BONDING

1 Bonds, except concealed propulsion bonds, must be inspected monthly. Defective bonds must be immediately replaced.

2 Direct current track circuits through road crossings, station platforms or other places where visual inspection of bonding cannot readily be made, must be tested frequently to determine that bonds are not broken or defective, by connecting ammeter in series with track battery and observing the movement of needle which should show either a gradually increased reading as train approaches battery end or gradually decreased reading if train is moving away from battery end. Any sudden movement of needle indicates that train has just passed over joints with defective bonding. (Rail joint bonding in electric propulsion circuit is tested by Transmission Department).

3 Bonding through road crossings, station platforms and other places where visual inspection cannot readily be made, must be renewed whenever planking or paving is removed. If planking or paving has not been removed for a long period and in Maintainer's judgment bonding is in need of renewal, the Maintainer must request Section Foreman to remove planking or paving.

4 Foreign current tests may be made by disconnecting battery and placing ammeter in series with track relay. If track circuits are found with foreign current, report should be made to the Signal Supervisor. In territory where foreign current is found in track circuit particular care should be taken to prevent bond wire and insulated joint failures.

RAIL CONNECTIONS

5 Rail connections must be inspected frequently. They must be kept tight and properly formed and when possible below top of ties.

6 Test of shunt and fouling section connections must be made at least once each 3 months. Effectiveness of switch circuit controller shunt must be determined by operating only the shunting contacts. Each contact must be tested separately.

7 Effectiveness of fouling section connections must be determined by shunting track circuit with a standard .060 ohm resistance at end of fouling section farthest from point of connection with main circuit and noting that shunt is effective.

BALLAST

8 Ballast must be kept at least 1 inch clear of rail, fastenings and anchors. When ballast is not clear of rail, Maintainer must request Section Foreman to clear. If Maintainer cannot secure action from Section Foreman he must take up with Signal Supervisor.

Maintenance of Way Department Rule reads:

"Where rails are bonded, any ballast, mud or dirt that may touch the rails should be removed to allow a clear space of at least 1 inch below the base of rail. At road crossings, platforms, etc., where it is not possible to keep the rails clear, the mud or dirt shall be removed and clean ballast substituted."

INSULATED JOINTS

9 Insulated joints must be inspected monthly to insure that fibre plates and bushings are in proper condition. Maintainer must notify Section Foreman if insulated joints are in need of renewal. If Maintainer cannot secure action from Section Foreman he must take up with Signal Supervisor.

NOTE: See Maintenance of Way Department Instructions for applying insulated joints.

10 To test insulated joints between adjacent track circuits or from track circuit to dead section, connect voltmeter between rails at relay end of track circuit and then connect shunt wire from north rail of one circuit to south rail of adjacent circuit or track and vice versa. If the voltmeter shows marked decrease in voltage when shunt wire is applied the insulated joint should be taken off and examined for defects.

11 Double end insulated joints may be tested with ohmmeter when such equipment is available.

BATTERIES, TRANSFORMERS AND RECTIFIERS

12 Batteries, transformers and rectifiers must be inspected frequently and maintained in accordance with current instructions.

13 Track feeds must have a current limiting device between feed and track and it must be adjusted to secure proper current through track relay. In no case shall the limiting device be less than that value which will allow track relay to release when track circuit is shunted at rails at either feed or relay end with a .060 ohm shunt.

RELAYS

14 Relays must be visually inspected frequently for defects, and must be maintained in accordance with current instructions.

15 For direct current circuits; once each year and more frequently, when conditions require, a check of the current through the relays must be made when ties and ballast are wet, to determine that sufficient current is flowing to insure proper operation, and when ties and ballast are dry that current flow does not exceed .250 amp Track shunt tests must be made at least once each 6 months to insure that track relays will drop away when a .060 ohm resistance shunt is applied across the rails when track and ballast is dry or frozen.

