retard the mechanism when the signal is returning to Stop. The H relay in de-energizing forms a shunt circuit over its back contacts and the signal motor in returning to Stop acts as a generator delivering current through the snubbing resistance which retards its movement sufficiently to keep the semaphore arm from striking the stop with any great amount of force.

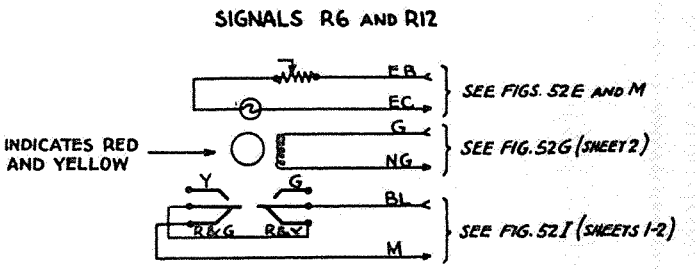
The lighting and operation of searchlight and color light type signals have been explained in detail in this chapter.

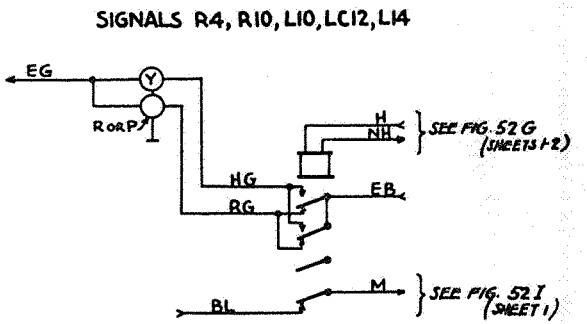
Signal indication lock, signal mechanism and time release repeater relay, and indicating light circuits.

The signal indication lock, signal mechanism and time release repeater relay and indicating light circuits are shown in Fig. 52i (sheets 1 and 2). The lock circuit for signal lever 4 is as follows: positive battery L4BL through a circuit controller contact of signal mechanism LA4 closed when the mechanism is in the stop position; through a front contact of relay LB4RGP, the repeating relay for signal mechanism LB4 energized when this signal is at Stop; through a contact on lever 4 closed when the lever is at the normal indication position, in order to prevent the lock magnet from energizing until such time as the indication point is reached; through a normally closed contact of push button 4PB to insure that the push button controlling the calling-on signal is in the normal position; through a back contact of track repeating stick relay 1TPS which insures that the track circuits in advance of the signal have been occupied and also prevents the restoring of the signal lever to normal if the track circuits have not been de-energized until such time as a time release has been operated; through the coils of the lock magnet on lever 4 to negative battery CL.









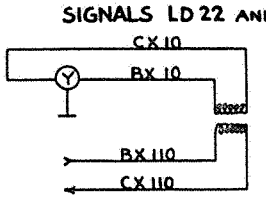


Fig. 52h.
Local Signal Wiring.

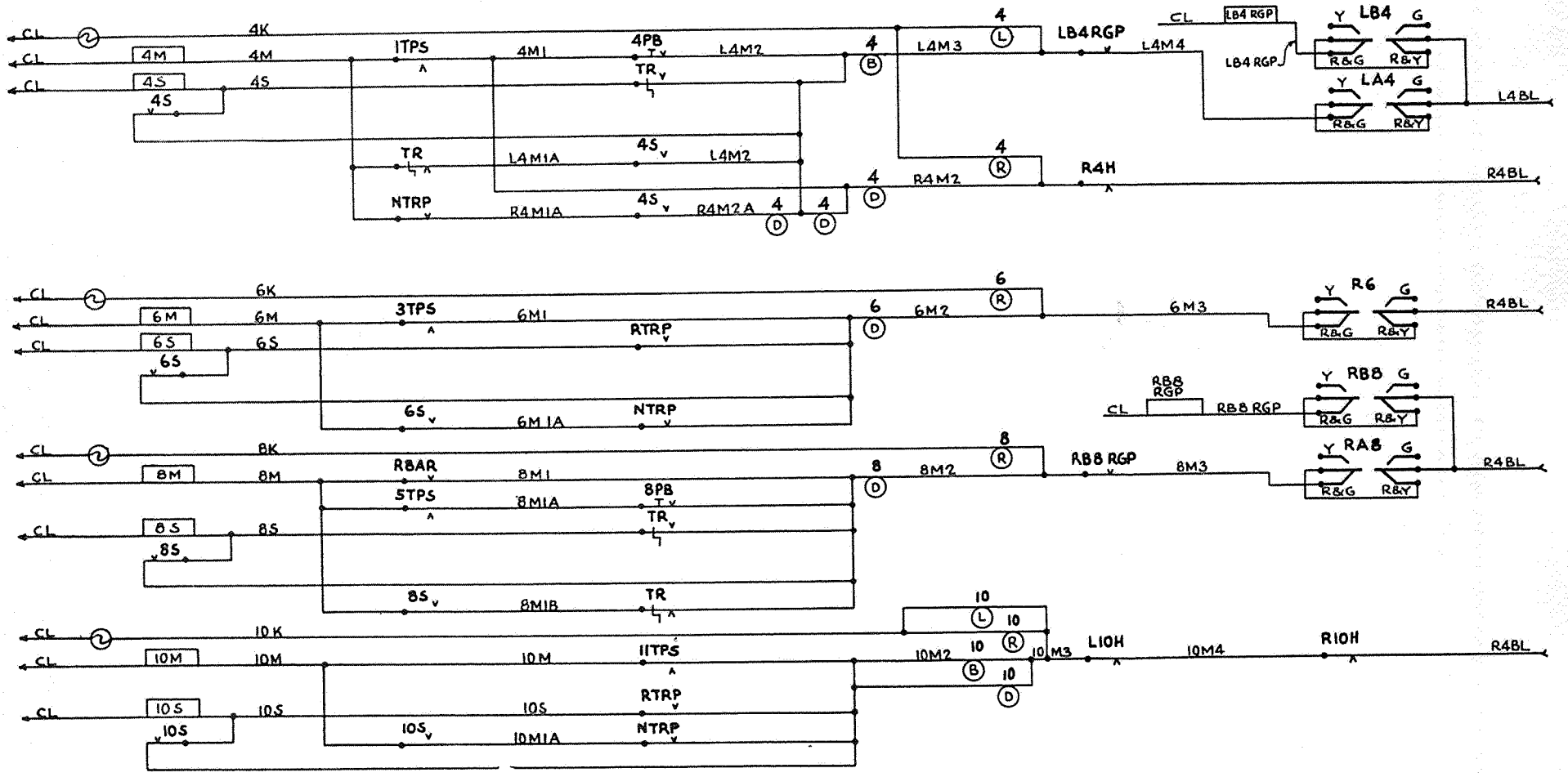


Fig. 52i (Sheet 1).
Signal Indication Lock, Signal Mechanism and Time Release Repeater Relay, and Indicating Light Circuits.

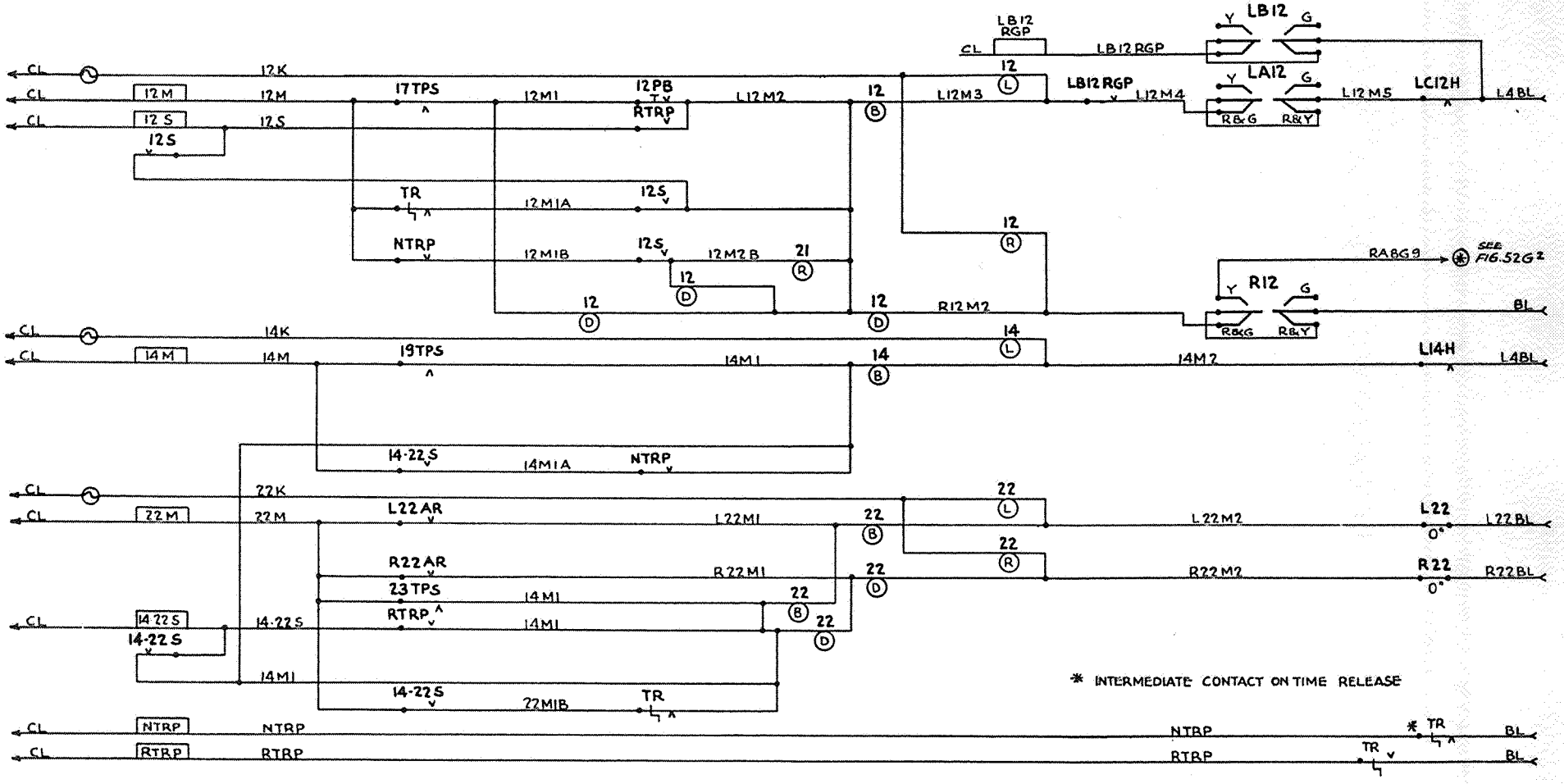


Fig. 52i (Sheet 2).
Signal Indication Lock, Signal Mechanism and Time Release Repeater Relay, and Indicating Light Circuits.

It will be observed that the normally closed contact on push button 4PB in series with back contact of relay 1TPS provides for release of the time locking when a train accepts semi-automatic signal LA4 and enters track circuit 1T. When a train is advanced by means of the "call-on" signal this contact on the "call-on" push button will remain open until the signal lever has been moved beyond the indication position, thus making the time locking effective for the "call-on" signal.

After the circuit passes through the contact on the signal lever closed at the indication point a tap is taken off the circuit going through a normally open contact of time release, through the coils of time release relay 4S to negative battery CL. An additional circuit is tapped off at the same point going through a front contact of relay 4S through the coils of relay 4S, to negative battery CL. A further circuit is tapped off at the same point passing through a front contact of relay 4S, through a contact in the time release made when the time release is run down, through the coils of magnet 4M, to negative battery CL. These cut around circuits are designed to provide time locking for the signal lever. Time release TR is without latch; when this time release is operated relay 4S energizes provided the initial circuit is complete; when relay 4S energizes it remains energized due to the stick circuit through its own front contact. Time release now starts to run down taking 1½ minutes to do so, closing its contact. When contact of time release closes the magnet on lever 4 energizes due to the circuit passing through the front contact of relay 4S and the contact of the time release.

A circuit has also been provided to notify the operator that the signal has displayed a more favorable aspect than Stop; this is done by means of a circuit tapped off the lock circuit after the circuit passes through front contact in signal repeating relay LB4RGP. The circuit goes through a contact on lever 4 closed when the lever is to the left, through the filament of a lamp, to negative battery CL. From this circuit it will be noted that from the time lever 4 is to the left and the mechanism starts to operate, a light over lever 4 will burn; as soon as the mechanism starts to operate the circuit is opened and the light is extinguished.

The signal repeating relay circuit for relay LB4RGP is as follows: positive battery L4BL through contacts of signal mechanism LB4 closed when the signal is at stop, through the coils of the relay to negative battery CL. This relay is provided to repeat the signal in the stop position.

There are also shown in Fig. 52i repeating relays for time releases. These circuits, however, are very simple and no explanation will be given.

Electric switch lever locking circuits.

The switch and route locking circuits are shown in Fig. 52j. The route locking circuit for lever 5 is as follows: positive battery BL through a front contact of track repeating stick relay 5TPS because lever 5 must be locked when track circuit 5TR is occupied, relay 5TPS being a repeating relay for track relay 5TR; through a front contact of track repeating relay 19TPS cut around by means of a contact on lever 9 closed when the lever is reverse due to the fact that with crossover 9 normal a movement over track circuit 19TR must lock lever 5 because with crossover 9 normal a move would be

made over derail 5; through a front contact of track repeating relay 1-17NS route locking relay controlled over track repeating relays 1, 3 and 17TPS cut around by a contact on lever 7 closed when lever 7 is reverse, this portion of the circuit to provide locking over lever 5 when track circuits 1, 17 or 3 are occupied and for a normal movement lever 5 is locked as soon as signal L4B is passed and track circuit 1TR is occupied; the cut around through the reverse contact in lever 7 is provided to release the locking in lever 5 when crossover 7 is reverse for a movement past signal L4 occupying track circuit 1TR, through the coils of detector magnet on lever 5, to negative battery CL.

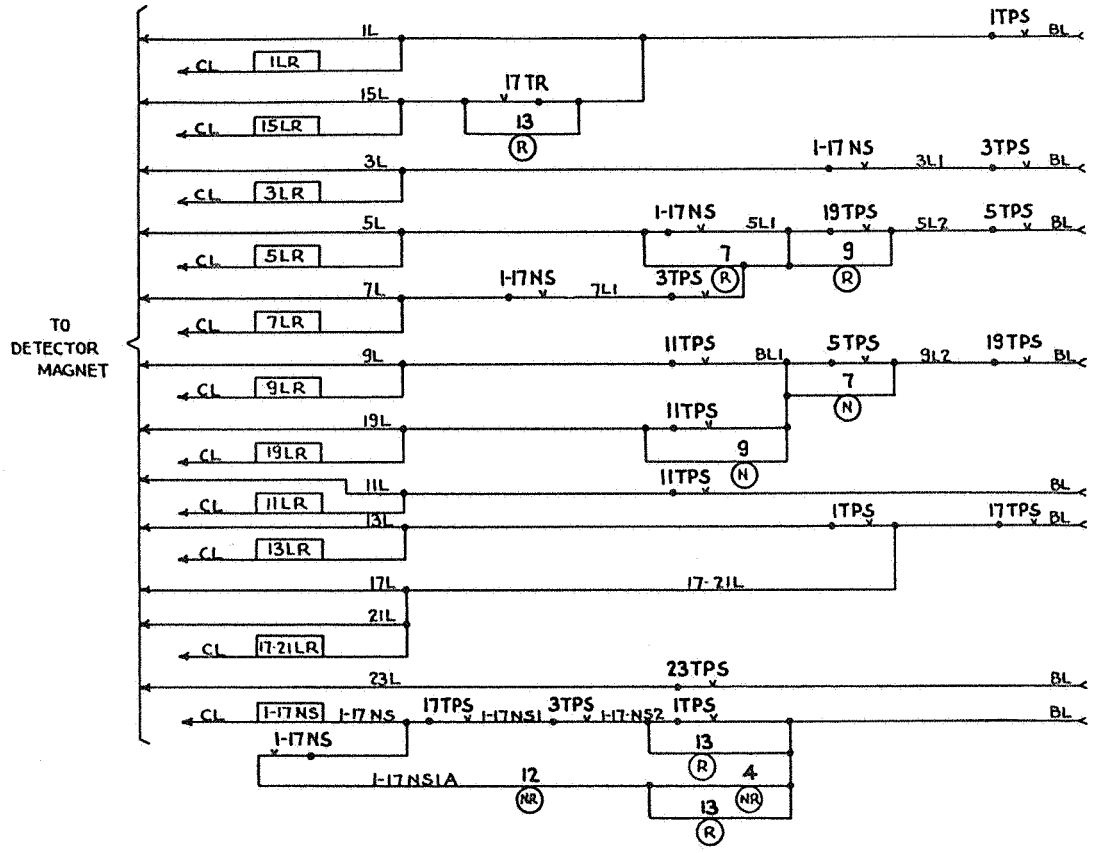


Fig. 52j.
Electric Switch Lever Locking Circuits.

After passing through the front contact of relay 1-17NS a circuit is tapped off going through the coils of lever lighting relay 5LR, to negative battery CL. This relay is provided for lever lighting, an explanation of which will follow.

Indicating light circuits.

Figure 52k shows the indicating light circuits. These circuits are self-explanatory and no further description of same will be given.

