

## CODED TRACK CIRCUIT CONTROL OF WAYSIDE SIGNALS

Coded track circuits are ideally suited to the control of wayside signals. By the use of several codes, several proceed indications may be transmitted over the rails and may be conveniently relayed at cut sections, to control the wayside signals without the use of line wires. This system provides a high degree of safety in eliminating the possibility of crosses and grounds which occasionally occur in the use of line wires, and the use of code inherently protects against the influence of any foreign current or any failure of the equipment. A proceed indication may be obtained only when the code-following track relay is responding to coded energy. Any condition, which causes the code-following track relay to hold its front contact or its back contact continuously closed, will give a stop indication. Furthermore, the use of code materially improves the shunting sensitivity of the track circuits because the shunt need be only good enough to prevent the track relay from picking up.

The coded track circuit system may use either coded d-c. or coded a-c. track circuit energy. Where wayside signals alone are considered, the coded d-c. track circuits are most suitable. Where cab signals are involved either alone or in conjunction with wayside signals, the use of a-c. track circuits is most suitable. In either case, the power supply for the system is preferably a single end-fed, low voltage (440 volt) transmission line. Where d-c. track circuits are used continuity of service is

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of Wayside Signals

assured by the use of both track and local (12 volt) storage batteries. Where a-c. track circuits are used in steam road territory, the power required for the track circuits is relatively low and continuity of service can be assured by the use of a tuned alternator which operates on d-c. energy from a local 12 volt storage battery during a period of power outage.

For territory where three-block, four-indication signaling is used or anticipated, we recommend our standard coded system which provides four indications by the use of three proceed codes, 75, 120 and 180. For territory where two-block, three-indication signaling is used and where a greater number of indications is not anticipated, a modified system using 45 and 180 code may be used. The use of the two widely separated codes in this modified system makes the decoding equipment somewhat simpler and a little lower in cost. Either arrangement is suitable for cab signaling.

Typical circuit TE19B1, sheet 1, shows the use of coded d-c. track circuits. At signal locations the CTP relay codes the battery energy fed to the track circuit. This CTP relay responds to battery energy coded at 180 code by the 180 code unit over a front contact of the H relay for the block in advance or battery energy coded at 75 code by the 75 coding unit over a back contact of the H relay when that relay is de-energized. At out sections the code-following track relay acts as the coding unit to interrupt the battery energy fed to the track circuit in the rear. It repeats the code received. At the signal location, the code-following track relay, while coding, feeds 12 volt battery energy, first, in

## Coded Track Circuit Control of Wayside Signals

one direction over its front contact and then in the other direction over its back contact, through the primary winding of the decoding transformer. This induces a low frequency alternating current in the secondary winding of the decoding transformer. This induced voltage in the secondary winding of the decoding transformer is mechanically rectified by a second contact on the code-following track relay which causes current to flow in the winding of the H relay in the same direction each time the code-following track relay changes its position in response to code. If the code-following track relay remains either energized or de-energized continuously the flux in the core of the decoding transformer remains constant and, with no alternating change of flux in the decoding transformer, no voltage is induced in its secondary winding and consequently the H relay can receive no energy. When the code-following track relay is operating at 180 code cycles per minute, the alternating current induced in the decoding transformer has a frequency of 3 cycles per second. The 180 decoding unit receives energy from an auto tap of the decoding transformer and is electrically tuned to 180 code cycles per minute, or 3 cycles per second so that it will pass energy to its rectifier to energize the D relay, only when it receives 180 coded energy. This method of decoding is exactly the same as has been used on coded locomotive equipments for years. It provides a high degree of selectivity and has been entirely satisfactory.

Typical circuit TE19D1, sheet 1, shows the use of coded

## Coded Track Circuit Control of Wayside Signals

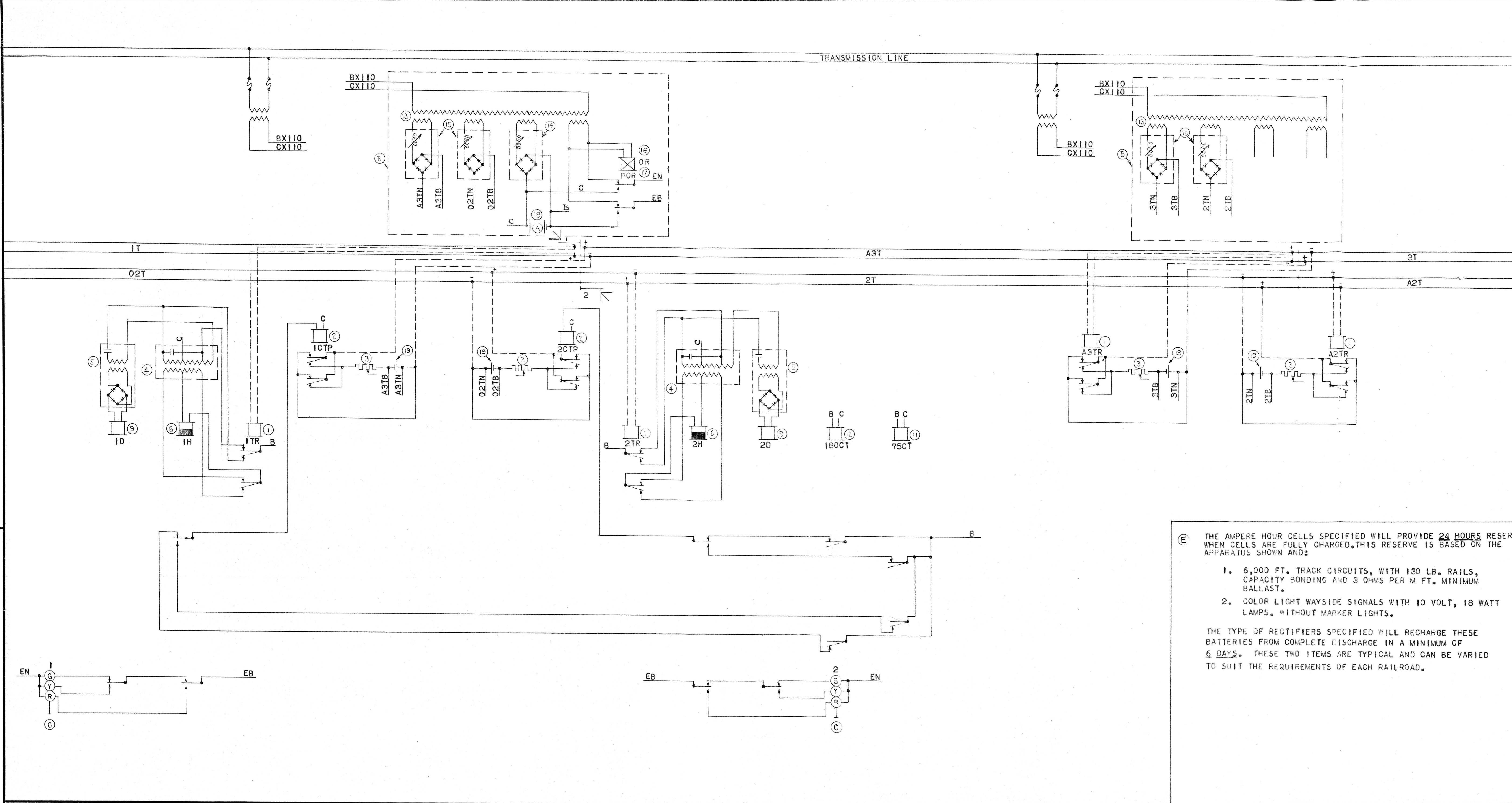
a-c. track circuits. In this case the primary side of the track transformer is selected over the H relay and receives coded alternating current energy directly over the contacts of the coding units. Alternating current at the entering or receiving end of the track circuit is fed through a transformer rectifier unit to the same d-c. code-following track relay. At cut sections, the code-following track relay repeats the code, again coding the primary side of the track transformer. The decoding arrangement for both H and D relays is the same as described above. As compared with coded d-c. track circuits, this arrangement eliminates the necessity for the track batteries and for the track battery charging rectifiers and it eliminates the use of the CTP code-following relay, but it requires the small transformer rectifier unit in the leads of the code-following track relay and requires a power-off relay and tuned alternator to guarantee continuity of service. While coded d-c. track circuits seem preferable for control of wayside signals alone, the coded a-c. track circuit arrangement has one advantage for the control of wayside signals in that a few of the high-class passenger trains may be equipped for cab signals and thus obtain the increased protection of cab signaling for this particular class of train with no changes whatsoever in the wayside equipment.