16 For alternating current circuits; track circuits must be maintained so that relays will drop away when shunts as listed below are applied across the rails. These tests must be made frequently when ties and ballast are dry. When circuit adjustment is changed or relay replaced, shunt test must be made. Resistance of shunts for the various relays and circuits are as follows:

RELAY TYPE	SINGLE OR DOUBLE RAIL	RESISTANCE OF SHUNT
K-2	Single	.5
N	Single	.5
N	Double	.2
D	Double	.1
OTHER	Single	.1
OTHER	Double	.060

GENERAL

17 If any apparatus is found to not meet the requirements, the condition must be reported to the Signal Supervisor as soon as possible and the situation must be protected as required by the rules and instructions in effect.

RAIL RENEWALS AND CHANGES

18 When rail renewals and changes are to be made, the track wires must be disconnected from the track relays affected before the rails are disconnected and such track wires must not be connected until rails are again connected. After rails are connected the wires may be connected to permit train movement, but after entrance of each train into section the track wires must be again disconnected from the rails affected and remain disconnected while train is occupying the track section where rail renewals or changes were made, until such time as proper shunting is obtained.

NEW YORK CENTRAL SYSTEM

SIGNAL AND TRAIN CONTROL COMMITTEE

N.Y.C.R.R.
M.C.R.R.
C.C.C.&St.L.Ry.
B.&A.R.R.
P.&L.E.R.R.
RUTL.R.R.

440

1	8-15-1939
2	1-15-1940

TRACK CIRCUITS

INSTRUCTIONS

Approved by Representatives of Lines shown.

Chairman

After N.Y.C. C-5

The purpose of this instruction is to establish uniform procedures in the adjustment of steady energy DC track circuits employing standard track relays fed from one cell of storage battery and to obtain maximum practical shunting sensitivity consistent with apparatus employed and variations in ballast resistance.

BATTERY END

The adjustments covered by this instruction are based upon a total resistance of 0.1 ohm in the battery leads to rail and an inserted resistance of 1.0 ohm with a lead cell and 0.65 ohm with a nickel iron cell or with primary cells. Primary cells must be connected in series, parallel, or series-parallel, so as to provide a shunt current of 1.6 amperes at a nominal voltage of 1.2. It is recommended that a minimum of 2000 ampere hours be installed for each track circuit.

Normally, a 1.0 ohm fixed resistor can be used with a lead cell and a Raco Type 602-3, 1.0 ohm adjustable resistor set at 0.65 ohm for a nickel iron cell or with primary cells; however, it is recommended that the adjustable unit be used for all circuits.

If the leads between the battery and the rails are longer than normal, the additional resistance introduced by the added length must be taken into account when making adjustments. To adjust the total limiting resistance (leads plus inserted resistance), connect a low resistance shunt (#6 AWG copper or larger) across the rails by means of clamps at the battery end of the track circuit and, with the charge *off*, set the adjustable resistor to allow approximately 2 amperes to flow. With primary cells, connect a voltmeter across the *battery terminals* and adjust the total resistance to .75 ohms by calculation using E/I.

When making adjustments, a low resistance ammeter with leads as short as practicable should be used and the current should be read on the 15 ampere scale of the meter.

RELAY END

To facilitate adjustment, the amount of series resistance which may be inserted in the relay leads has been calculated for various minimum ballast settings and the results plotted as curves which form a part of this instruction. The calculations are based upon a bonded track resistance of .025 ohm per thousand feet which is the equivalent of 127# rail with rail head bonds.

Three minimum ballast settings are plotted for each type of relay on storage battery circuits. In addition, a one ohm ballast curve is given for primary battery circuits. The four ohm ballast setting may be used where ballast and ties are in excellent condition, the three ohm setting may be used generally under average ballast and tie conditions, while the two ohm or one ohm setting should be used only where ballast and ties are poor.