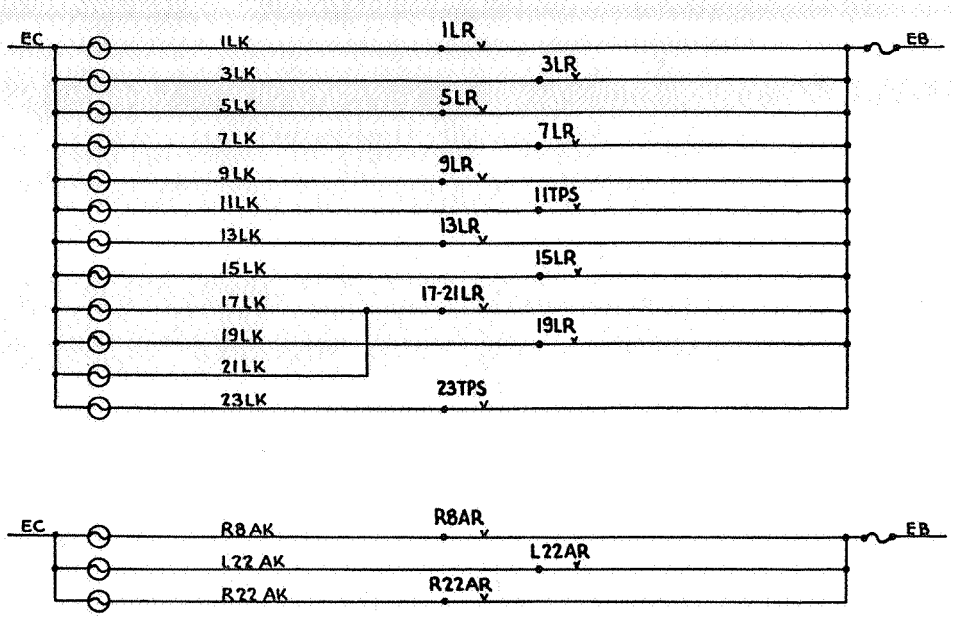


Fig. 52k.
Indicating Light Circuits.

Switch motor circuits.

Figure 521 shows the switch motor circuits for a crossover or two derails and also for a single switch or derail. The details of these circuits are fully explained in Chapter XIX—Electric Interlocking, with the exception of the introduction of the rectifiers and resistors. These rectifiers and resistors are used to divide the current from the polarized control circuit in such a way that each coil of the polar magnet assembly receives the correct amount of energy for most efficient operation. It will be noted that the reversal of the polarized control circuit automatically changes the energy received by each of the two coils.

Figure 52m shows the power distribution diagram for the interlocking station.

Drawbridge Circuits

Track and signal layout.

Figure 53 shows the track and signal layout. The interlocking machine operating the draw locks, rail locks, smashboards, signals, etc., is located at grade in the center of the draw span. The machine is of the mechanical type with S. & F. locking. Electric locks are provided for signal and smashboard indication locking with the usual approach and time locking included. Alternating current track circuits are used.

The symbols used in these circuits are similar to those used in the electro-pneumatic interlocking portion of this chapter.

Approach relay and annunciator circuits.

Figure 54 shows the approach relay and annunciator circuits. The circuit for approach relay 2P is as follows: positive battery B through a front

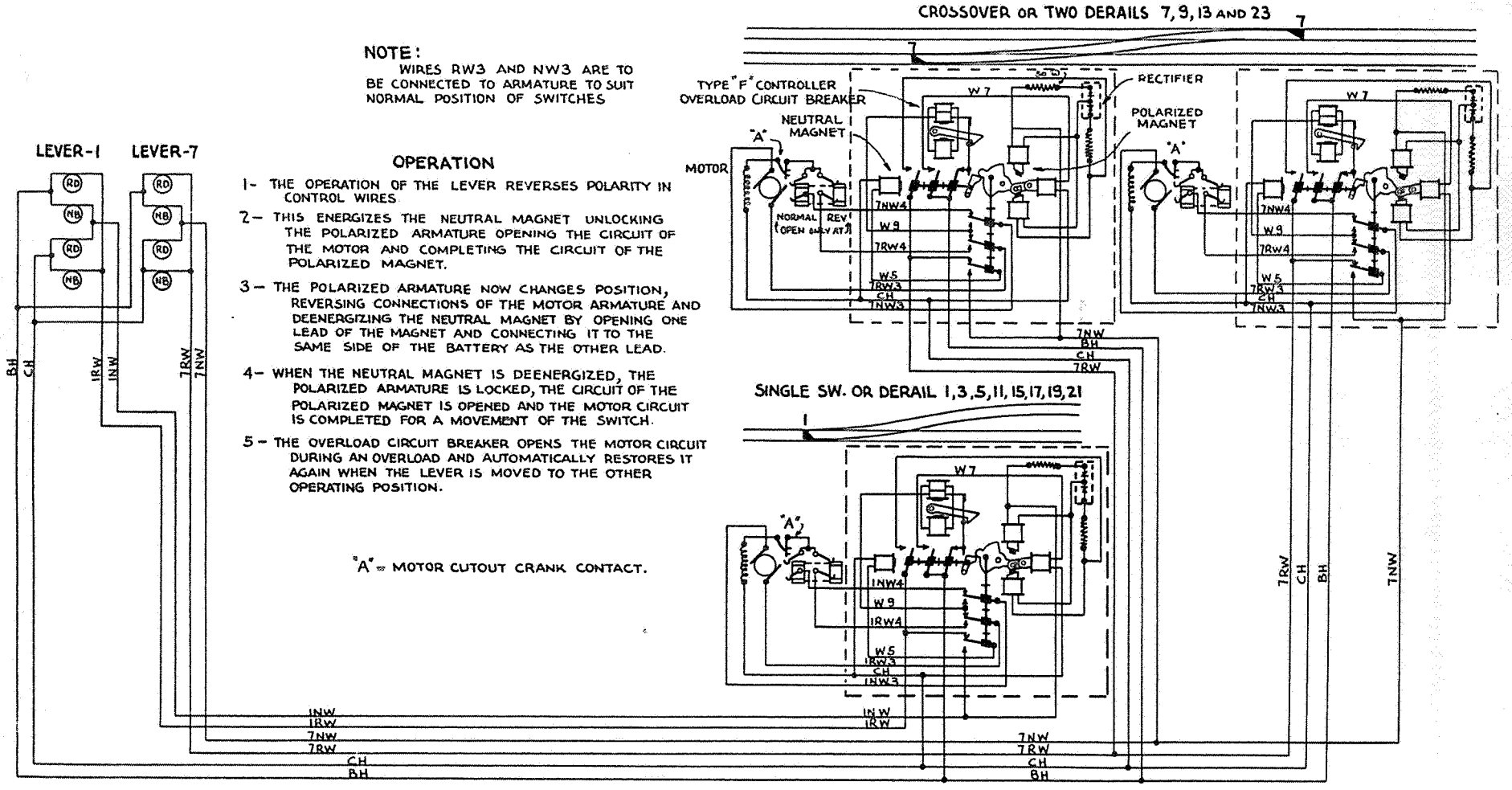


Fig. 521.
Switch Motor Circuits.

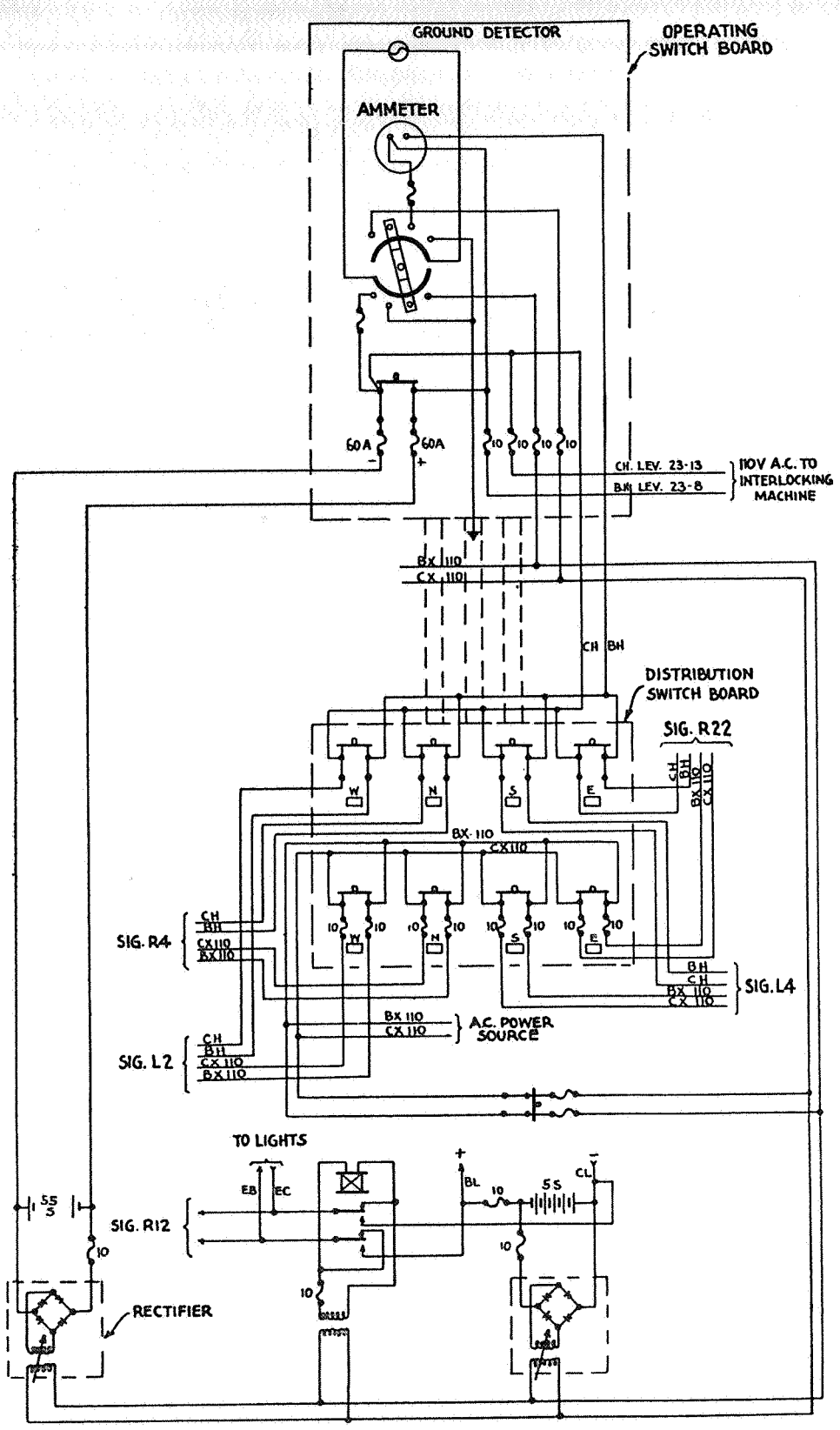


Fig. 52m.
Power Distribution Diagram (in the Interlocking Station).

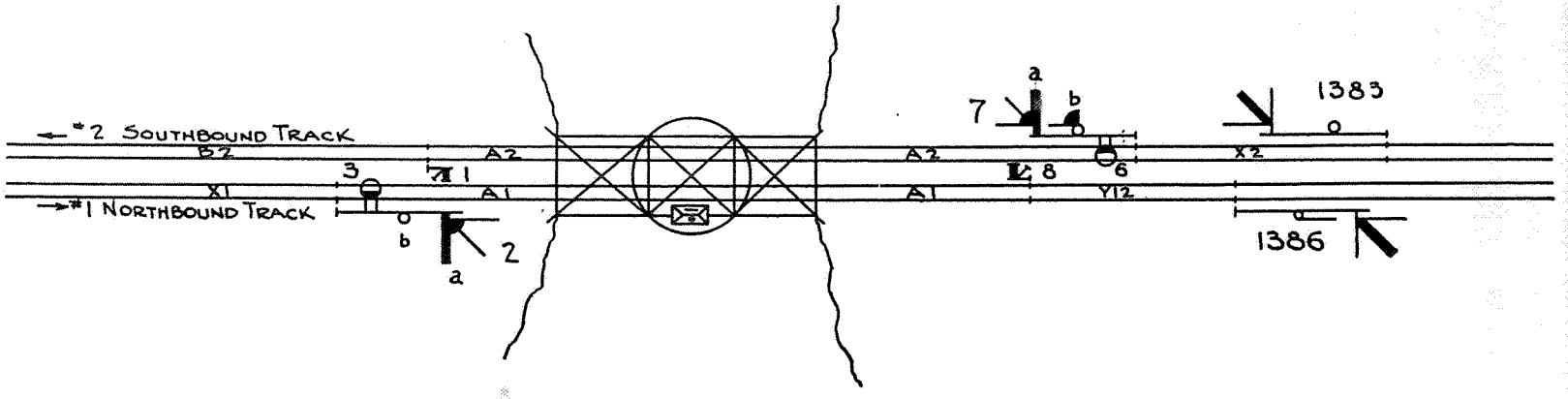


Fig. 53.
Track and Signal Layout.

contact of track relay B13, as the southward approach circuit starts at this point, and when track relay B13 is de-energized the approach relay must be de-energized, (track circuit B13 is one of the track circuits in one of the adjoining interlockings,) through the normal or reverse contacts of track relay X2, this track circuit being between the home and approach signals for the drawbridge, and with this track circuit occupied the approach relay must be de-energized, through a contact in the drawbridge circuit controller on the north end of the bridge closed when the rails are locked, through coils of approach relay 2P, to negative battery C. This drawbridge is located between two interlockings known as "BG" and "RO." (In this circuit description whenever reference is made to "BG" or "RO" it is to be understood that the circuits start or end at these interlockings.

Figure 54 shows the circuit for annunciator bell "BV" the control of which is as follows: positive battery B1 through contacts on signal lever 2 or 7 closed when the lever is in the normal position, as the audible indication is provided only when the lever is in this position, through a back contact of approach relay 1P or 2P, so that with either of these approach relays de-energized the circuit to the bell is closed, through a knife switch to provide a means of silencing the bell, through the coils of the bell, to negative battery C.

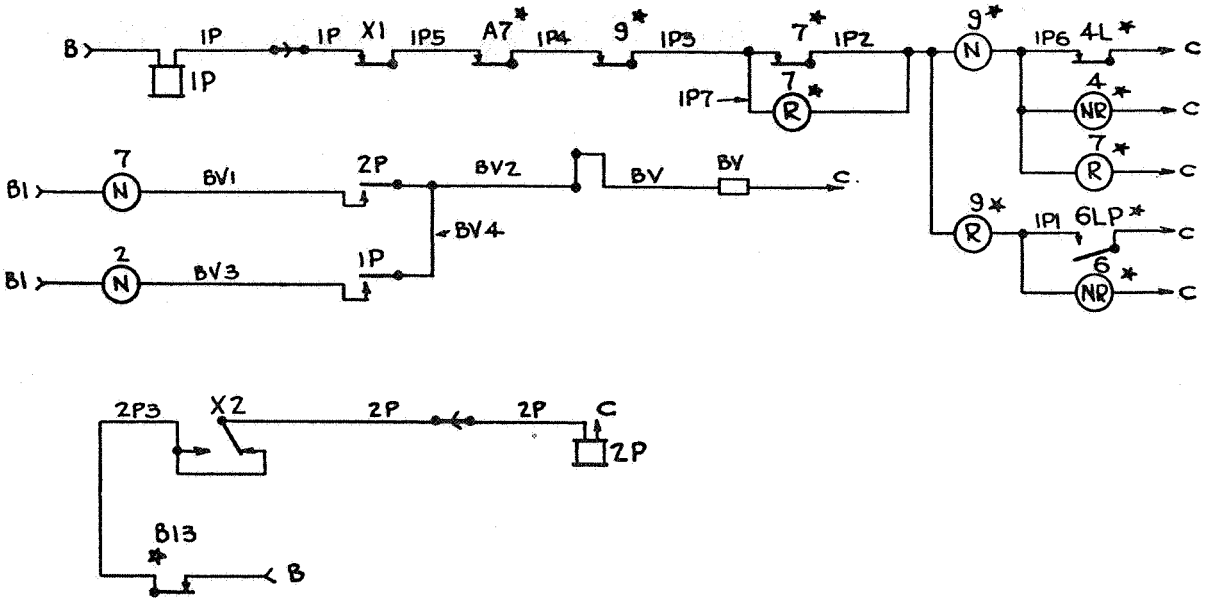
Smashboard circuits.

As soon as the draw span has been closed, the wedges driven, the rails seated and locked in place, the first operation is to raise the smashboards. The smashboards are motor-driven, the circuits for which are shown in Fig. 55. The circuit for smashboard 3 is as follows: positive battery B, through a contact on lever 3 closed with lever in the reverse position, through contact in drawbridge circuit controller closed with drawbridge locked, to the mechanism of the smashboard, to negative battery C.

Home or 45 degree signal circuits.