Typical circuit TE19G2, sheet 1, shows the modified form of coded d-c. track circuits. Here, the only change is the simpler

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form of decoding equipment which is made possible by the use of widely separated codes. The 180 decoding unit is replaced by a small decoding transformer which will supply sufficient energy to operate the D relay only when the code-following track relay is responding to the high code.

Typical circuit TE19D5, sheet 1, shows the modified system using coded a-c. track circuits. This arrangement has the a-c. track circuit characteristics described above and the simpler decoding equipment of the modified code system.



REFERENCES										REVISIONS	
ITEM NO.	INSTRUMENT	TYPE OR STYLE	NO. OF CONTACTS		ADDITIONAL DESCRIPTION	PLATE OR DWG. NO.	CAT. OR SH. NO.	REF. NO.	PCE. NO.	REVISIONS	
			F	B						NO.	DATE
①	TRACK RELAY	CD	2SP	2SP	CODE FOLLOWING 1 OHM (D)	C9452		3		6	2-1-38
②	LINE RELAY (CTP)	CD	2SP	2SP	CODE FOLLOWING OHMS (D)	C9452		3			
③	TRACK RESISTOR										
④	DECODING TRANSFORMER	W-10				F6020					
⑤	CLEAR DECODING UNIT	Y-10			180 CODE	W-55					
⑥	H RELAY	DN-22	2	2	SLOW RELEASE OHMS	W-40					
⑦	H RELAY	DN-11	4	4	SLOW RELEASE OHMS	W-25					
⑧	H RELAY	DN-11	6	6	SLOW RELEASE OHMS	E4901	Ab				
⑨	D RELAY	DN-22	2	2	55 OHMS	W-40	Ac	188770			
⑩	D RELAY	DN-11	4	4	55 OHMS	W-25	A	188688			
⑪	CODE TRANSMITTER (75 CT)	OSCIL-LATING	2SP	2SP	33 OHMS (D)	W-7	A	197087			
⑫	CODE TRANSMITTER (180 CT)	OSCIL-LATING	2SP	2SP	33 OHMS (D)	W-7	Aj	197088			
⑬	SIGNAL LIGHTING & RECTIFIER TRANS.	W-10			60/100~	F6020		192281			
⑭	RECTIFIER	RX-42			60/100~ (E)	S-32	Ba	102026			
⑮	RECTIFIER	RX-10			60/100~ (E)	S-20	Eb	165631			
⑯	POWER TRANSFER RELAY	ANL-30	2	2	10 VOLT, 100~	E1175		164485			
⑰	POWER TRANSFER RELAY	ANL-30	2	2	10 VOLT, 60~	E1175					
⑱	LINE STORAGE BATTERY	LEAD									
⑲	TRACK STORAGE BATTERY	LEAD									

THE ABOVE REFERENCES ARE FOR 60 OR 100 CYCLE APPARATUS.

**NOTES**

- (A) SYSTEM OPERATES ON NOMINALLY 10 VOLTS D.C.
- (B) POWER UNIT FOR USE WITH SINGLE END FED TRICKLE CHARGE TRANSMISSION LINE.
- (C) LIGHTING CIRCUITS FOR COLOR LIGHT WAYSIDE SIGNAL. CIRCUITS FOR OTHER TYPES OF WAYSIDE SIGNALS ARE SHOWN ON TE19F31.
- (D) SILVER PLATINUM (SP) CONTACTS.

(E) THE AMPERE HOUR CELLS SPECIFIED WILL PROVIDE 24 HOURS RESERVE WHEN CELLS ARE FULLY CHARGED. THIS RESERVE IS BASED ON THE APPARATUS SHOWN AND:

- 6,000 FT. TRACK CIRCUITS, WITH 130 LB. RAILS, CAPACITY BONDING AND 3 OHMS PER M FT. MINIMUM BALLAST.
- COLOR LIGHT WAYSIDE SIGNALS WITH 10 VOLT, 18 WATT LAMPS, WITHOUT MARKER LIGHTS.