USE OF ADJUSTMENT CURVES

After determining that proper limiting resistance has been inserted in the battery leads, select the Figure which covers the type of relay and cell to be used. From the minimum ballast curve (2, 3 or 4 ohms) read the series resistance to be inserted in the relay leads for the length of circuit under adjustment.

For example using Figure 1, which covers a B1 track relay Dwg. 56001-714 Gr. 1 with coils in multiple and a lead storage cell, the amount of resistance inserted to adjust a 3,000 foot circuit to 4 ohm ballast per thousand feet is found to be 5 ohms.

In some cases within interlocking limits, an additional relay is installed in a turnout along with the regular relay on the main track. This calls for adjusting a circuit with two relays fed from the same cell. To make this adjustment, the total length of track circuit is taken as the distance from the battery end to the relay end of the circuit on the main track plus the length of the turnout. Using this total circuit length, the amount of series resistance to be added is read from the curve and 85% of the value indicated inserted in each relay.

MEASURING BALLAST AND RAIL RESISTANCE

It is unnecessary to measure ballast and rail resistance in order to use the adjustment curves, however, when a circuit does not operate properly with normal adjustment or where it is suspected that some abnormal condition obtains within the circuit, it may be necessary to measure its characteristics.

To measure ballast and rail resistance, disconnect the track relay and place a low resistance shunt, attached to the rail with clamps, across the track at the relay end of the circuit. Measure the voltage (E) across the rails and the current (I) to track at the feed end with the circuit so shunted. The approximate rail resistance R_m is then determined by E/I. Remove the shunt and again read the voltage across the rails and the current to track at the feed end. The approximate ballast resistance B_m is then determined by E/I.

For all practical purposes these values for rail and ballast resistance may be assumed to be correct, however, on long circuits having very low ballast and high rail resistance, an appreciable error may exist. The degree of error can be readily determined by dividing R_m by B_m to arrive at a ratio. In Figure A, the ratios R_m/B_m are plotted as abscissae enabling a correction factor to be read from the curve. Multiplying R_m by the correction factor and dividing B_m by the correction factor will give true values for rail and ballast resistance. It will be noted from Figure A that ratios less than .15 result in errors of less than 5.5% which may be neglected.

Dividing the measured rail resistance for the circuit by the length of the circuit in thousands of feet will give the rail resistance per thousand feet of track, which value should not exceed .025 ohm.

Multiplying the measured ballast resistance for the circuit by the length of the circuit in thousands of feet will give the ballast resistance per thousand feet of track.

To determine minimum ballast resistance for a particular circuit, readings should be taken during, or shortly after a rain. The lowest ballast resistance for any circuit usually occurs at the start of a rain storm after a long dry spell, however, readings taken on wet track should be sufficiently accurate as the adjustment curves are based upon maximum rail resistance, minimum ballast resistance, maximum relay working current, and a minimum battery voltage all occurring at the same time.

NEW YORK CENTRAL SYSTEM
SIGNAL DEPARTMENT
TRACK CIRCUIT ADJUSTMENT AND MEASUREMENT OF BALLAST AND RAIL RESISTANCE — INSTRUCTIONS

Approved Hasson
Chief Signal Engineer

S-441

Printed in U. S. A.