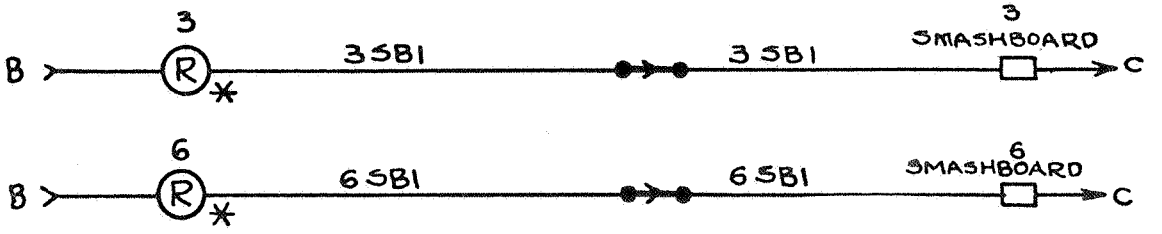
The home or 45 degree signal circuits are shown in Fig. 56. The circuit for signal 2 is as follows: positive battery B through a front contact of track indicating relay 1A, to provide track circuit protection and the semi-automatic feature for signal 2 which will be noted later in the explanation of the circuit for relay 1A, through a contact on lever 2 closed in the reverse position, through a closed contact on time release 2SR, through a contact in the drawbridge circuit controller closed with drawbridge locked, through a contact on the circuit controller of smashboard mechanism of signal 3 closed when the smashboard is in the vertical position in order to insure that the smashboard is entirely clear of the train before a Proceed signal can be displayed, through the coils of relay $2^{a}H$, control relay for signal 2, to negative battery C.

The "call-on" or Stop; then Proceed indication, as referred to in the electro-pneumatic portion of the chapter, is provided and the circuits for same are also shown in Fig. 56. The circuit for the "call-on" (slow-speed) indication for signal 2 is as follows: positive battery B through a closed contact of time release 2, so that signal 2 will display a Stop indication as soon as the time release is operated (this time release is provided with



★ APPARATUS LOCATED AT ADJACENT INTERLOCKINGS.

Fig. 54.
Approach Relay and Annunciator Circuits.



✱ CONTACTS MARKED THUS ARE IN ELEC: LOCK, OPERATED BY LEVER LATCH

Fig. 55.
Smashboard Circuits.

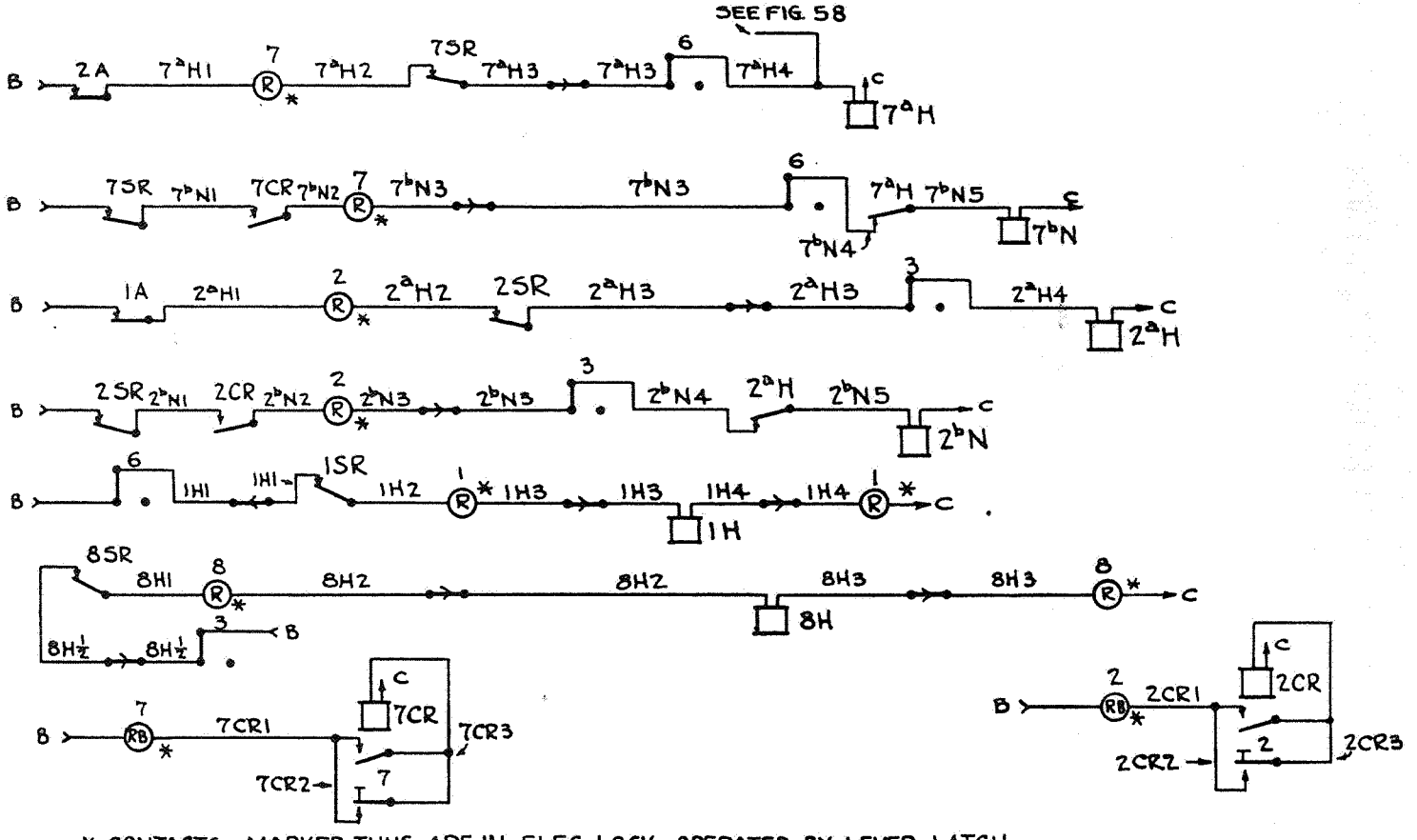


Fig. 56.
Home or 45 Degree Signal Circuits.

latch and is normally wound up), through front contact of relay 2CR, "call-on" relay for signal 2 as this relay is normally de-energized, the circuit for which will be explained later; through a contact on lever 2 closed in the reverse position, through a closed contact of drawbridge circuit controller, through a contact of circuit controller on smashboard mechanism 3 closed when smashboard is in the vertical position, through a back contact of relay $2^{a}H$, control relay for the 45 degree position of signal 2, as this relay must be de-energized before the Stop; then Proceed indication can be displayed, through the coils of relay $2^{b}N$, to negative battery C.

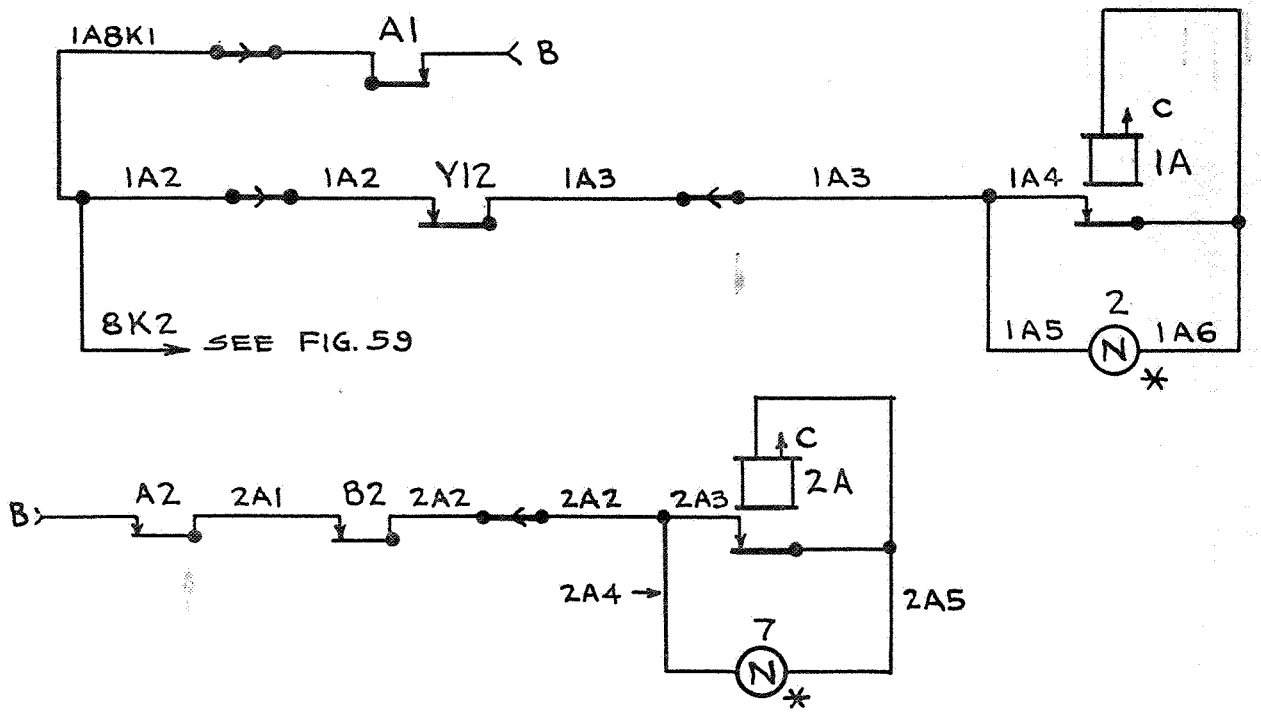
The circuit for relay 2CR, the "call-on" relay shown in Fig. 56, is as follows: positive battery B through a contact on signal lever 2 closed between the reverse and the normal indication position; this contact is provided so that the advance locking, provided by the route locking circuits, will not be defeated; through an open contact of push button 2, through the coils of relay 2CR, to negative battery C. A circuit is provided which cuts around the push button and goes through a front contact of relay 2CR to provide the stick feature so that once the push button is operated with lever 2 reversed, the relay will remain energized until the lever is returned to the normal position.

Track indicating relay circuits.

The circuits for the track indicating relays are shown in Fig. 57. The circuit for track indicating relay 1A is as follows: positive battery B through a front contact of relay A1, track relay for the track circuit between signal 2 and dwarf signal 8, through contacts of the drawbridge circuit controllers on the ends of the draw span closed when the drawbridge is locked, through a front contact of relay Y12, track relay for track circuit between dwarf signal 8 and automatic signal 1386, through a contact of drawbridge circuit controller on the north end of the draw span closed when the drawbridge is locked, through a contact on signal lever 2 closed in the normal position so that relay 1A will remain de-energized once a train movement has been made past signal 2 until such time as lever 2 is restored to normal position, through coils of relay 1A, to negative battery C. A circuit is provided which cuts around the contact on lever 2 closed in the normal position and goes through front contact of relay 1A, through the coils of the relay, to negative battery C which provides the stick circuit.

90 degree signal circuits.

Figure 58 shows the 90 degree signal circuits. The circuit for signal 2 is as follows: positive battery B through a front contact of relay 12SA, relay controlling the approach position of automatic signal 1386, through contacts of drawbridge circuit controllers on ends of draw span closed when the drawbridge is locked, through a front contact of relay $2^{a}H$, the 45 degree control relay for signal 2, this relay being normally de-energized as the signal is normally at Stop and so that relay controlling the 90 degree position of signal 2 cannot be energized until the relay controlling the 45 degree position has been energized, through coils of relay $2^{a}J$, clear control relay, to negative battery C. Relay 12SA is a slow drop-away



* CONTACTS MARKED THUS ARE IN ELEC. LOCK, OPERATED BY LEVER LATCH

Fig. 57.
Track Indicating Relay Circuits.

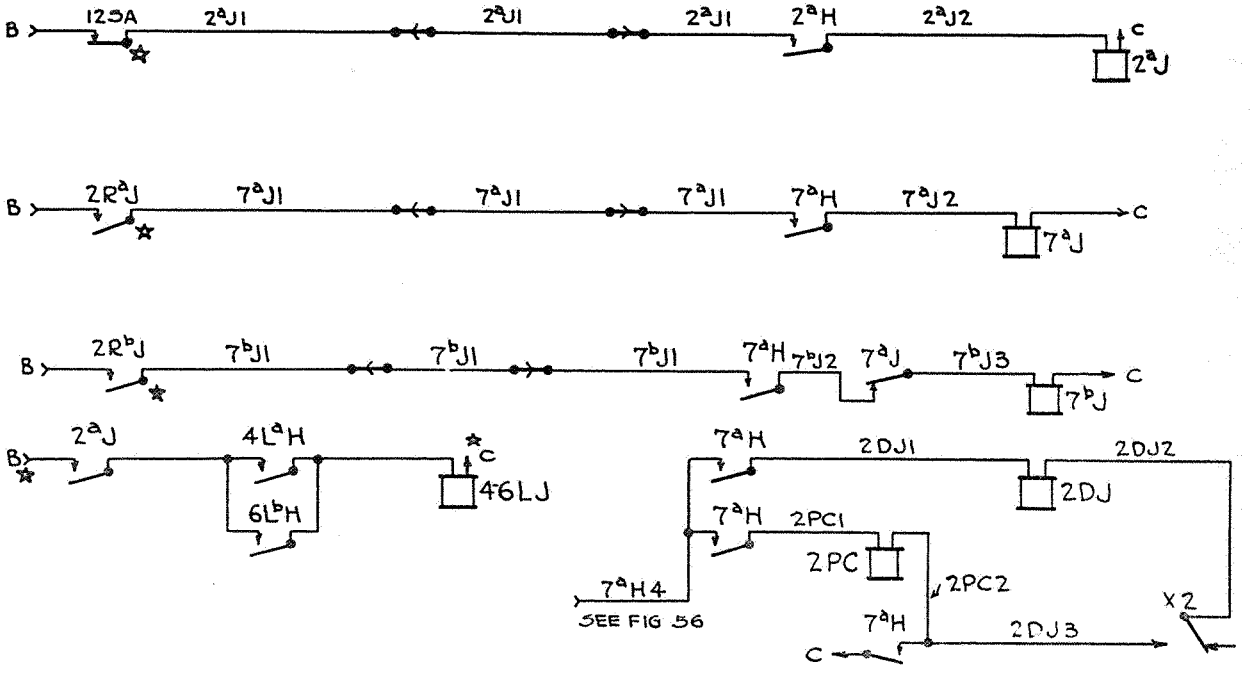


Fig. 58.
90 Degree Signal Circuits.

relay, the slow drop-away feature having been provided to prevent the de-energization of control relays when armature of track relay is changing position due to the reversal of track circuit current.

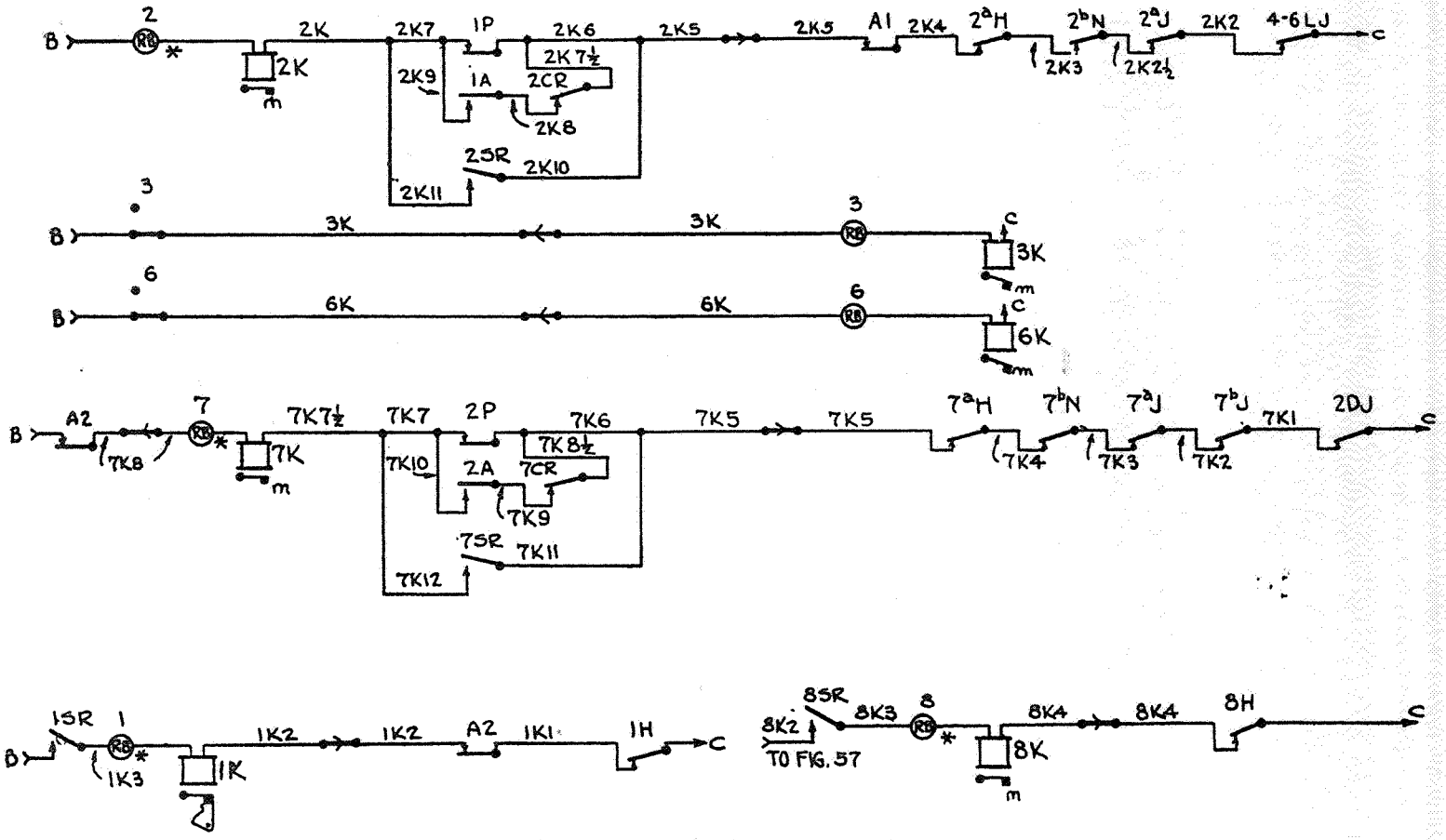
Signal lighting circuits.