THE TYPE OF RECTIFIERS SPECIFIED WILL RECHARGE THESE BATTERIES FROM COMPLETE DISCHARGE IN A MINIMUM OF 6 DAYS. THESE TWO ITEMS ARE TYPICAL AND CAN BE VARIED TO SUIT THE REQUIREMENTS OF EACH RAILROAD.

**REFERENCES**

FOR TYPICAL LIGHTING PROTECTION CIRCUITS, SEE TP68A

CODED D.C. TRACK CIRCUITS,

TWO-BLOCK SIGNALING LIGHT-TYPE WAYSIDE SIGNALS, U.S. & S. CO. STD.

AUTOMATIC BLOCK SYSTEM NORMALLY-CODED-TRACK-CIRCUIT TYPE, SINGLE-DIRECTION-RUNNING TYPICAL SYSTEM CIRCUITS SCALE: NONE

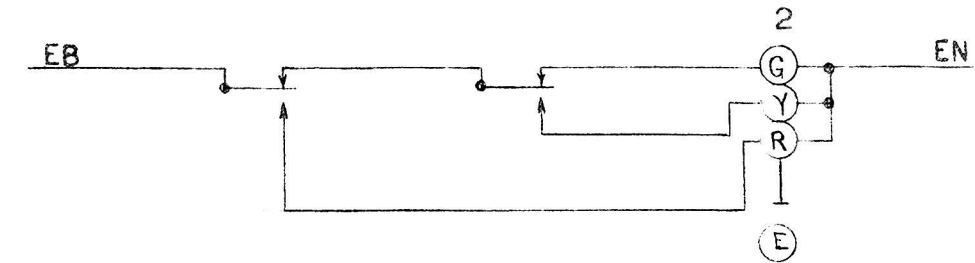
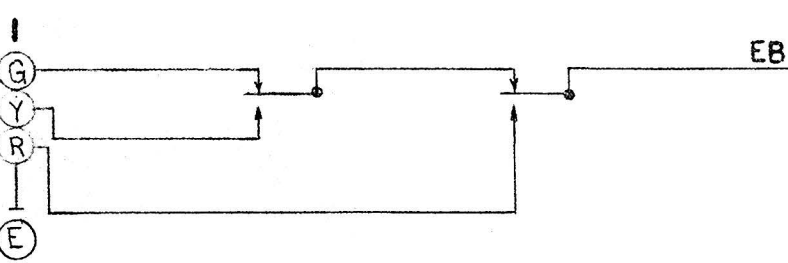
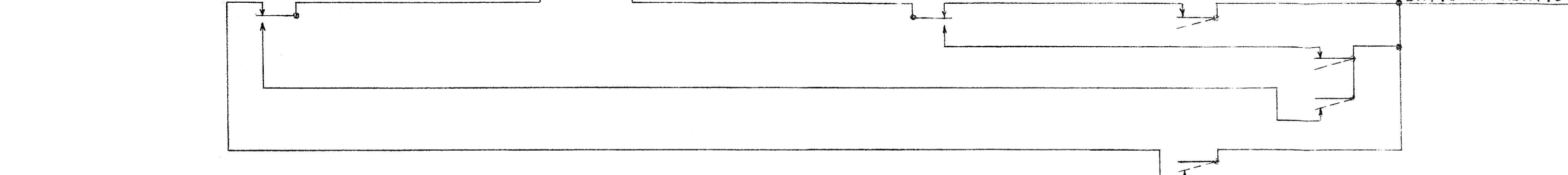
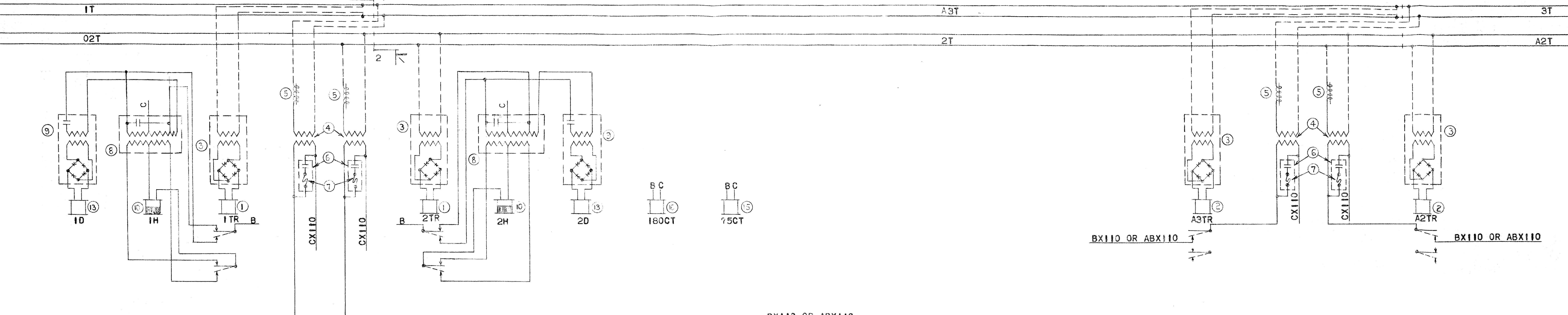
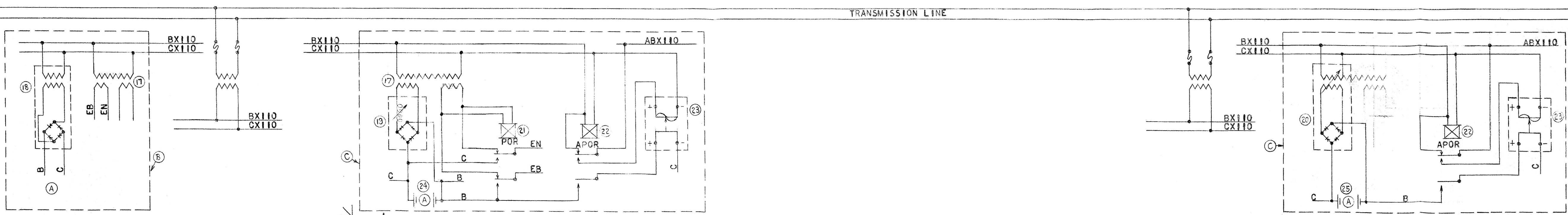
DESIGNED... CWF  
DRAWN... J. Se.  
TRACED... F. J. H.  
CHECKED... C. W. F.  
OK'D... R. R. K.