ISSUED 6-11-58

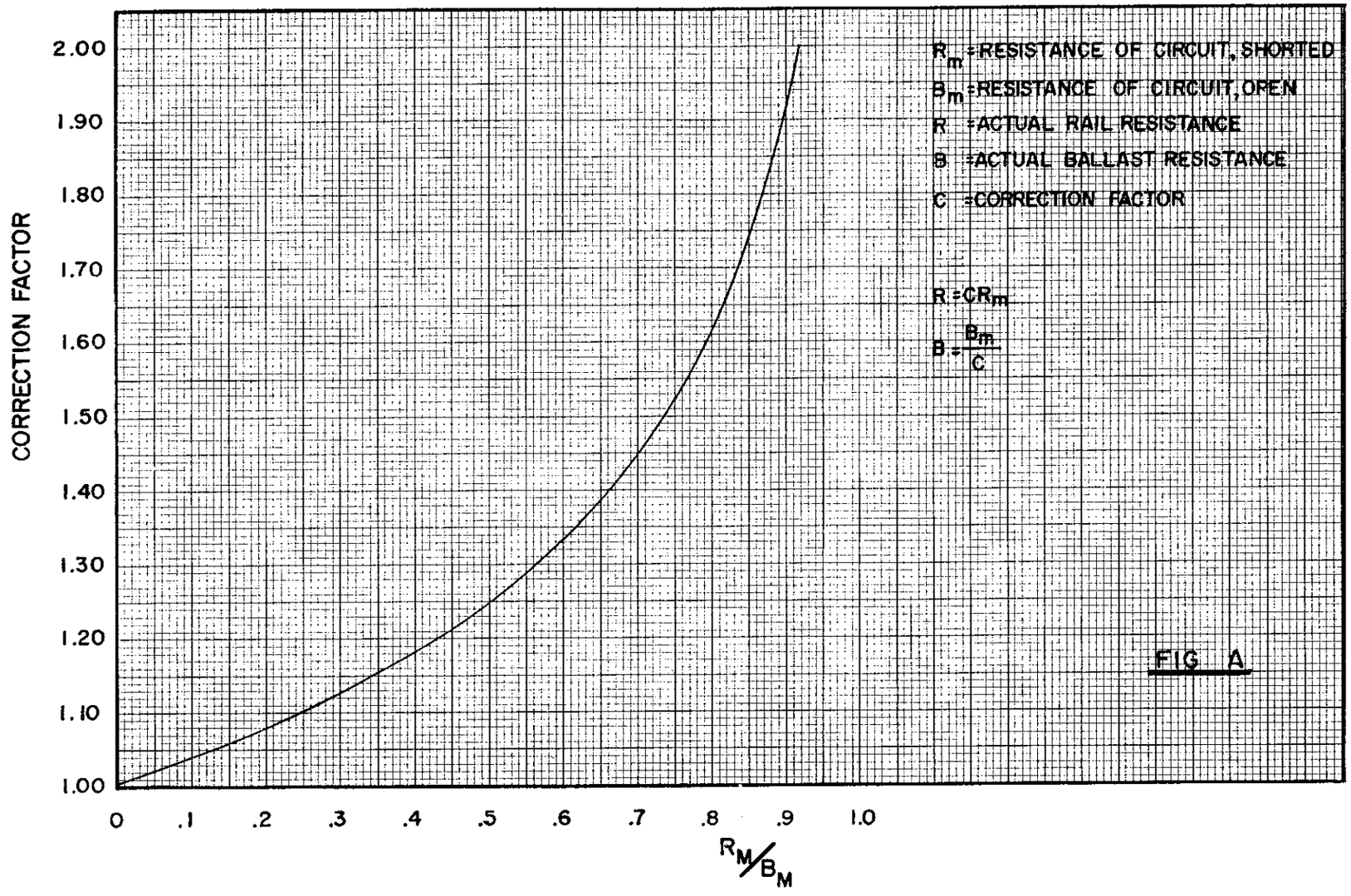