The signals used in this installation are of the position light type. The lighting circuits for these signals are the same as shown and explained in Fig. 39.

Signal indication lock circuits.

The signal indication lock circuits are shown in Fig. 59. The indication lock circuit for lever 2 is as follows: positive battery B through a contact on lever 2 closed between the reverse and normal indication positions, as the circuit is open when the lever is normal to save battery, through the coils of the lock magnet on lever 2, through a front contact of relay 1P, approach indicating relay for track 1, used to provide approach locking for signal 2, through a contact in drawbridge circuit controller on the south end of draw span closed with the drawbridge locked, through a front contact of track relay A1, so that lever 2 cannot be restored to normal position until after train has completed movement over draw span and has passed dwarf signal 8, through back contacts of relays $2^{a}H$, $2^{b}N$, $2^{a}J$ and 4-6LJ to insure that the relays controlling signals 2 and the approach signal thereto assume their most restrictive indications, to negative battery C. The contact in relay 1P is cut around by means of a circuit through a back contact of relay 1A, the track indicating relay for track 1, through a back contact of "call-on" relay 2CR, as this relay must be de-energized before lock circuit can be completed, this circuit also providing a check on the relay operation, as the relay providing the "call-on" feature cuts around the front contact of the track indicating relay; this cut around circuit provides for the restoring of lever 2 to normal position after a second movement has de-energized relay 1P and before the former movement is completed. A further cut around circuit is provided around contacts of relay 1P, 1A and 2CR. This circuit is through an open contact of time release 2SR. This cut around is provided to close the circuit for the lock on lever 2 provided approach indicating relay is de-energized and a movement has not been made past signal 2 de-energizing track indicating relay 1A.

The levers operating the smashboards are provided with electric locks to insure that the smashboard has reached the horizontal position before the drawbridge can be unlocked. In Fig. 59 the indication lock circuit for lever 3 is as follows: positive battery B through a contact of circuit controller of smashboard mechanism 3 closed when the smashboard has reached a point 5 degrees from horizontal, to provide for the smashboard being in this position before latch on lever can be placed normal thus releasing the mechanical locking, through a contact of drawbridge circuit controller on the south end of the bridge closed when the bridge is locked, through a contact on lever 3 closed between the reverse and the normal indication positions so that the circuit will be open when the lever is normal, through the coils of electric lock magnet, to negative battery C.



* CONTACTS MARKED THUS ARE IN ELEC. LOCK, OPERATED BY LEVER LATCH.

Fig. 59.
Signal Indication Lock Circuits.

Track model light circuits.

Figure 60 shows the track model light circuits. The circuit for light 1AEL is as follows: ACB-10 through a front contact of relay 1A, so that with relay 1A de-energized the light will be out as the light indications are normally lighted, through the lamp 1AEL, to ACC-10.

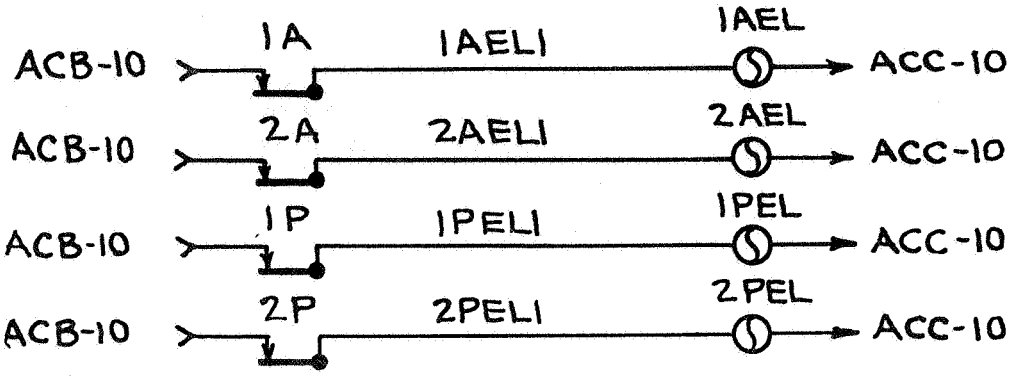


Fig. 60.
Track Model Light Circuits.

Automatic Interlocking

Track and signal layout.

Figure 61 shows the track and signal layout for an automatic interlocking. The track circuits are direct current. The signals are motor semaphore type and the local circuits controlling same are explained in Chapter XII—Semaphore Signals.

Track and signal repeating relay circuits.

The circuits for the track repeating relays are shown in Fig. 62a. The circuit for track repeating relay JKP is as follows: positive battery BL through front contacts of track relays K and J, track circuits on track 1 approaching the crossing, as these track circuits are the ones to be repeated, through the coils of relay JKP, through front contacts of relays J and K, to provide additional protection against crosses and grounds, to negative battery NL. An additional circuit is provided on each track relay in which the contacts are connected so that when the track relay is de-energized a shunt is placed on the coils of the repeating relay.

The circuits for signal repeating relays are shown in Fig. 62b and the circuit for 6HP is as follows: positive battery BL through a contact of circuit controller on mechanism of signal 5 closed when the signal is in the approach position, through a contact of circuit controller on mechanism of signal 6 closed when the signal is in the stop position, through the coils of relay 6HP, through a contact of circuit controller on mechanism of signal 6 closed when the signal is in the stop position, through a contact of circuit controller on mechanism of signal 5 closed when the signal is in the approach position to provide additional protection against crosses and grounds, to negative battery NL. Relay 6HP is a repeating relay for signals 5 and 6 in their normal position which is approach and stop, respectively.

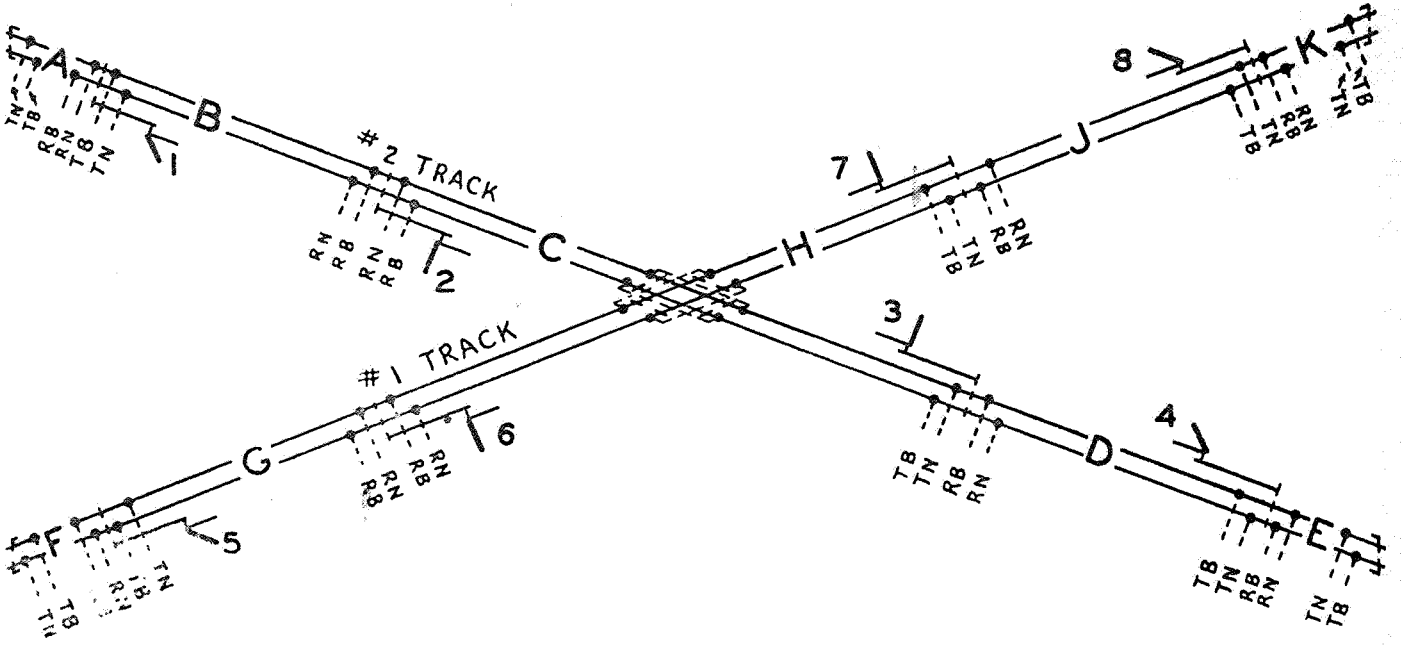


Fig. 61.
Track and Signal Layout.

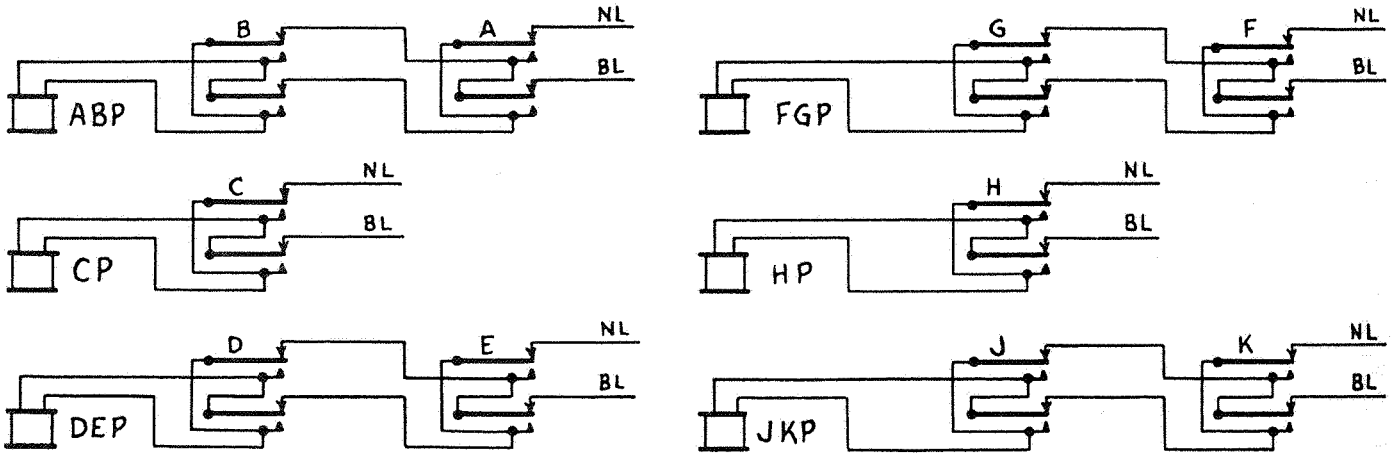


Fig. 62a.
Track Repeating Relay Circuits.

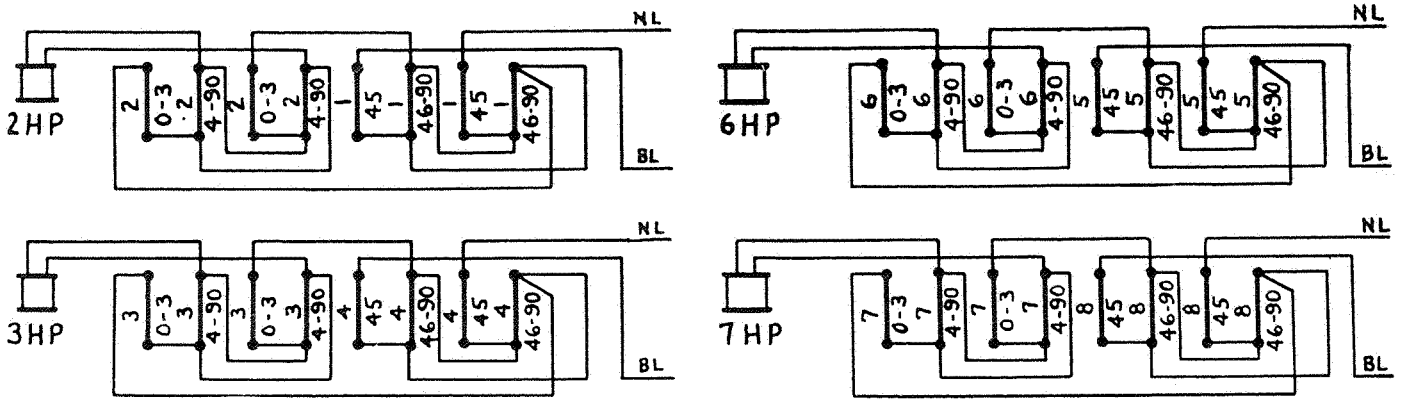


Fig. 62b.
Signal Repeating Relay Circuits.

A circuit has been provided on contacts of circuit controller on mechanism of signal 6 closed when signal 6 is between 4 and 90 degrees to shunt the coils of relay 6HP as this relay is to be energized only when signal 6 is at Stop. A circuit goes through contacts of circuit controller on mechanism of signal 5 closed when signal 5 is between 46 and 90 degrees to shunt the coils of relay 6HP if for any reason signal 5 should clear with signal 6 at Stop.

Directional stick relay circuits.

Figure 63 shows the directional stick relay circuits. The circuit for 1FS is as follows: positive battery BL through front contacts of repeating relays 7HP and 6HP as these signals must be in the stop position when the direction of traffic is established, through front contacts of track repeating relays JKP and FGP, as the directional selecting relay must be de-energized after either track repeating relay is de-energized to prevent operation of signals on the opposing track, through the coils of directional selecting relay 1FS for track 1, to negative battery NL. The front contacts of track repeating relays JKP and FGP are cut around by a circuit taken through a back contact of track repeating relay HP to provide for relay 1FS energizing to allow for the operation of signals on the opposing track as soon as the crossing is cleared. If it were not for this circuit the signals on the opposing track could not be displayed for movement of train until after a train completed its movement through all the circuits beyond the crossing. The circuit is made stick to provide for the directional relay remaining energized if a train is using track 2 when a second train comes in on the clearing circuit of track 1 to prevent the signal on track 2 from cutting out in front of a train.

Z relay circuits.

Figure 64 shows the Z relay circuits. These relays have been provided to afford protection while the crossing is occupied. The control of ZH1 is as follows: positive battery BL through a back contact of relay HP, track repeating relay for track circuit H, the track circuit on track 1 between home signals, so that with this track circuit occupied relay HP will be de-energized, energizing relay ZH1, through the coils of the relay, to negative battery NL. A stick circuit is provided controlled from positive battery BL, through front contact of relay JKP and back contact of relay FGP or back contact of relay JKP and front contact of relay FGP to provide for relay ZH1 remaining energized after train has passed over crossing and relay HP energized, through front contact of relay ZH1, through coils of relay, to negative battery NL. It will be noted that this circuit provides for home relay 1HR remaining de-energized until track circuits beyond the crossing are unoccupied so that a signal, for a following move, will not be displayed for train movement until the train has passed beyond the limits of the interlocking and track circuits approaching same. A knife switch has been provided at the crossing so that relays ZH1 and ZH2 can be energized directly over knife switch to hold all crossing signals at Stop in case a train on the opposing railroad may wish to cross after a train on the other railroad has displayed the signals for movement over the crossing and for some reason does not cross.

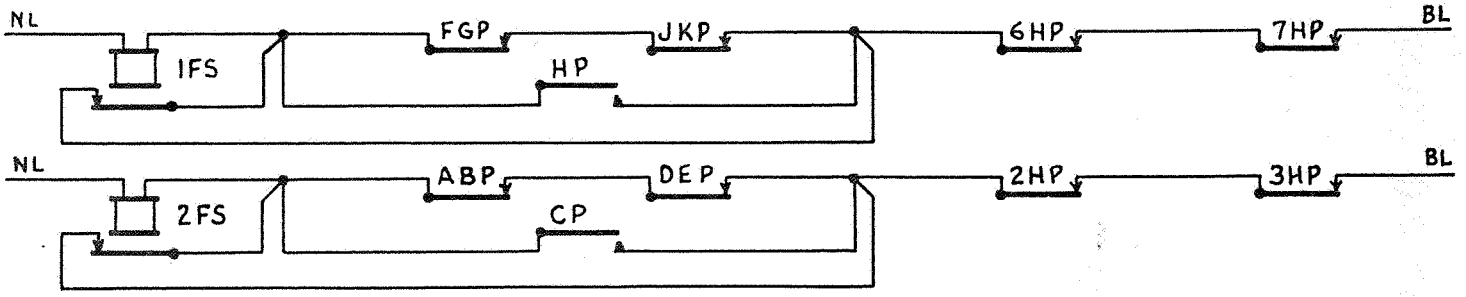


Fig. 63.
Directional Stick Relay Circuits.