APPROVED H.A.T. DATE 7-6-34

DATE 6-15-34 SHEETS 3 SHEET No. 1

TE19B1

TRANSMISSION LINE



ITEM NO.	INSTRUMENT	TYPE OR STYLE	NO. OF CONTACTS		ADDITIONAL DESCRIPTION	CAT. PLATE OR DWG. NO.	REF. OR SH. NO.	P.C.E. NO.	REVISED AND REDRAWN NO.
			F	B					
1	TRACK RELAY (AT SIGNAL)	CD	2SP	2SP	CODE FOLLOWING 18.5 OHMS @	C9452	3	206022	
2	TRACK RELAY (AT CUT)	CD	1T	1SP	CODE FOLLOWING 18.5 OHMS @	C9452	3	197464	
3	RELAY-TRANSFORMER-RECTIFIER UNIT	RQ-B				C9135	110		
4	TRACK TRANSFORMER	W-10			HIGH EFFICIENCY	F6020			
5	TRACK REACTOR	VT-2				F6401			
6	CAPACITOR				2.5 MF	W-70	C	193020	
7	FUSE, 1 AMP.	N.E.C.			NOT INCLUDED IN ITEM 6				
8	DECODING TRANSFORMER	W-10				F6020			
9	CLEAR DECODING UNIT	Y-10			180 CODE	W-55			
10	H RELAY	DN-22	2	2	SLOW RELEASE OHMS	W-40			
11	H RELAY	DN-11	4	4	SLOW RELEASE OHMS	W-25			
12	H RELAY	DN-11	6	6	SLOW RELEASE OHMS	E4901	Ab		
13	D RELAY	DN-22	2	2	55 OHMS	W-40	Ac	188770	
14	D RELAY	DN-11	4	4	55 OHMS	W-25	A	188668	
15	CODE TRANSMITTER (75 CT)	OSCILLATING	2T	2T	33 OHMS @	W-7	Aa	196682	
16	CODE TRANSMITTER (180 CT)	OSCILLATING	2T	2T	33 OHMS @	W-7	Ah	196680	
17	SIGNAL LIGHTING & RECTIFIER TRANS.	W-10			50/100 ~	F6020		188438	
18	RECTIFIER	RQ-41			60/100 ~	S-340			
19	RECTIFIER	RX-42			60/100 ~ (F)	S-32	Ba	102026	
20	RECTIFIER	RT-10			60/100 ~ (F)	S-4	Dn	188978	
21	POWER TRANSFER RELAY	ANL-30	2	2	10 VOLT	E1175		164485	
22	POWER TRANSFER RELAY	ANL-30	2	2	110 VOLT	E1175		172603	
23	TUNED ALTERNATOR					C9358	5		
24	STORAGE BATTERY	LEAD 160 A.H.				(F)			
25	STORAGE BATTERY	LEAD 40 A.H.				(F)			

THE ABOVE REFERENCES ARE FOR 100 CYCLE APPARATUS.

NOTES

- (A) SYSTEM OPERATES ON NOMINALLY 10 VOLTS D.C.
- (B) THIS VIEW APPLIES WHEN CONTINUITY OF POWER IS OBTAINED BY THE USE OF A DOUBLE END FED TRANSMISSION LINE AND AUTOMATIC SUBSTATIONS. REQUIRED ONLY AT SIGNAL.
- (C) THIS VIEW APPLIES WHEN A SINGLE END FED TRICKLE CHARGE TRANSMISSION LINE IS USED AND CONTINUITY OF A-C POWER IS OBTAINED BY THE USE OF LOCAL POWER-OFF CONTROLLED POWER RESERVE UNITS.
- (D) USE SILVER PLATINUM (SP) CONTACTS FOR D-C CIRCUITS AND TUNGSTEN (T) CONTACTS FOR 110 VOLT A-C CIRCUITS.
- (E) LIGHTING CIRCUITS FOR COLOR LIGHT WAYSIDE SIGNAL. CIRCUITS FOR OTHER TYPES OF WAYSIDE SIGNALS ARE SHOWN ON TE19FS.

- (F) THE AMPERE HOUR CELLS SPECIFIED WILL PROVIDE 24 HOURS RESERVE WHEN CELLS ARE FULLY CHARGED. THIS RESERVE IS BASED ON THE APPARATUS SHOWN AND:
1. 6,000 FT. TRACK CIRCUITS, WITH 130 LB. RAILS, CAPACITY BONDING AND 3 OHMS PER M FT. MINIMUM BALLAST.
  2. 0.5 - 0.7 AMP., 100 CYCLE MINIMUM AXLE CURRENT.
  3. COLOR LIGHT WAYSIDE SIGNALS WITH 10 VOLT, 18 WATT LAMPS, WITHOUT MARKER LIGHTS.

THE TYPE OF RECTIFIERS SPECIFIED WILL RECHARGE THESE BATTERIES FROM COMPLETE DISCHARGE IN A MINIMUM OF 6 DAYS. THESE TWO ITEMS ARE TYPICAL AND CAN BE VARIED TO SUIT THE REQUIREMENTS OF EACH RAILROAD.

CODED LOW-ENERGY A.C. TRACK CIRCUITS,

TWO-BLOCK SIGNALING, LIGHT-TYPE WAYSIDE AND CAB SIGNALS, D.C. TRACK RELAY, U.S. & S. CO. STD.