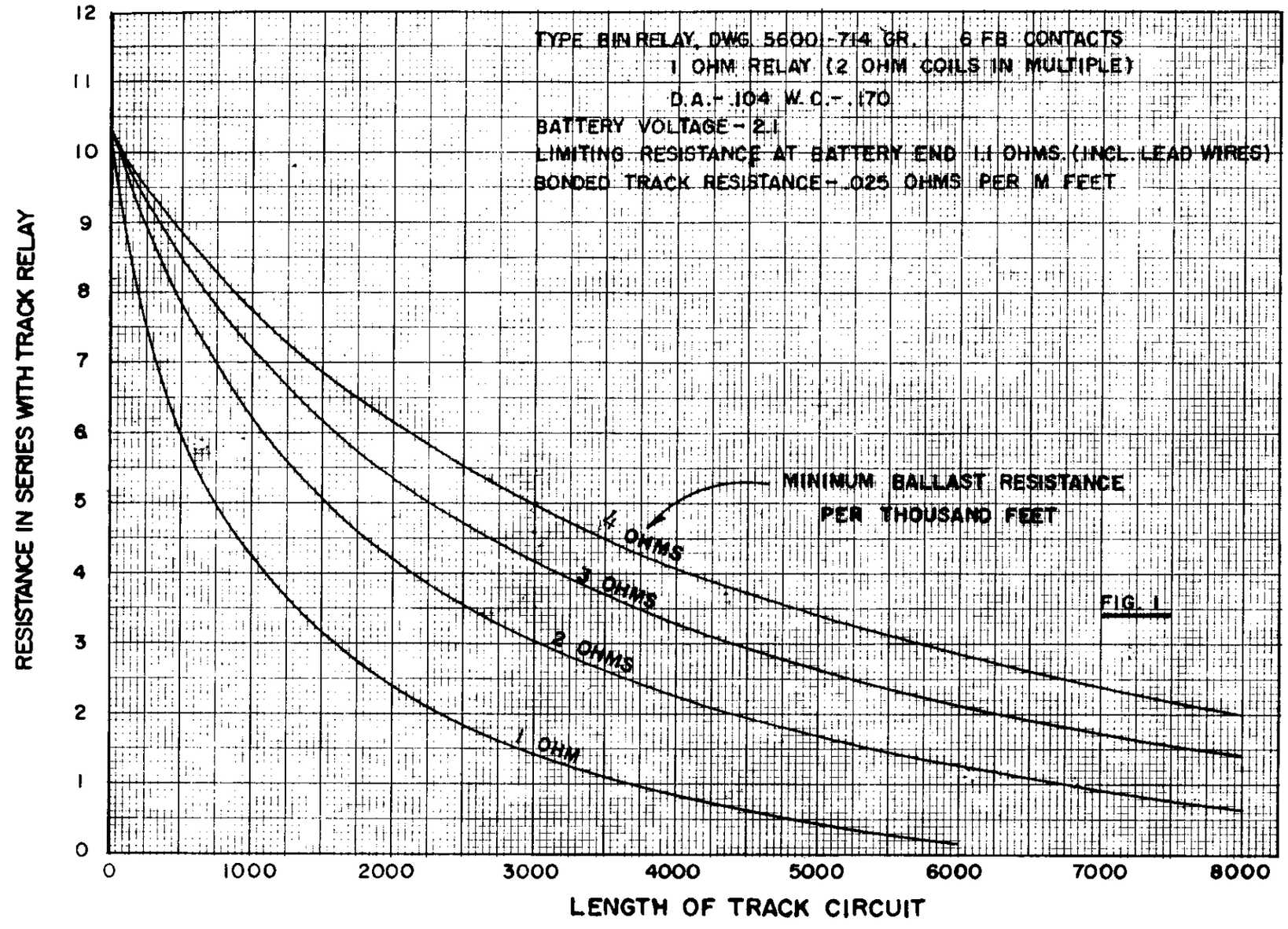
FIG A

S-441

Printed in U. S. A.