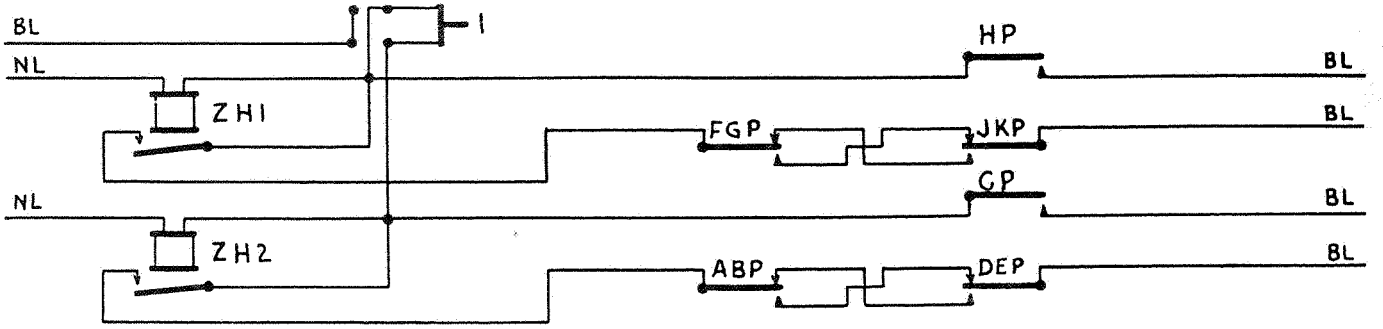


Fig. 64.
Z Relay Circuits.

Home relay circuits.

The home relay circuits are shown in Fig 65. The circuit for relay 1HR is as follows: positive battery BL through a front contact of relay 2FS directional selecting relay for track 2 so that with traffic set up on track 2 traffic cannot be set up on track 1, through front contacts of relays CP and HP so that with the track circuits between the home signals occupied, relay 1HR will be de-energized, through a back contact of relay ZH1 which provides additional protection against relay HP failing to be de-energized, through coils of relay 1HR, through front contact of relay JKP and back contact of relay FGP or back contact of relay JKP and front contact of relay FGP to provide the approach energizing circuit for the normal stop home signals, to negative battery NL. The home relay is the relay through which the interlocking signals are directly controlled.

Home signal circuits.

The home signal circuits are shown in Fig. 66. The circuit for relay HR6 is as follows: positive battery BL through a front contact of relay 1HR, as relay 1HR must be energized before signal 6 can be operated, through a front contact of relay JKP, track repeating relay for track circuits beyond the crossing for track 1 as signal 6 must be at Stop with these track circuits occupied, through the coils of relay HR6, through front contact of track repeating relay JKP and front contact of relay 1HR to provide additional protection against crosses and grounds, to negative battery NL. An additional circuit is provided through back contacts of relays 1HR and JKP to shunt the coils of relay HR6 when either relay is de-energized.

Approach signal circuits.

Figure 67 shows the approach signal circuits. The circuit for relay controlling signal 5 is as follows: positive battery BL through a front contact of relay 1HR, as relay 1HR must be energized before signals can indicate Proceed, through a contact on mechanism of signal 6 closed when the signal is at 90 degrees, as signal 6 must be at Proceed before signal 5 displays other than the Approach indication, through the coils of relay DR5, through a contact on mechanism of signal 6 closed when the signal is at 90 degrees, through a front contact of relay 1HR, to provide additional protection against crosses and grounds, to negative battery NL. An additional circuit is provided through back contact of relay 1HR which shunts coils of relay DR5. An additional circuit is provided through contacts of mechanism on signal 6 closed when the signal is between stop and 88 degrees which shunts coils of relay DR5 until signal 6 is practically in the proceed position.

Electric Interlocking
Without Mechanical Locking between Levers

Track and signal layout.

Figure 68 shows the track and signal layout for a system of this type. The signals are of the color light type. The track circuits are of the alternating current type.

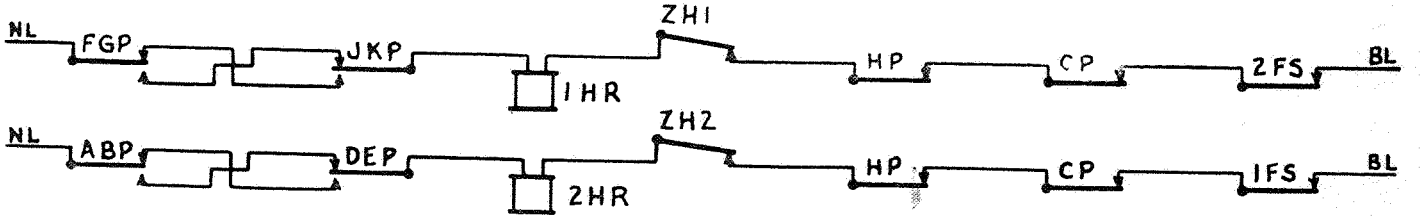


Fig. 65.
Home Relay Circuits.

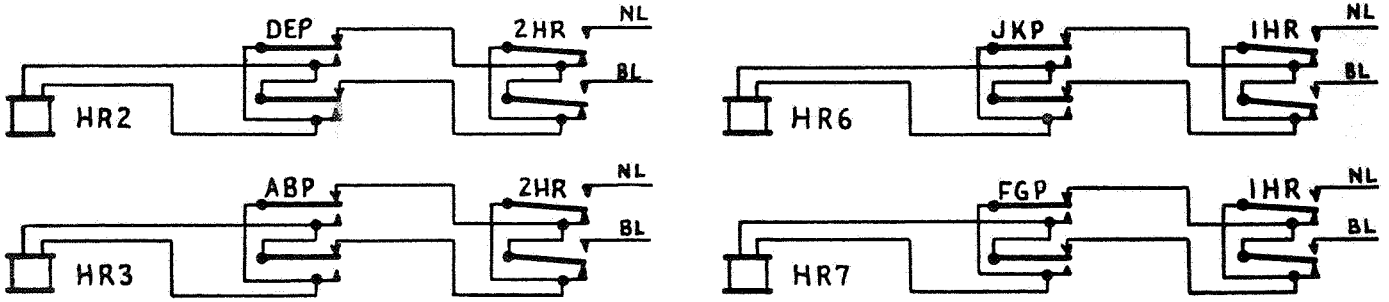


Fig. 66.
Home Signal Circuits.

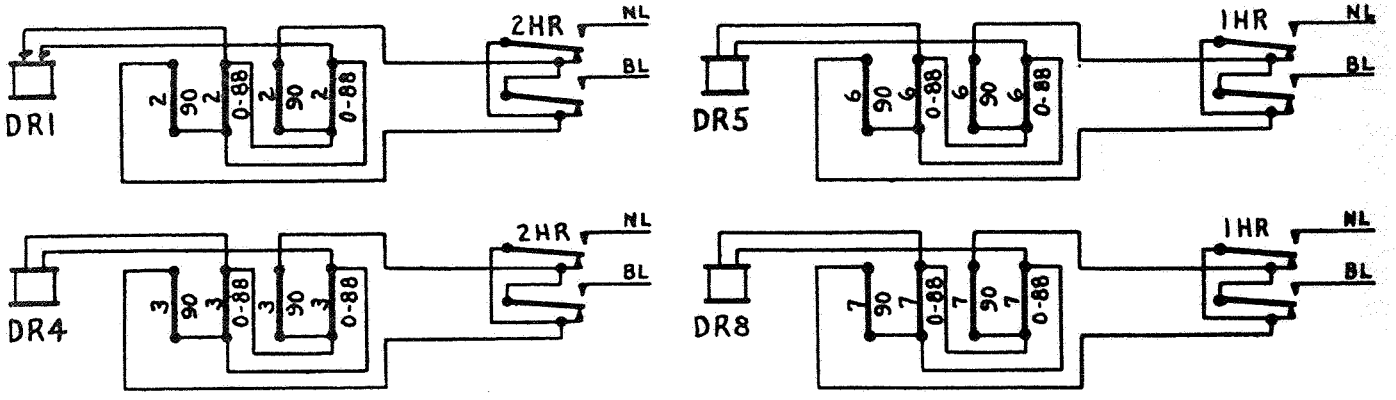


Fig. 67.
Approach Signal Circuits.

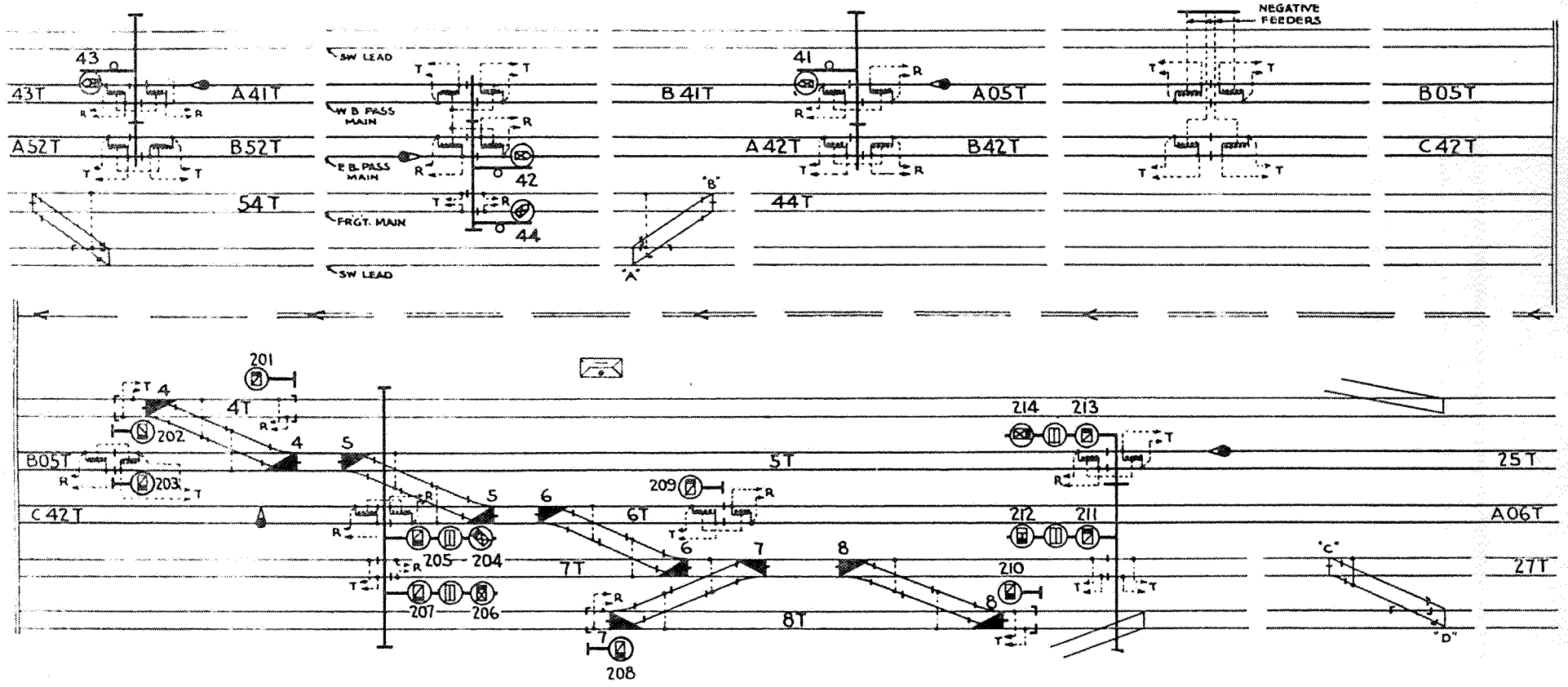


Fig. 68.
Track and Signal Layout.

Track repeating relay circuits.

Figure 69 shows the track repeating relay circuits. The control of track repeating relay 6TP is as follows: BX110 through a front contact of track relay 6TR, as this is the relay to be repeated, through primary of step-down transformer, to obtain proper voltage for rectifier, through front contact of track relay 6TR to insure against crosses and grounds, to NX110. The secondary side of the transformer goes to the rectifier, by which the alternating current is rectified to direct current. The positive direct current passes through the coils of relay 6TP to the negative direct current side of the rectifier.

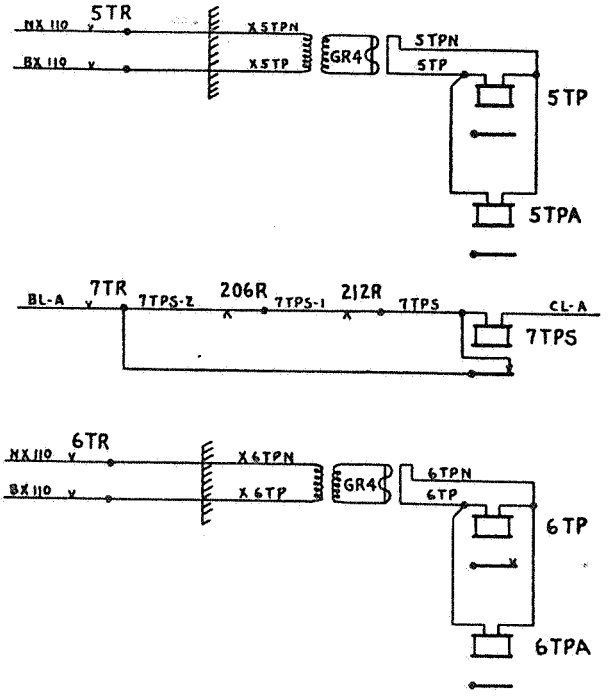


Fig. 69.
Track Repeating Relay Circuits.

Relay 6TPA is in multiple with relay 6TP and is used as an additional repeating relay to provide sufficient contacts for the circuits that follow.

Relay 7TPS is a track stick repeating relay. This track repeating relay is different from the others in that once signal lever 206 or 212 is operated to the right and track circuit 7TR occupied, either lever so operated must be restored to normal and relay 7TR energized before relay 7TPS will energize. The circuit for relay 7TPS is as follows: positive battery BL-A through a front contact of track relay 7TR, the track circuit to be repeated, through a back contact of lever repeating relay 206R, through back contact of lever repeating relay 212R, through the coils of track repeating relay 7TPS, to negative battery CL-A. The back contacts of lever repeating relays 206R and 212R are cut around by a circuit tapping off the previous circuit after going through the front contact of track relay 7TR, the circuit passes through a front contact of relay 7TPS and through the coils of relay 7TPS, to negative battery CL-A. This circuit provides the stick feature of relay 7TPS.

Lever repeating relay circuits.

Typical lever repeating relay circuits are shown in Fig. 70. The control of lever repeating relay 206R is as follows: positive battery BL-A through a contact on signal lever closed when signal lever is to the right, through the coils of relay 206R, to negative battery CL-A; likewise when signal lever is turned to the left, positive battery BL-A through a contact on signal lever closed when lever is to the left, through the coils of relay 207R, to negative battery CL-A. Thus it will be seen that one signal lever controls the high-speed as well as the low-speed indication on the same mast.

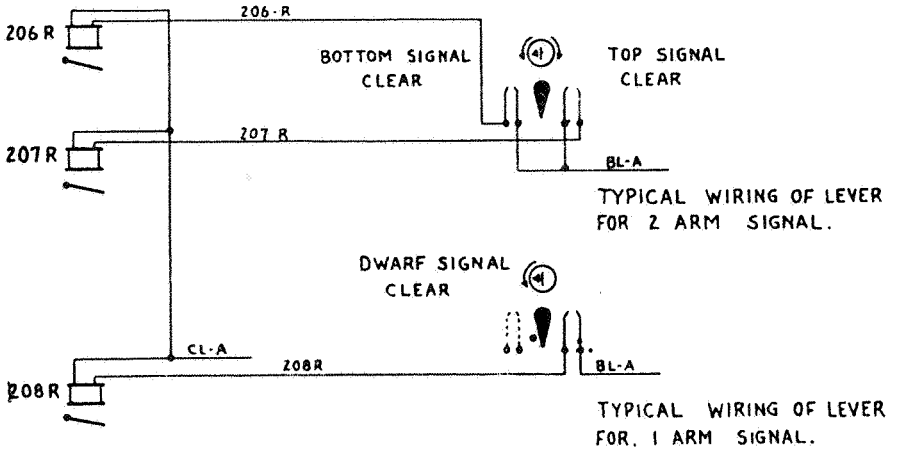


Fig. 70.
Typical Lever Repeating Relay Circuits.

Approach relay and annunciator circuits.

The approach relay control circuits are found in Fig. 71. The control circuit for approach relay 204AR is as follows: 44BX110 through a front contact of relay 42ALRP, the approach lighting repeating relay for signal 42, as this lighting relay is controlled over the track circuit in approach to signal 42, which is the track circuit at which the approach circuit for signal 204 starts, thence through a front contact of slow drop-away relay 42PC, which relay is controlled over relay 42HD, which in turn is controlled through all the track circuits between the home and approach signals and pole changed by the home relay at the interlocking; this portion of the circuit insures that approach relay 204AR will remain de-energized with the track between the home and approach signal occupied; through the coils of relay 204AR, to 44NX110. A circuit is provided through the back contacts of relays 42PC and 42ALRP to shunt the coils of relay 204AR to further insure that with either relay 42PC or 42ALRP de-energized, relay 204AR will de-energize.

An annunciator circuit is provided to announce westward trains from the terminal. The circuit is shown in Fig. 71 and is as follows: positive battery BL-A through a back contact of relay 520A, a relay controlled from the next block station, through the coils of the bell, to negative battery CL-A.