AUTOMATIC BLOCK SYSTEM NORMALLY-CODED-TRACK-CIRCUIT TYPE, SINGLE-DIRECTION RUNNING TYPICAL SYSTEM CIRCUITS U.S. & S. CO. SWISSVALE, PA. SCALE: NONE

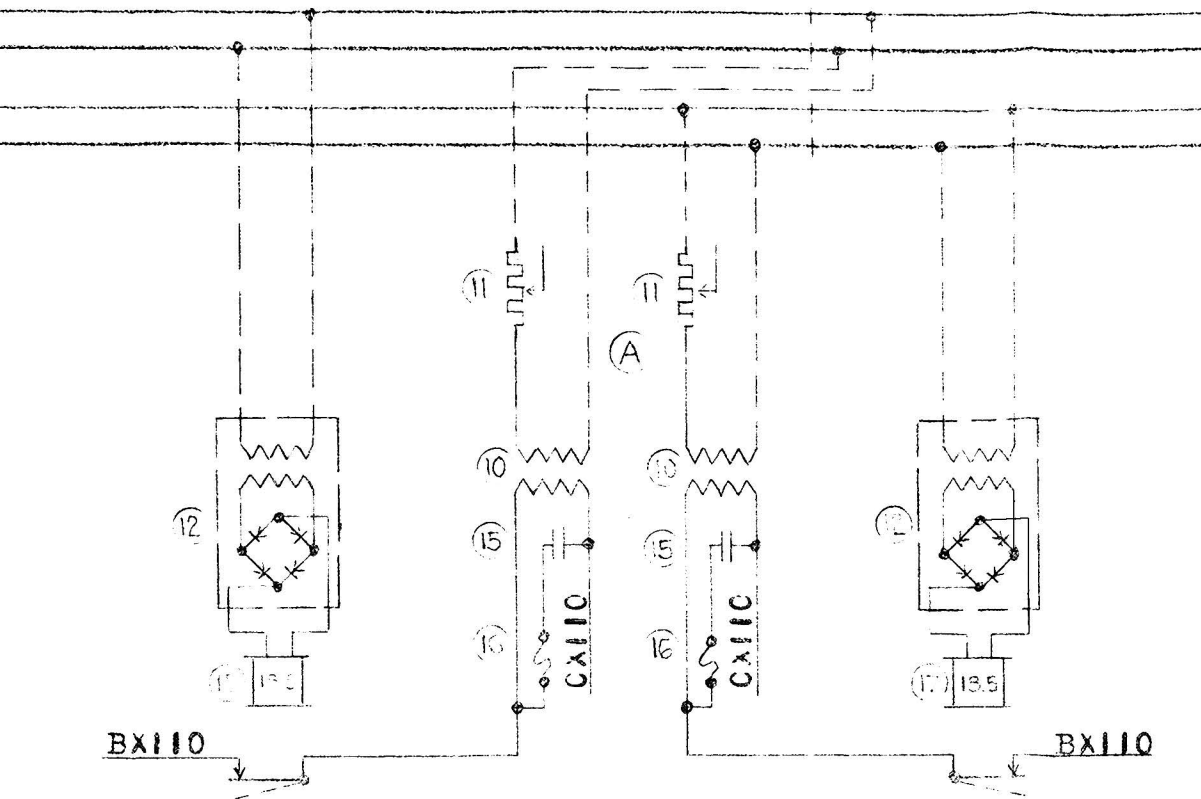
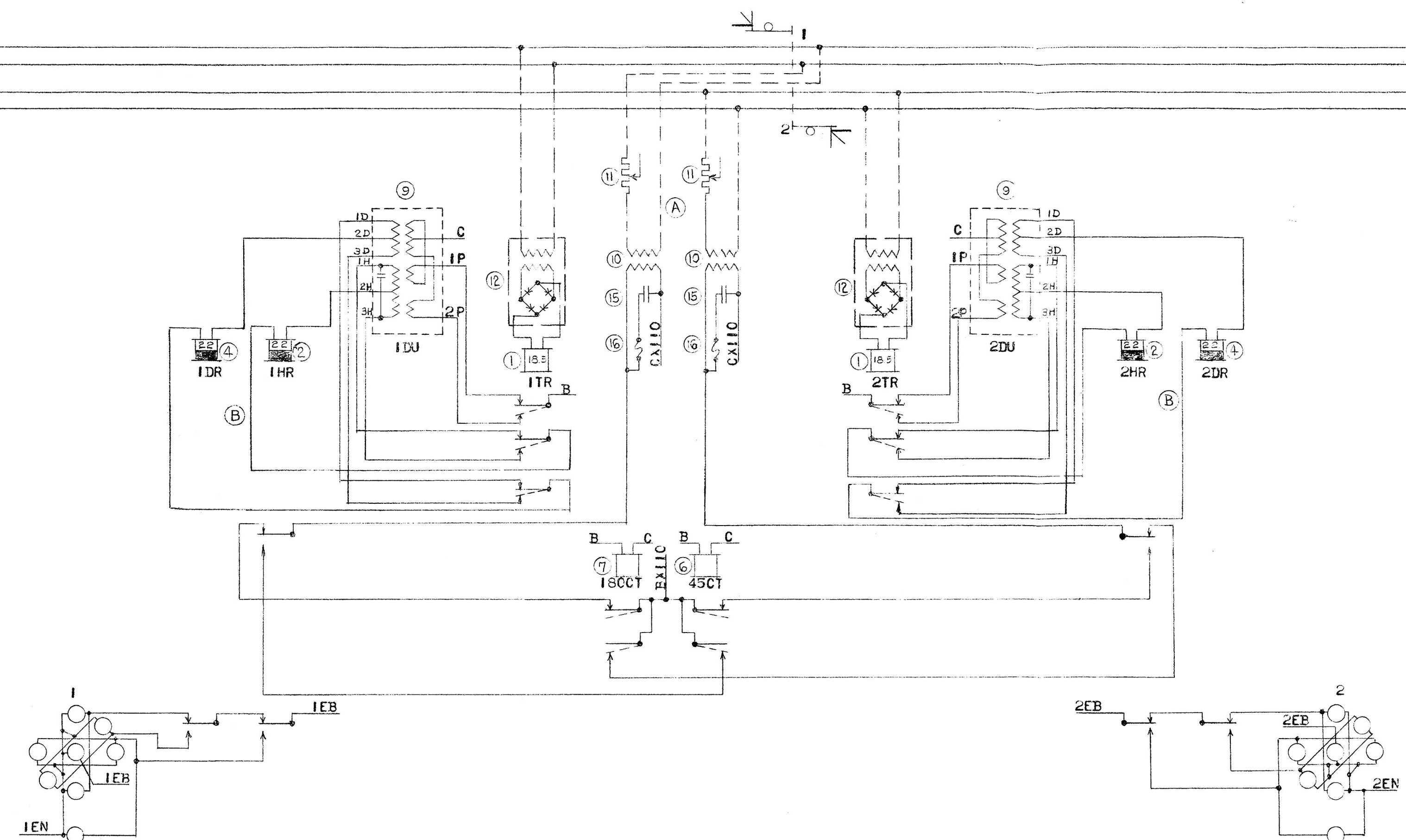
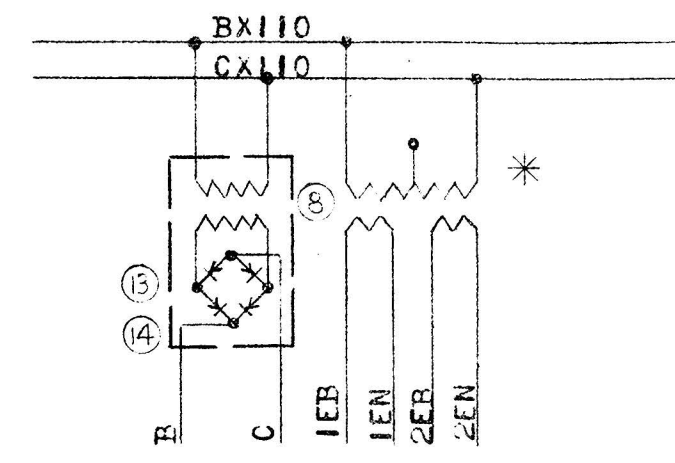
APPROVED: H.A.T. DATE 12-3-34  
 3 SHEETS SHEET NO. 1  
 DATE 6-20-34  
 TE19DI