ISSUED 5-6-57

SHEET 2 Cont'd on SH 3

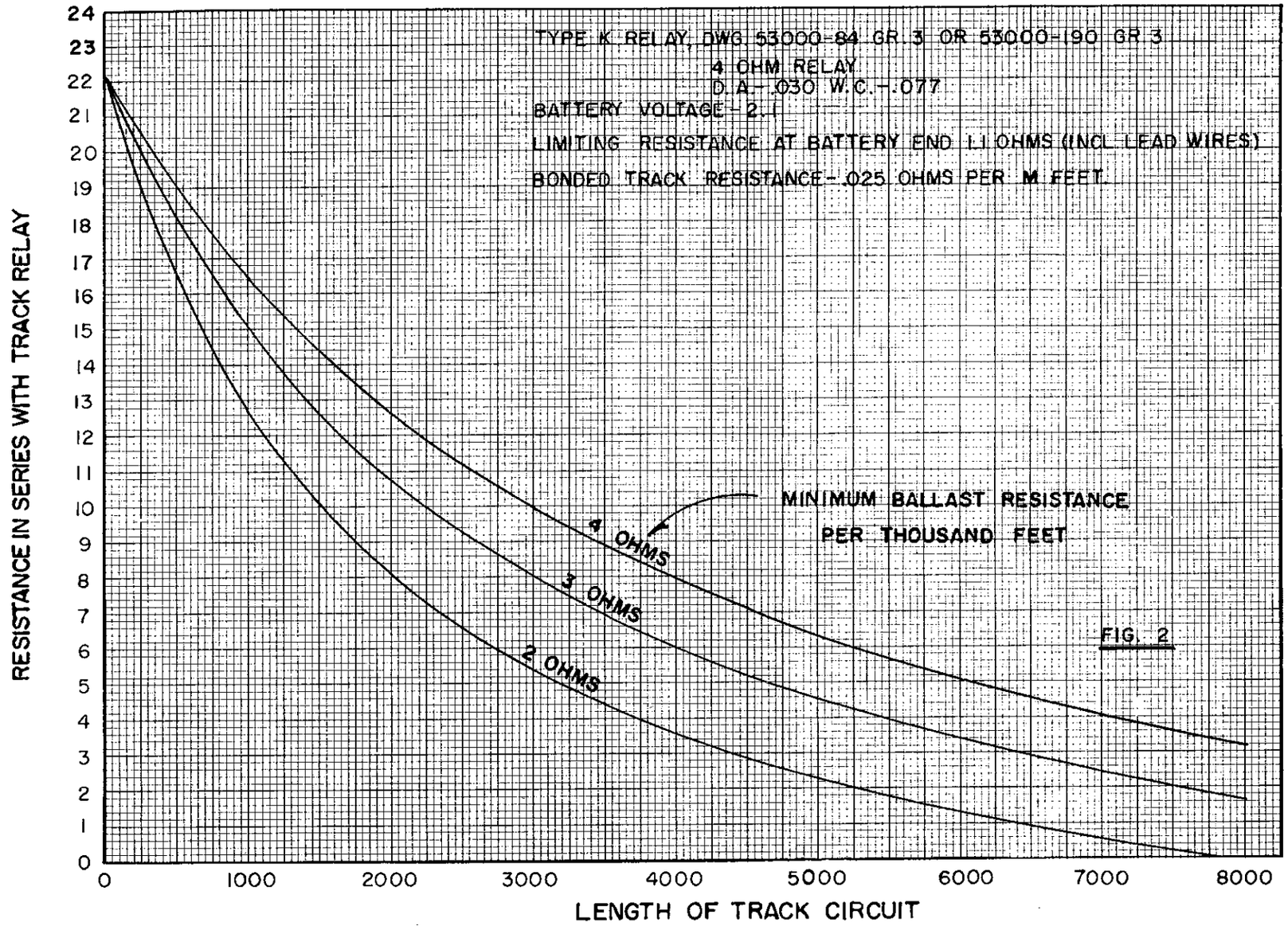


S-441

Printed in U.S.A.