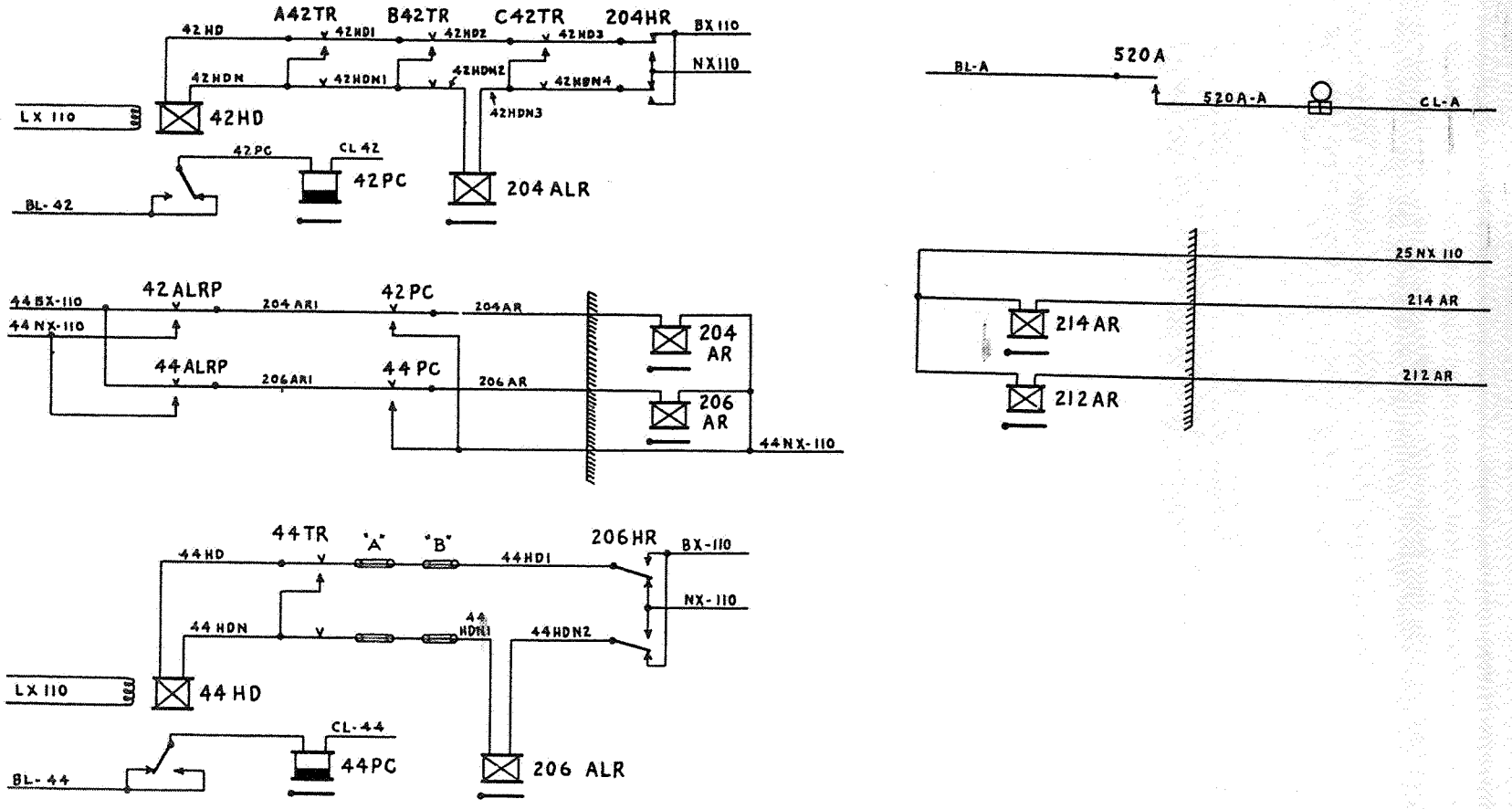


Fig. 71.
Approach Relay and Annunciator Circuits.

Thermal and approach stick relay circuits.

Figure 72 shows the thermal and approach stick relay circuits. These relays are provided to introduce time locking on the switches after a signal has been cleared for a train movement. The thermal unit is used for the dwarf and "call-on" signals for the time element and a clockwork release is provided for the high-speed signals, the principle of the thermal unit depending on the current through a winding, creating sufficient heat to close a contact. The control circuit for thermal stick relay 203THS is as follows: BX110 through a back contact of relay 203HR, as signal 203 must be at Stop before a route can be changed, through the primary coils of a step-down transformer, to provide proper voltage, through a back contact of relay 203HR to insure against crosses and grounds, to NX110. The secondary side of the step-down transformer is connected direct to a rectifier from which positive battery passes, through a front contact of relay 214HDP, which is a repeater of the home and approach relay for signal 214, and acts as an approach relay to signal 203 since it is a repeater of relay 214HD, which is controlled over track circuits B05 and A05, through the coils of relay 203THS to the negative side of the rectifier. The front contact of relay 214HDP is cut around by a circuit through a contact in the thermal unit, when relay 214HDP de-energizes, due to an approaching train, and relay 203THS having been de-energized by the clearing of signal 203, restoring signal 203 to Stop, connects the winding of the thermal relay through a circuit of low resistance, through a back contact of relay 203THS. The thermal unit heats, closing its contact, resulting in cutting around the front contact of relay 214HDP and energizing relay 203THS. The time required for the heating of the thermal unit is the predetermined time locking interval for the switches in advance of signal 203. As soon as relay 203THS energizes, the low-resistance circuit through the thermal unit is opened and hence the cut around thermal relay contact opens. Relay 203THS now sticks up through the thermal unit and its own front contact but the small current sustaining the relay will not affect the operation of the thermal unit, as the current value is too small. The current which passes through the thermal unit normally with a train on the approach section and the signal at Stop serves as a check that the heating coil is not burned out.

The control circuits for the approach stick relays are similar to the THS circuits, as shown in Fig. 72, except that a clockwork release instead of a thermal unit is used for giving a release in case the signal is put to Stop with a train on the approach track section, and an automatic pick-up circuit is provided through a back contact of the repeater of the track circuit ahead of the signal. If it were not for the thermal and approach stick relays, a signal could be restored and the route changed immediately in advance of a train. It will, however, be noted later that the THS relays and the AS relays are used in the control of the switches so that with a THS or an AS relay de-energized the switch control circuit is open.

KR and WP relay circuits.

Typical KR and WP relay circuits are shown in Fig. 73. The KR or switch repeating relay circuit is as follows: positive battery BH through

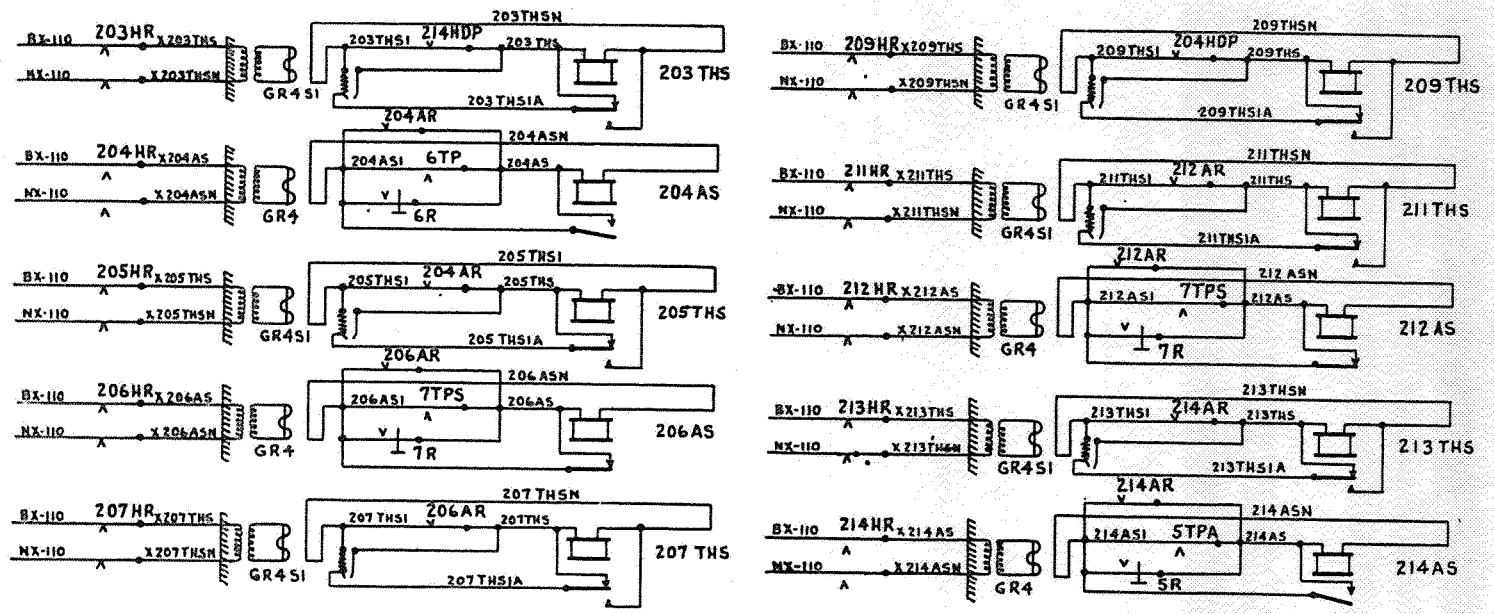


Fig. 72.
Thermal and Approach Stick Relay Circuits.

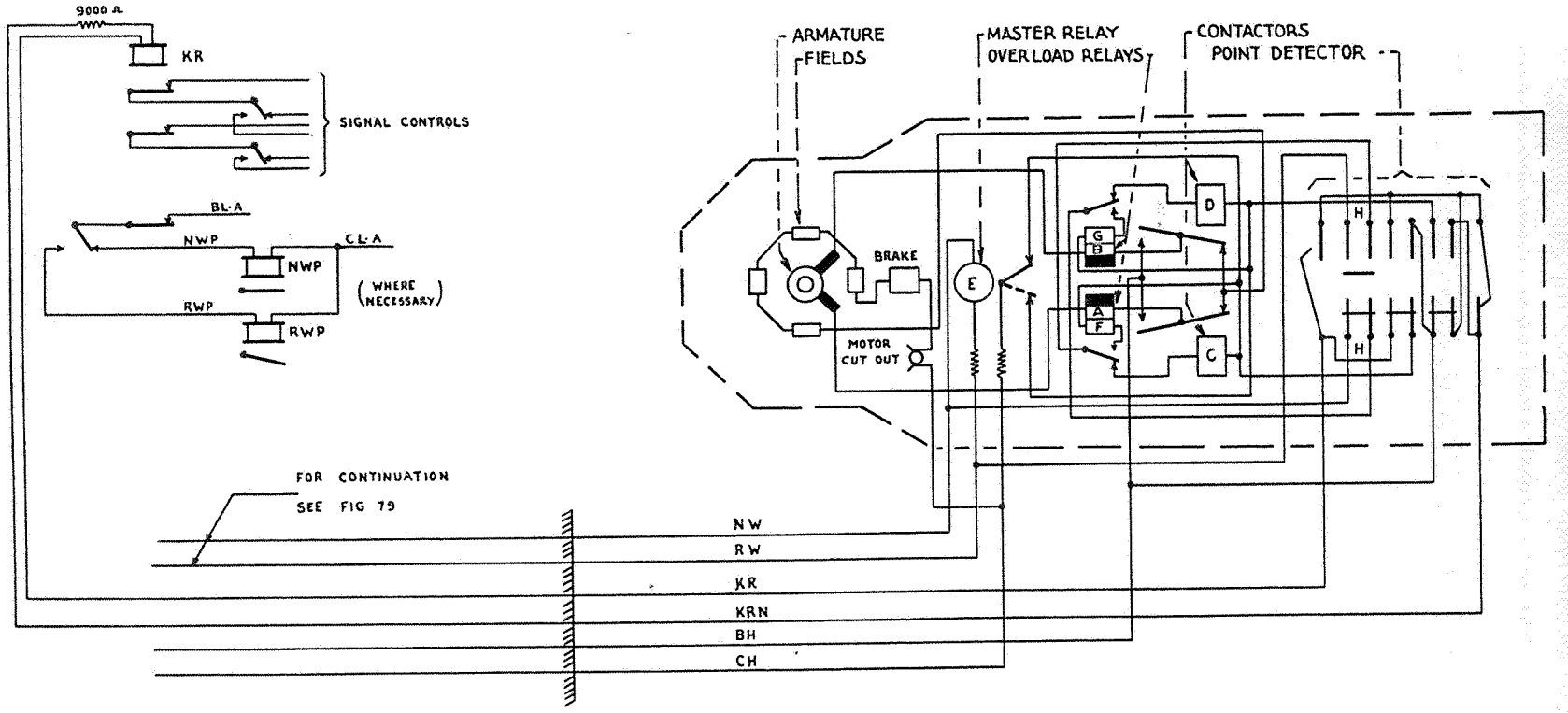


Fig. 73.
Typical KR and WP Relay, Switch Control and Operating Circuits.

a contact in the switch mechanism circuit controller closed when the switch is locked in the normal position, through a normally closed shunting contact in the switch mechanism circuit controller, to check the integrity of this contact, over wire KRN, through a resistance of 9,000 ohms, through the coils of relay KR, over wire KR to another contact in switch mechanism circuit controller closed when the switch is locked in the normal position, through a normal contact of the master relay E, to check correspondence of lever and switch, through a fixed resistance, to negative battery CH. Battery BH signifies a battery voltage of 110 volts, direct current. The KR relay is a polarized relay and its relative position depends upon the position of the switch through contacts of the mechanism circuit controller. A current limiting resistance of 9,000 ohms is used in the KR control circuit on account of 110-volt battery being used for the relay control.

The WP relay circuits are also shown in Fig. 73 and are known as NWP and RWP relays. The control for the NWP relay as shown is as follows: positive battery BL-A through a front neutral and a normal polar contact of the KR relay, through the coils of the NWP relay, to negative battery CL-A. The relays are used to repeat the normal and reverse positions of the KR relay, when more contacts are required than provided by the KR relay.

Switch control and operating circuits.

Typical switch operating circuits and a portion of the control circuit are also shown in Fig. 73. The portion of the switch control circuit within the interlocking station is shown in Fig. 79 and will be described later. The master relay E is a two-position polar relay which is normally de-energized and holds its contacts closed in the position to which it was last operated. It is operated through a series limiting resistance from the polarized control circuit, wires NW and RW, to the normal or reverse position according to the polarity of the current applied. If current is applied to reverse relay E its contact is closed to the position shown dotted. This completes the circuit for contactor D as follows: positive battery from control wire NW through normally closed contact H in the point detector mechanism, through a back contact of overload relay G/B, through coils of contactor D, through reverse contact of master relay E and a limiting resistance to negative battery CH. This energizes contactor D and closes the motor circuit as follows: positive battery BH through a front contact of contactor D, through coil B of overload relay G/B, motor armature, through coil A of overload relay A/F, back contact of contactor C, motor fields, and through the brake and the motor cutout contact to negative battery CH. This releases the magnetic brake and the motor operates the switch to the reverse position and locks it. On the first movement of the unlocking stroke the normally open contact H in the point detector mechanism closes and both remain closed until the end of the locking stroke when the normally closed contact H opens de-energizing contactor D which opens the motor circuit and the brake applies to stop and holds the mechanism. When E is operated normal, contactor C energizes and the direction of current through the motor armature is reversed to that in the previous description thus causing the motor to operate in the opposite direction to move the switch normal. If the machine became stalled during its reverse operation the motor current

would increase and cause the overload relay G/B to energize due to this higher current through its coil B. This would open its back contact and de-energize contactor D which in turn would open the motor circuit. The energization of overload relay G/B transfers the circuit, previously through its back contact to contactor D, through its front contact to its own coil G which causes it to stick up until the lever which controls the master relay E is again operated. The operation of E opens the circuit through coil G and the overload relay G/B is de-energized, whereupon another attempt can be made to operate reverse. When operating normal, overload relay A/F functions in a similar manner to G/B for the reverse direction. It will be noted that coils A and B of overload relays A/F and G/B respectively are both in series with the motor operating circuit for both normal and reverse operation and in case of an increased motor current as previously described, both relays would be operated but only the one whose contacts are used for the particular direction of operation would be effective.

If the lever which controls master relay E is operated while the switch is in motion from normal to reverse, for example, contactor D would open and C would close and the direction of switch movement would be changed toward normal.

Electric switch lever locking circuits.

The electric switch lever locking circuits are shown in Fig. 74. The switch locking circuit for relay 7ES is as follows: positive battery BL-A through a front contact of relay 207THS, the thermal stick relay for signal 207, and through a front contact of relay 206AS, the approach stick relay for signal 206; these relays provide the time locking feature on the switches, through a front contact of switch locking relay 6ES which contact is cut around by a front contact of switch repeating relay 6NWP so that the circuit for route locking relay 7ES will not be affected by similar relay 6ES except when crossover 6 is reversed, through a front contact of switch locking relay 8ES, which contact is cut around by a front contact of switch repeating relay 7NWP so that relay 7ES will not be affected by relay 8ES except when crossover switch 7 is reversed, through a front contact of relay 7TPS, so that relay 7ES will remain de-energized while track circuit 7T is occupied if relay 7ES has been de-energized due to an eastward movement, through the coils of relay 7ES, to negative battery CL-A. A stick circuit is provided through a front contact of relay 7ES which cuts around the front contact of relay 7TPS so that relay 7ES will not be de-energized except for an eastward movement.