REVISIONS

NO.	DATE	DESCRIPTION
5	1-27-38	REVISED AND REDRAWN

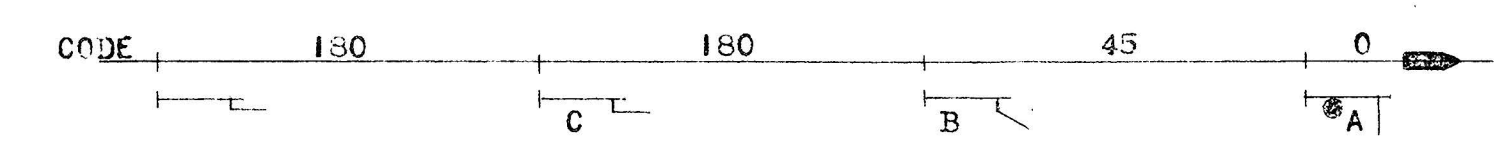
REFERENCES

DESIGNED R.R.K.  
 DRAWN FISHER  
 TRACED  
 CHECKED R.R.K. 12-23-34  
 OK'D



CONTROL LIMIT CHART  
WAYSIDE SIGNALS

TRAFFIC CONDITION	TRACK RELAY	"H" RELAY	"D" RELAY	WAYSIDE INDICATION SIGNAL	
				2 BLOCK	3 INDICATION
TRAIN IN BLOCK	DOWN	DOWN	DOWN	A - STOP	
TRAIN IN 1ST BLOCK AHEAD	CODING 45	UP	DOWN	B - APPROACH	
TRAIN IN 2ND BLOCK AHEAD	CODING 180	UP	UP	C - CLEAR	



NOTES  
APPARATUS ORDERING REFERENCES - SUBJECT TO CHANGE  
CHECK REFERENCES BEFORE ORDERING

IDENTIFICATION OR NOMENCLATURE	INSTRUMENT	TYPE OR STYLE	NUMBER OF CONTACTS	PLATE OR DRAWING NUMBER	PIECE NUMBER
①	CODE FOLLOWING TRACK RELAY	CD	4 4	C9452 7	210440
②	H RELAY	DN-18, 220, SLOW-PICK UP, SLOW RELEASE	4 4	C9077 74	SIM. TO 172633
③	H RELAY	DN-18, SLOW-PICK UP, SLOW RELEASE	6 6	C9077 73	SIM. TO 174008
④	D RELAY	DN-19, 220, SLOW RELEASE	4 4	C9077 87	SIM. TO 179495
⑤					
⑥	CODE TRANS-MITTER (45CT)	OSCILLAT-ING	2 2	C-9375 9	210392
⑦	CODE TRANS-MITTER (180CT)	OSCILLAT-ING	2 2	W-7- Ah	196680
⑧	LIGHTING TRANSFORMER	W-11-220/110V, 50/100~*		C9228 4	171840
⑨	DECODING UNIT 45/180	SATURABLE TYPE-12V.		C9454 9	210441
⑩	TRACK TRANSFORMER	W-10 25~		C9228 4	199563
⑪	TRACK RESISTOR	SU-32-A1		F6509 4K	
⑫	RELAY-TRANS-RECTIFIER UNIT	RQ-8		C9135 110	208458
⑬	LINE RECTIFIER (TWO TRACKS)	RQ-21 25/100~		C-9135 43	210642
⑭	LINE RECTIFIER (ONE TRACK)	RQ-12 25/100~		C-9135 22	210643
⑮	CAPACITOR	2.5 MFD. & FUSE CLIP		W-70 C	193020
⑯	1 AMP. FUSE	250V. NEC-STD.			
⑰	CODE FOLLOWING TRACK RELAY	CD	2 2	C9452 1	197484

(A) EXISTING TRACK TRANSFORMER SPEC. 430 AND REACTOR SPEC. 504 MAY BE USED.  
(B) 4 POINT DN-18 OR 6 POINT DN-18 H RELAY MAY BE USED AS REQUIRED.

\* FOR 25~ OPERATION CONNECT 110V TO IP AND 3P.

REVISIONS

1 | 1-15-38  
REFERENCES COMPLETED  
DECODING UNIT CHANGED  
R.R.K.  
2 | 2-8-38  
4PT. H RELAY (2) WAS  
DN-11 PC.210561  
2PT. D RELAY (2) WAS  
DN-19 PC.210633  
ITEM (5) ELIMINATED  
ITEM (3) WAS DN-11  
1/19/37 1/19/38

REFERENCES

MADE FOR UNION R.R. G.O.418058  
CODED LOW ENERGY 25/60~ A.C. TRACK CIRCUITS

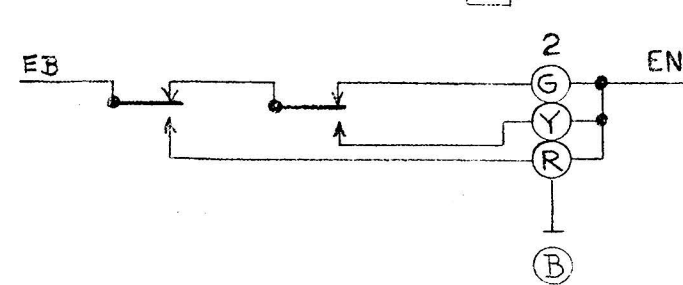
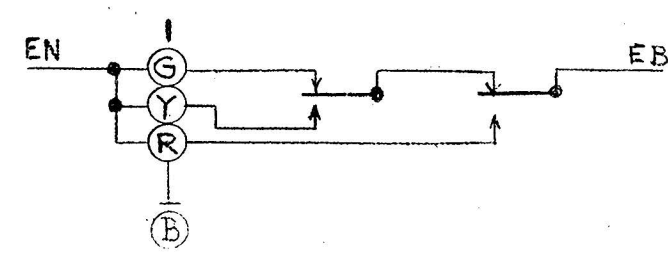
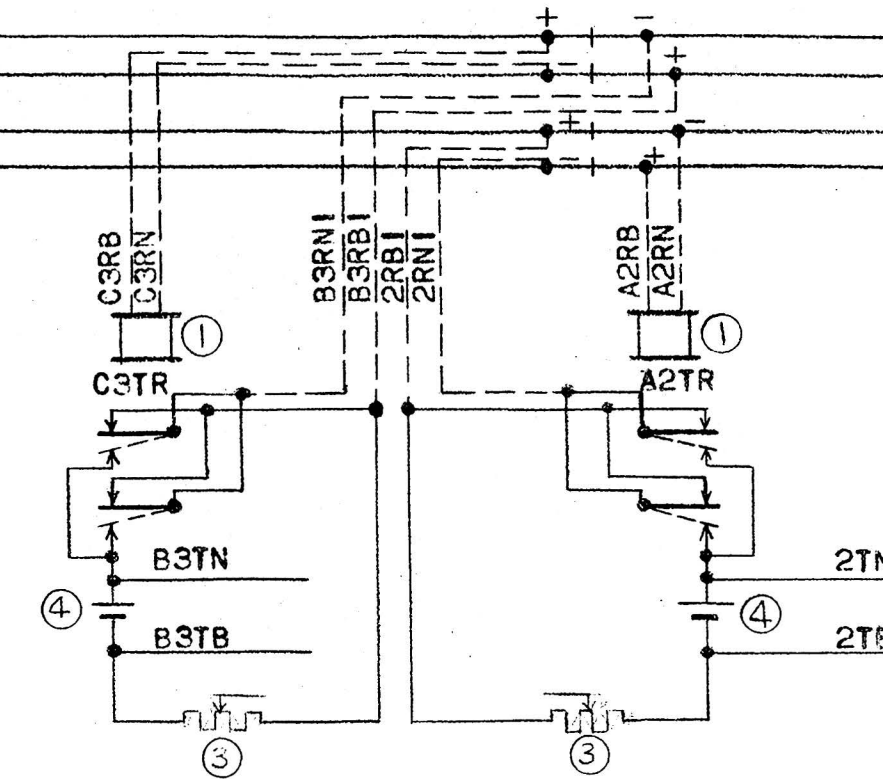
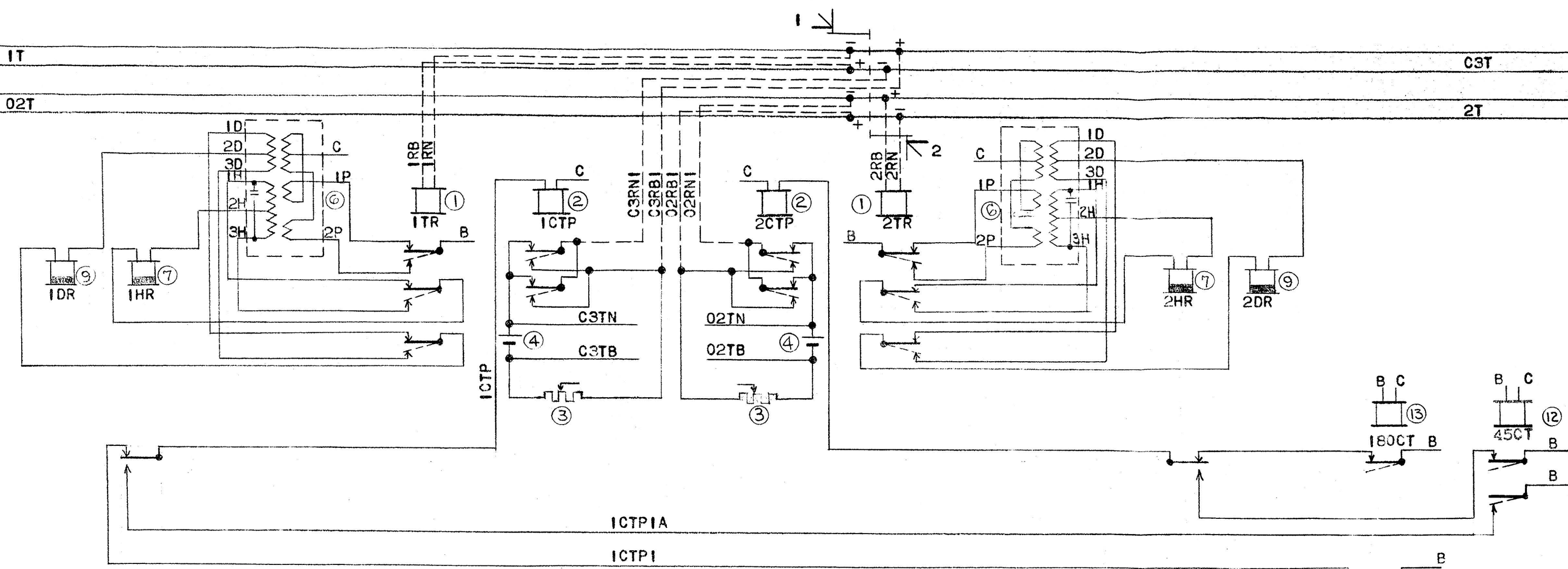
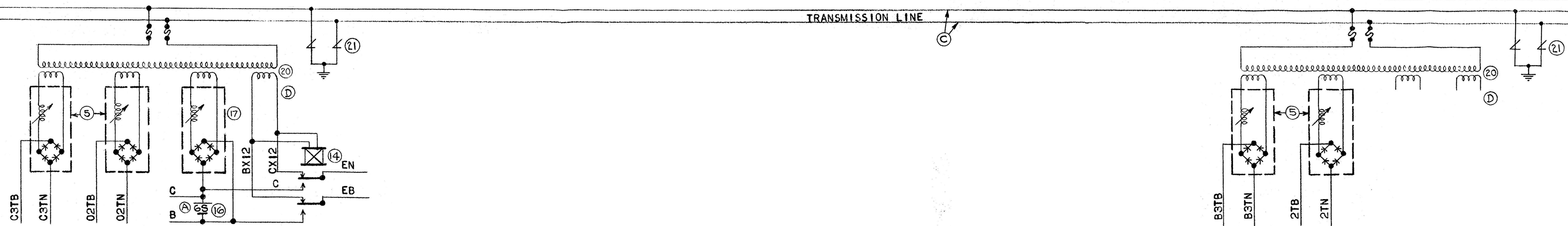
TWO-BLOCK SIGNALING,  
POSITION LIGHT WAYSIDE SIGNALING,  
D.C. TRACK RELAY.