Home or 45 degree signal control circuits.

Figure 75 shows the home or 45 degree signal control circuits. The home or 45 degree signal control circuit for signal 204 over switch 6 normal is as follows: BX110 through a back contact of relay 209R, lever repeating relay for the opposing signal to insure that signal 209 is in its most restrictive position, through a normal polar and front neutral contact of switch indicating relay 6KR, through a normally closed contact in time release 6, to hold signal 204 in the stop position while time release is operating, through a front neutral and normal polar contact in switch indicating relay

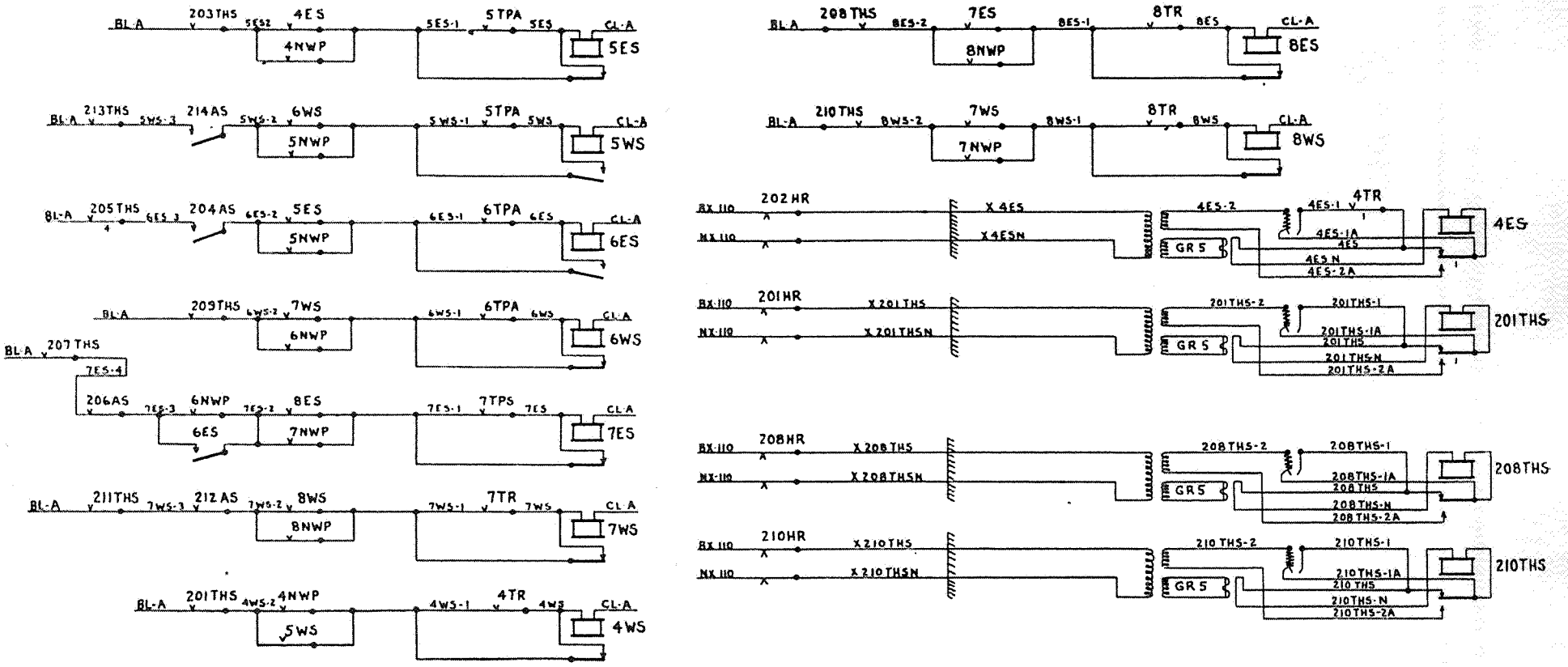


Fig. 74.
Electric Switch Lever Locking Circuits.

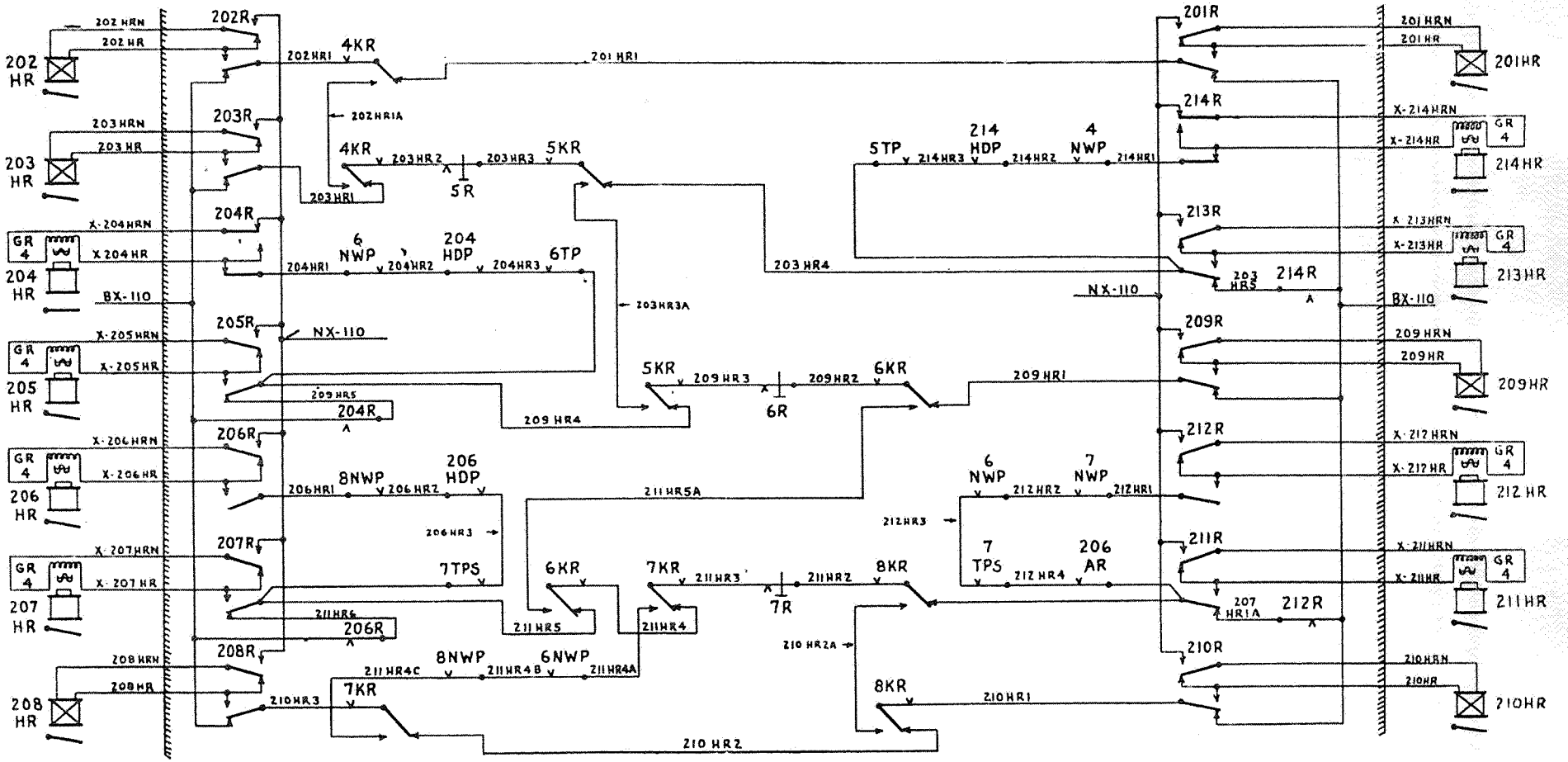


Fig. 75.
Home or 45 Degree Signal Control Circuits.

5KR, as switch 5 must be normal for this movement, through a front contact of track repeating relay 6TP as the track circuit must be unoccupied, through a front contact of relay 204HDP which provides the track circuit protection between signal 209 and the next signal east, through a front contact of relay 6NWP, as switch 6 must be normal for this movement, through a front contact of lever repeating relay 204R, as lever 204 must be reversed to the right, through the coils of step-down transformer to energize relay 204HR, through a front contact of lever repeating relay 204R, to insure against crosses and grounds, to NX110.

The circuit for signal 205 governing movements over crossovers 6 and 8 reverse is as follows: BX110 through a back contact of lever repeating relay 210R, the opposing signal; through two reverse polar and two front neutral contacts of switch indicating relay 8KR to insure that crossover 8 is locked in the reverse position, through a normal contact of time release 7, to hold signal in stop position while time release is operating, through a normal polar and a front neutral contact of switch indicating relay 7KR to insure switch 7 is locked in the normal position, through two reverse polar aud two front neutral contacts of switch indicating relay 6KR to insure that crossover 6 is locked in the reverse position, through a normal contact of time release 6 to hold signal in stop position while time release is operating, through a normal polar and a front neutral contact of switch indicating relay 5KR to insure that crossover 5 is locked in the normal position, through a front contact of lever repeating relay 205R, the relay for the lever involved, through the primary of the step-down transformer for relay 205HR, through a front contact of relay 205R to insure against crosses and grounds, to NX110. It will be noted that the practice in a number of cases is to use an alternating current circuit, utilizing a direct current relay controlled by a rectifier. The lower signal arms are "call-on" signals and are not controlled by any track circuits. They can be displayed for movements over all routes.

90 degree signal control circuits.

The 90 degree signal control circuits are shown in Fig. 76. The circuit for relay 214HD is polarized through 41PC relay contacts up or down and for the proceed position is as follows: BX110 through a front contact of pole changing relay 41PC, through front contacts of track relays A05TR and B05TR to provide track circuit protection; through the coils of relay 214HD, through front contacts of track relays B05TR and A05TR to insure against crosses and grounds, through the coils of relay 41ALR, the approach lighting relay for signal 41, through a front contact of relay 41PC, to NX110. When either track circuit A05T or B05T is occupied the circuit for 214HD is open and the 214HD coils shunted, also relay 41ALR, being in series with 214HD, de-energizes, completing the lighting circuit for signal 41. The circuit for 214DR, the 90 degree control relay is as follows: BX110 through a contact of relay 214HD closed in the proceed energized position, through a front contact of relay 214HR, as the relay controlling the home position of signal 214 must be energized before the 90 degree control relay energizes; through the step-down transformer for relay 214DR, the 90 degree control relay, to NX110.

The circuit for relay 41PC is as follows: positive battery BL-41 through a normal or reverse contact of relay 41HD, through the coils of relay 41PC,

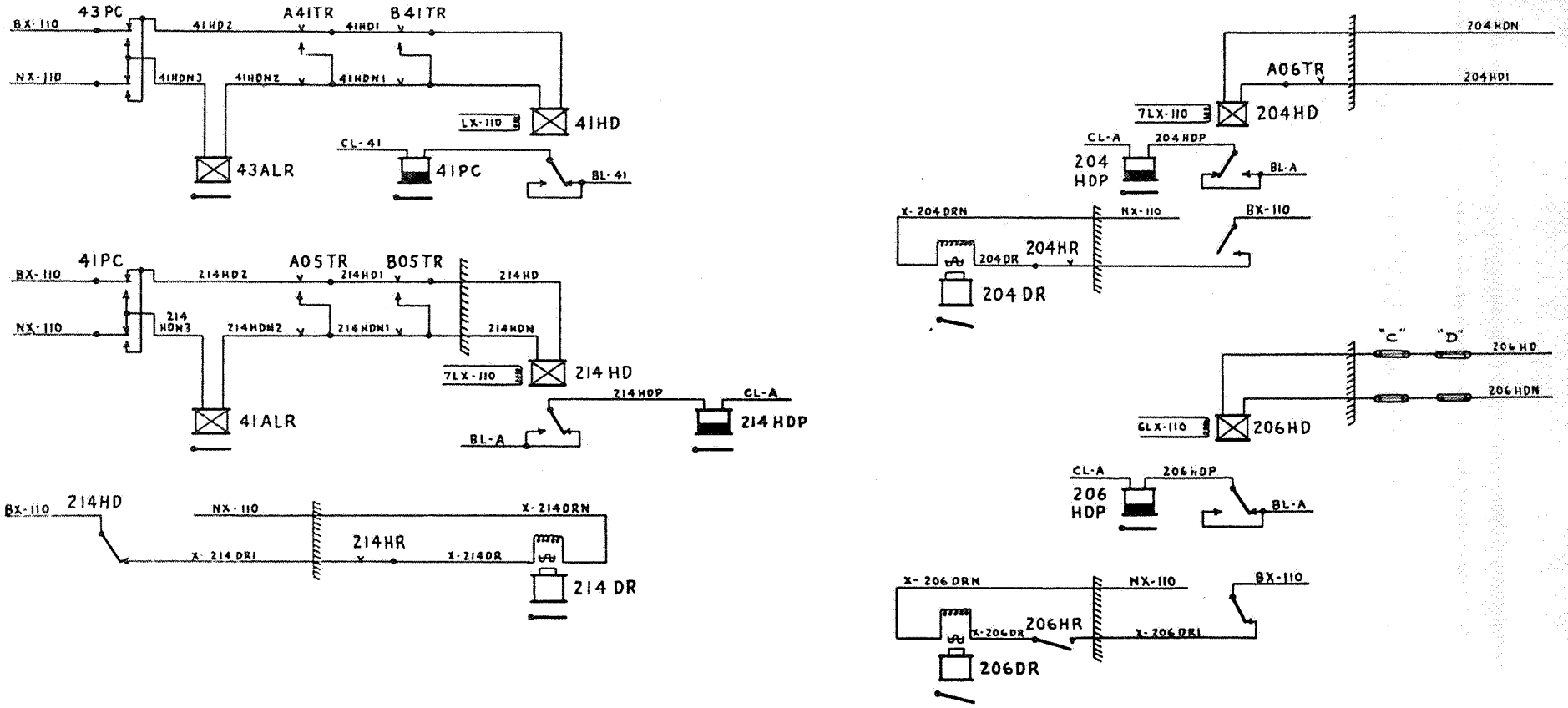


Fig. 76.
90 Degree Signal Control Circuits.

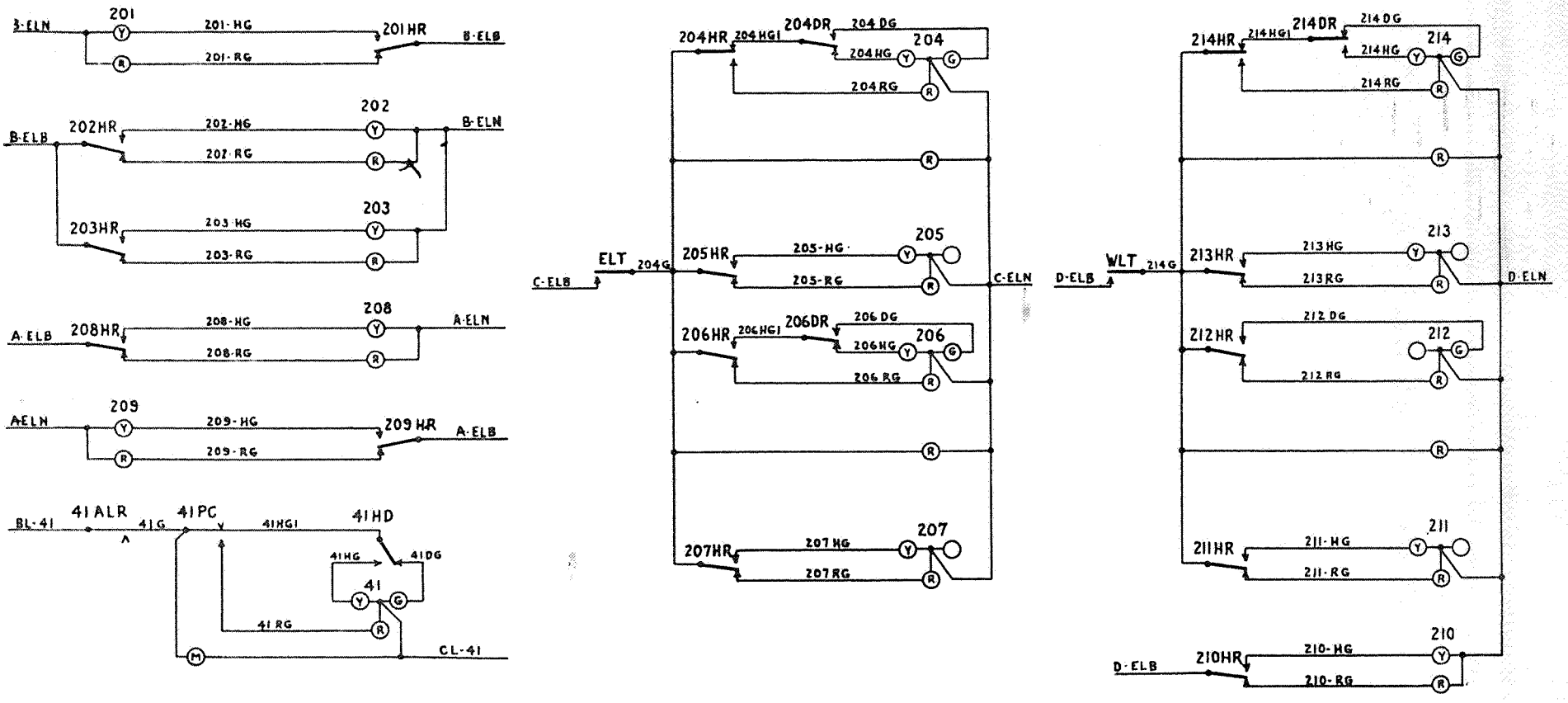


Fig. 77.
Signal Lighting Circuits.

to negative battery CL-41. With relay 41HD de-energized, relay 41PC is de-energized. When relay 41PC is de-energized, the current through the circuit for relay 214HD is in the reverse direction to the manner previously described. The reversal of the flow of current causes the contacts of relay 214HD to close to the left or reverse instead of as shown.