AUTOMATIC BLOCK SYSTEM  
NORMALLY-CODED-TRACK CIRCUIT TYPE,  
SINGLE DIRECTION RUNNING  
TYPICAL SYSTEM CIRCUITS  
U.S. & S. CO., SWISSVALE, PA. SCALE: NONE

APPROVED: [Signature] DATE: 11/19/37  
SHEETS: 1 SHEET NO. 1

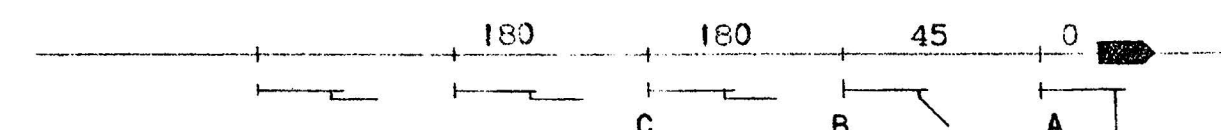
TE19D5





**CONTROL LIMIT CHART  
WAYSIDE SIGNALS**

TRAFFIC CONDITION	TRACK RELAY	H RELAY	D RELAY	WAYSIDE 2 BLOCK- 3 INDICATION
				SIGNAL
TRAIN IN BLOCK	DOWN	DOWN	DOWN	A = RED
TRAIN IN 1ST BLOCK AHEAD	CODING 45	UP	DOWN	B = YELLOW
TRAIN IN 2ND BLOCK AHEAD	CODING 180	UP	UP	C = GREEN



RECOMMENDED APPARATUS SUBJECT TO CHANGE.  
CHECK REFERENCES BEFORE ORDERING

IDENTIFICATION OR NOMENCLATURE	INSTRUMENT	TYPE OR STYLE	NUMBER OF CONTACTS	PLATE OR DWG. NO.	REF. OR SH. NO.	PC. NO.
①	CODE FOLLOWING TRACK RELAY	TYPE "CD"	2 SP 2 SP	C9452	7	
②	CODE FOLLOWING LINE RELAY	TYPE "CD" 12 VOLT	2 SP 2 SP	C9452	7	
③	TRACK RESISTOR	1 Ω		F6509	2b	
④	TRACK BATTERY	LEAD TYPE				
⑤	TRACK RECTIFIER	RX21		S-25		
⑥	DECODING UNIT 45/180	SATURABLE TYPE		C9454	9	210441
⑦	H RELAY	DN-18, 22 W SLOW PL. SLOW RLS.	4 4	C9077	74	SIM. TO 172663
⑧	H RELAY	DN-18, 22 W SLOW PL. SLOW RLS.	6 6	C9077	73	SIM. TO 174008
⑨	D RELAY	DN-18, 22 W SLOW PL. SLOW RLS. RELEASE	4 4	C9077	87	SIM. TO 179495
⑩						
⑪						
⑫	45CT CODE TRANSMITTER	OSCILLATING TYPE	2 S-P 2 S-P	W-7		210392
⑬	180CT CODE TRANSMITTER	OSCILLATING TYPE	2 S-P 2 S-P	W-7		
⑭	POWER-OFF RELAY	ANL-30	2 2	E1175	A6	
⑮						
⑯	LINE BATTERY	LEAD TYPE				
⑰	LINE RECTIFIER	RX42		S-32		
⑱						
⑲						
⑳	TRANSFORMER	W10		F6020		
㉑	LIGHTNING ARRESTER	440-550 VOLTS				

(A) SYSTEM OPERATES ON NOMINALLY 12 VOLTS D.C.  
(B) TYPICAL WAYSIDE SIGNAL CONTROL AND LIGHTING CIRCUITS FOR OTHER TYPES OF LIGHT SIGNALS SHOWN ON TE19F. WHEN MARKER LIGHTS ARE USED THE METHOD OF OPERATION TO CONFORM WITH THE R.R. CO'S. PRACTICE.  
(C) TRICKLE CHARGE TRANSMISSION LINE, 440 OR 550 VOLTS.  
(D) LINE TRANSFORMER ㉑ PLATE F6020, WITH HIGH VOLTAGE LEADS AND SECONDARY WINDING AS REQUIRED IF LOCATED IN INSTRUMENT CASE.

REFERENCES  
FOR TYPICAL LIGHTING PROTECTION CIRCUITS, SEE TP68AI

DESIGNED HAT  
DRAWN EWL-F  
TRACED  
CHECKED RAC 3/12/36  
OK'D  
AUTOMATIC BLOCK SYSTEM  
NORMALLY-CODED TRACK-CIRCUIT TYPE, SINGLE-DIRECTION RUNNING  
TYPICAL SYSTEM CIRCUITS  
U. S. & S. CO., SWISSVALE, PA. SCALE: NONE  
APPROVED DATE 3/12/36  
SHEETS SHEET No. 1  
DATE 6-25-33  
TE19G2

REVISIONS  
1 9-9-36  
WAS TE19J1  
2 12-3-38  
LOADING CIRCUIT REVISD.  
3 1/17/36