Signal lighting circuits.

The signal lighting circuits are shown in Fig. 77. The lighting circuit for signal 214 is as follows: positive energy D-ELB through a back contact of approach lighting relay WLT, through front contact of relay 214HR, the home control relay, through a front contact of relay 214DR, 90 degree control relay, to the green light on signal 214, to negative energy D-ELN. When home control relay 214HR is de-energized, the circuit goes through a back contact of relay 214HR to the red light on signal 214, to negative energy D-ELN. When home control relay 214HR is energized and the 90 degree control relay 214DR is de-energized, the circuit is through a front contact of home control relay 214HR, through a back contact of the 90 degree control relay 214DR, to the yellow light on signal 214, to negative energy D-ELN.

Approach lighting relay circuits.

The high signals, eastward, are approach lighted through relay ELT, and westward through relay WLT. The circuits for these relays are shown in Fig. 78 and the circuit for ELT is as follows: positive battery BL-C through a front contact of relay 206ALR, approach lighting relay for signal 206, through a front contact of approach lighting relay 204ALR, approach lighting relay for signal 204, through the coils of relay ELT, to negative battery CL-C.

The circuit for a series lighting relay was explained in connection with the 90 degree control circuit for signal 214, and is typical.

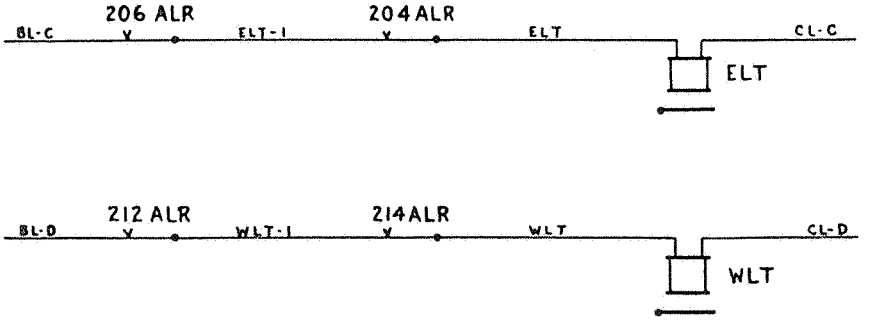


Fig. 78.
Approach Lighting Relay Circuits.

Lock stick and lock repeating relay circuits.

The lock stick and lock repeating relay circuits are shown in Fig. 79. The circuit for 4LP is as follows: positive battery BH through a front contact of switch locking relay 5ES, directional locking stick relay for eastward movements over switch 5, through a front contact of switch locking relay 5WS, directional locking stick relay for westward movements over

switch 5, through a front contact of track repeating relay 5TP as switch 4 must not be moved with track circuit 5T occupied, through a front contact of track relay 4TR for the reason as stated for the contact in relay 5TP, through a front contact of route locking relay 4ES, directional locking stick relay for eastward movements over switch 4, through a front contact of route locking relay 4WS for the reason as stated for the contact of relay 4ES, except that the stick locking is for a westward instead of an eastward movement over switch 4, through a front contact of 4LS, lock stick relay for lever 4, through the coils of lock repeating relay 4LP, through a limiting resistance of 6,500 ohms, to negative battery CH; the front contact of 4LS is cut around by a circuit which is closed by a contact on lever 4 while it is being moved from normal to reverse or vice versa, to keep relay 4LP energized until the lever movement has been completed. This front contact of 4LS is also cut around by a stick circuit through a front contact of 4KR and its own front contact. Relay 4LP, in combination with relays 4LS and 4KR and lever 4, controls the movements of switch 4.

Relay 4LS, the lock stick relay, is a quick-acting relay, the circuit for which is as follows: positive battery BL-A through multiple normal and reverse contacts on lever 4, through the coils of relay 4LS, the stick circuit being through a front contact of 4LS to negative battery CL-A, and the pick-up circuit being through a back contact of relay 4LP to negative battery CL-A. Relay 4LP is slow drop-away, so that when lever 4 is operated, relay 4LS de-energizes very quickly but relay 4LP remains energized through 4KR and the circuit is completed from the 4LP circuit through a back contact of 4LS, a front contact of 4LP and pole changing contacts on lever 4 to apply energy to the switch machine control wires NW and RW to operate the switch machine as previously described in connection with Fig. 73. When the master relay E (Fig. 73) responds to the lever movement the switch indicating relay 4KR de-energizes, opening the stick circuit for 4LP and through its back contact establishes a cut around circuit around 4LS back contact and 4LP front contact in the switch control circuit, thus maintaining energy on this circuit until the switch has completed its operation and the 4KR relay is energized. When the 4KR relay de-energized as above and opened the stick circuit of relay 4LP this relay, being slow drop-away, retained its front contact closed until the back contact of 4KR closed, but when opened, through its back contact, closed the pick-up circuit for 4LS which picked up and closed the pick-up circuit for 4LP relay, thus restoring these relays ready for further lever movement. Circuit for relay 4LS as explained is typical for all switches.

The circuits for relays 4LP and 4LS are such that a lever movement will have no effect if made while 4LP is de-energized due to a train movement or otherwise. Such a lever movement will cause relay 4LS to de-energize and immediately energize so that when 4LP is energized, the switch control circuit 4NW2 is still open at the back contact of 4LS. The lever must be operated again while relay 4LP is energized if the operator still wishes to reverse the switch. One purpose of this feature is to prevent operating a switch under a light engine or gas-electric car in the event of a momentary loss of train shunt.

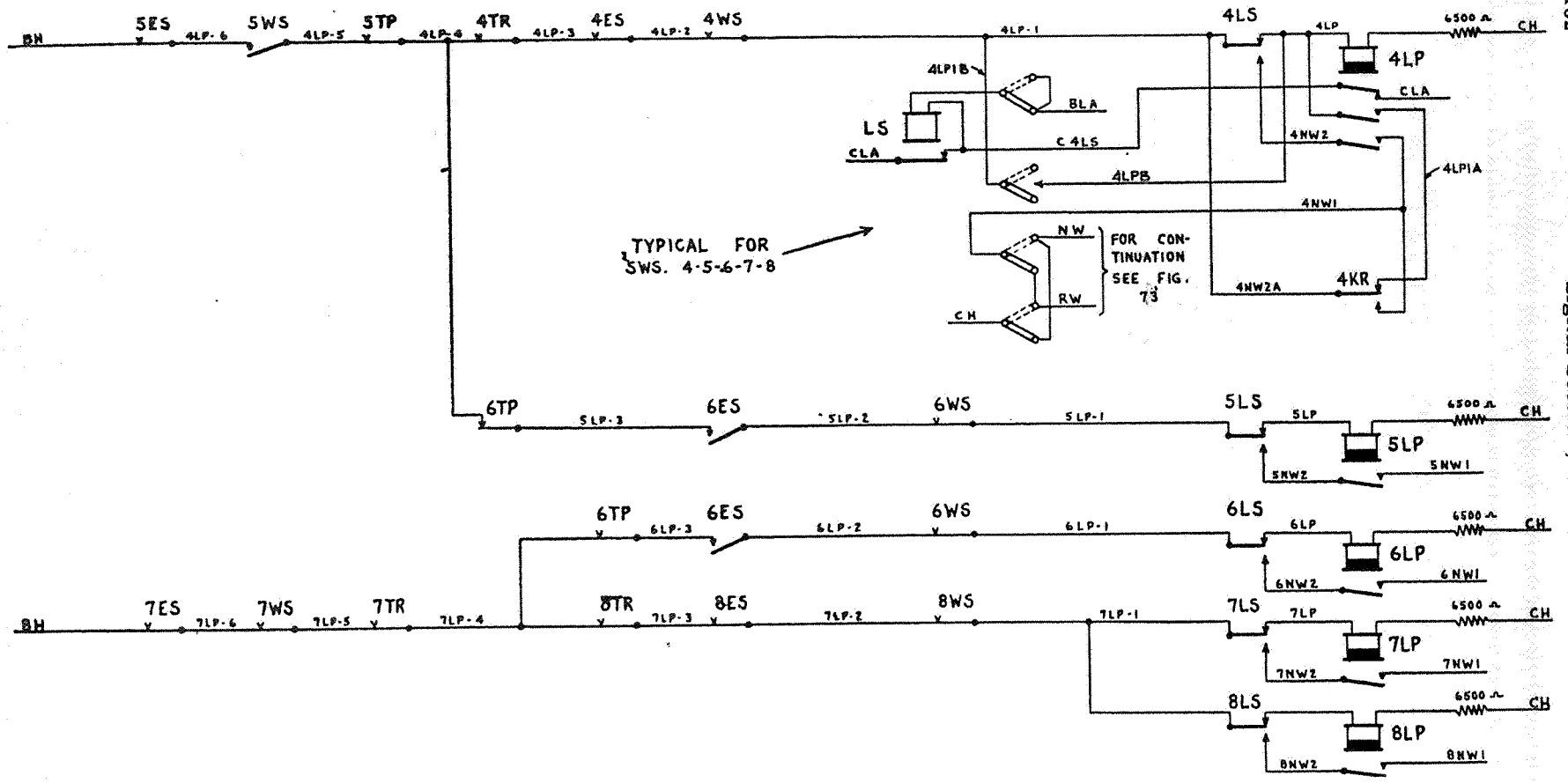


Fig. 79.
Lock Stick and Lock Repeating Relay Circuits.

Control machine, typical light circuits.

The machine utilized for the operation of an interlocking of this type is explained in Chapter IV—Centralized Traffic Control. The machine is equipped with a track chart having movable switches, lights indicating track occupancy, hands-off lights, arrow lights indicating a proceed signal and transit lights. The circuit for the movable switch on the track chart is shown in Fig. 80 and is as follows: positive battery BL-A or negative CL-A through a polar contact of switch indicating relay KR so that the position of the switch on the board will correspond to the position of the switch on the ground, through a contact of relay operating the movable switch, through the coil of the movable switch relay to CL-A or BL-A. It will be noted that the relays for the movable switch are set for the next operation, that is, as soon as the switch indicating KR relay changes position, battery of the correct polarity flows through the correct movable switch relay coil to reverse the switch on the track chart to agree with the position of the switch on the ground, at the same time opening its own circuit and connecting the other coil ready for the next operation.

The circuit for the transit light shown in Fig. 80 is as follows: positive battery BL-A through a back contact of KR relay as the relay will be de-energized whenever the switch is not in the normal or reverse position and locked, through a lamp mounted on the machine directly below the switch lever, to negative battery CL-A.

The circuit for the hands-off light shown in Fig. 80, is as follows: positive battery BL-A through a back contact of lock repeating relay LP as the movement of a switch lever is entirely ineffective if made when the lock repeating relay is de-energized, through a lamp mounted on the machine directly above the switch lever, to negative battery CL-A.

The circuit for the light indicating track occupancy, as shown in Fig. 80, is as follows: positive battery BL-A through a back contact of track

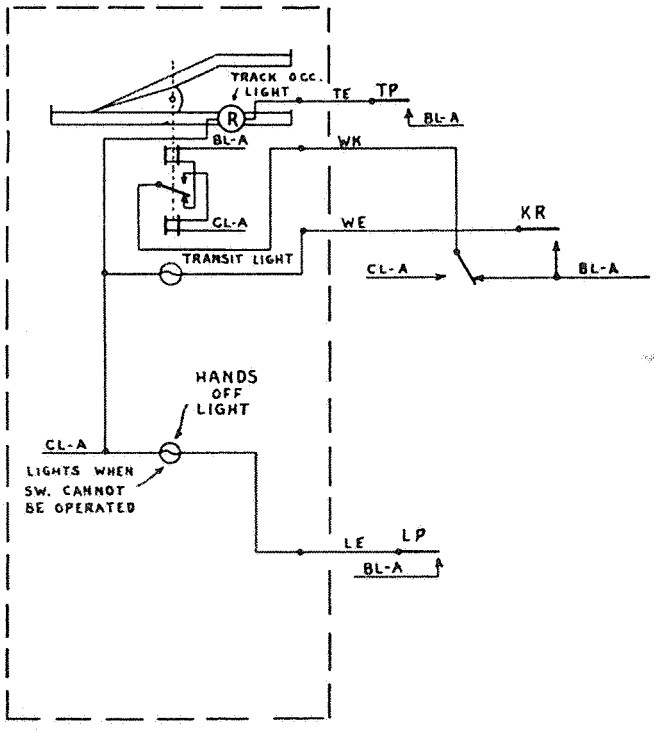


Fig. 80.
Control Machine Typical Light Circuits.

repeating relay TP as this relay will be de-energized with the track occupied, through a lamp on the machine, to negative battery CL-A.

The circuits for the arrow lights indicating a proceed signal are shown in Fig. 81 and the circuit for signal 201 is as follows: positive battery BL-A through a back contact of thermal stick relay 201THS, as stick relay will be de-energized when signal 201 indicates Proceed, through a front contact of lever repeating relay 201R, as this relay must be energized to permit signal 201 to indicate Proceed, to the lamp, to negative battery CL-A.

The circuits for track occupancy lights are also shown in Fig. 81 and the circuit for 41TE light is as follows: positive energy AEL-B through a back contact of relay 214HDP to 41TE lamp, to negative energy AEL-N.

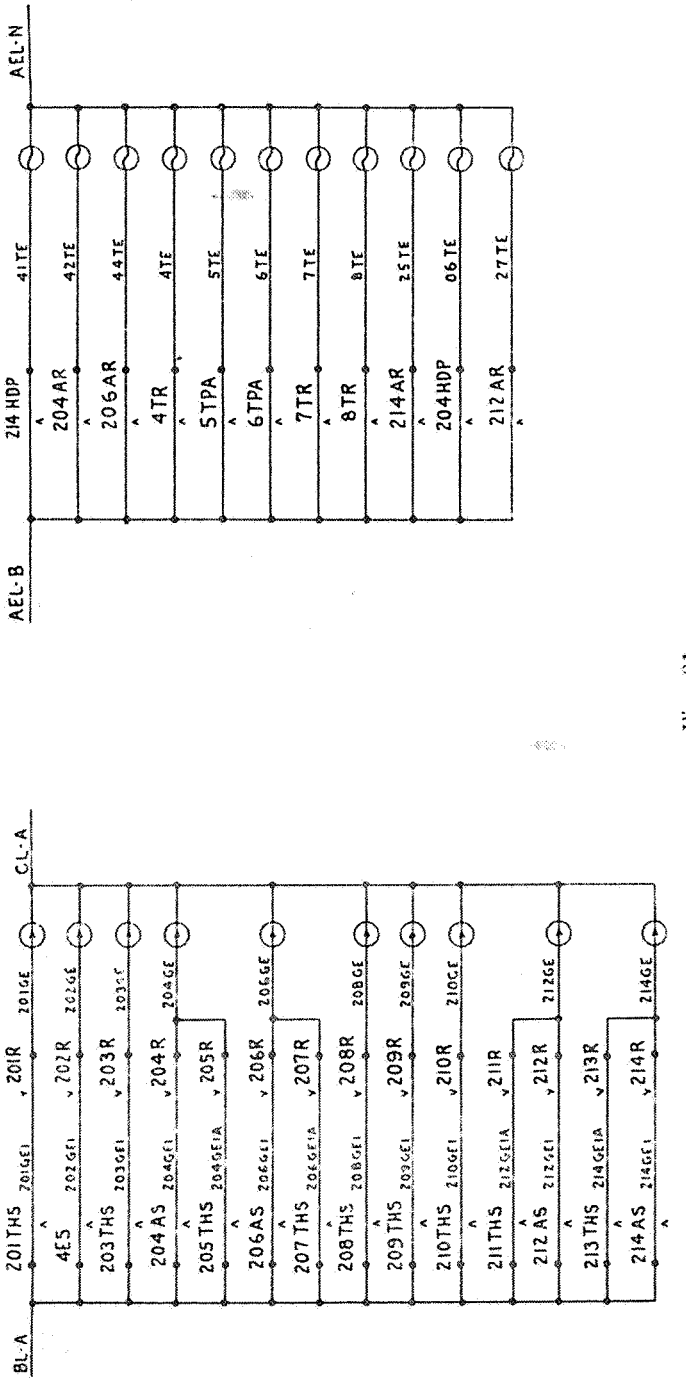


Fig. 81.
Signal and Approach Light Indicating Circuits.