ISSUED 4-20-64

SHEET 3 Cont'd. on SH. 4

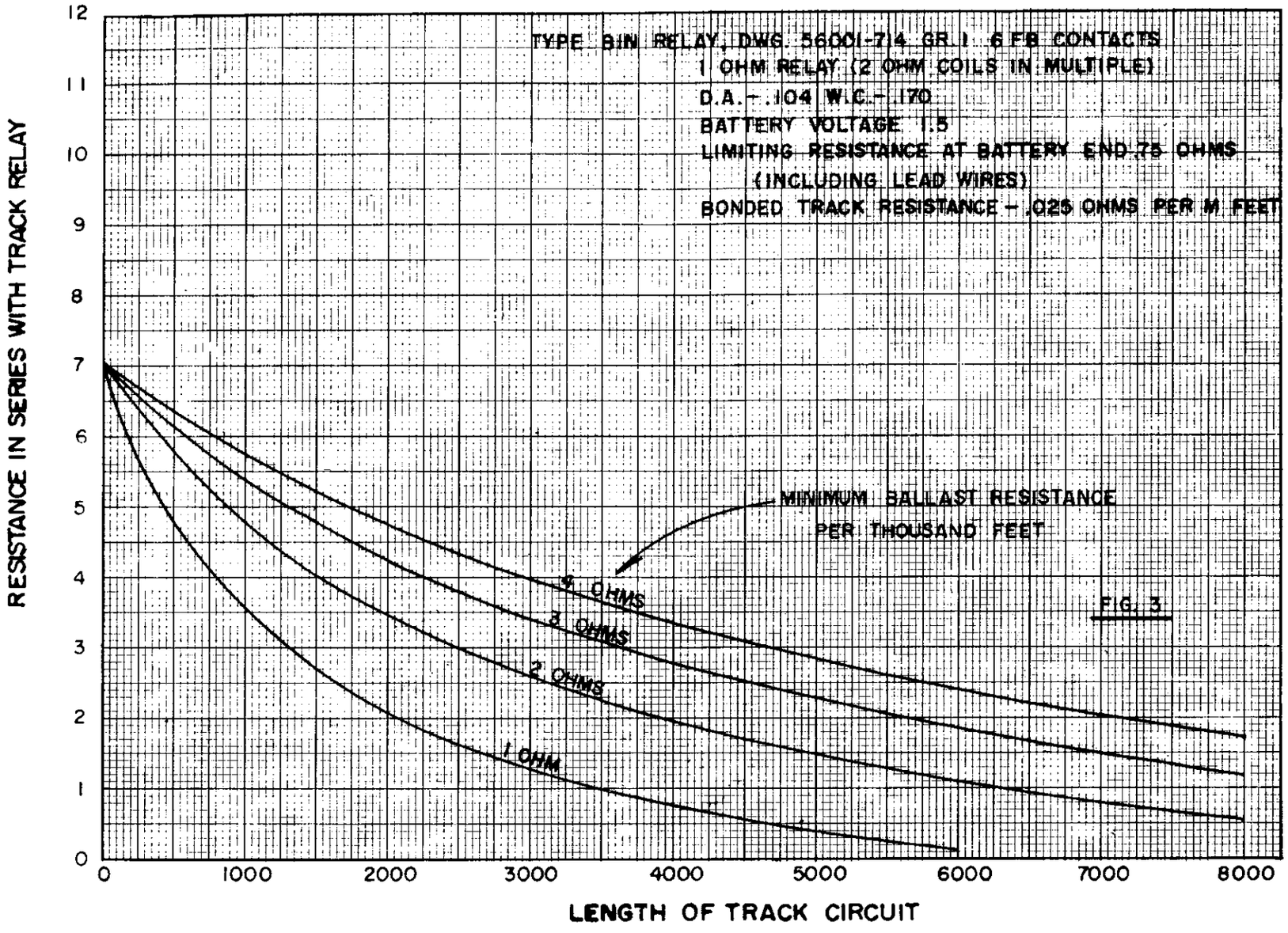


S-441

Printed in U. S. A.

ISSUED 5-6-57

SHEET 4 Cont'd on SH 5



S-441

Printed in U.S.A.

ISSUED 4-20-64

SHEET 5 Cont'd. on SH. 6

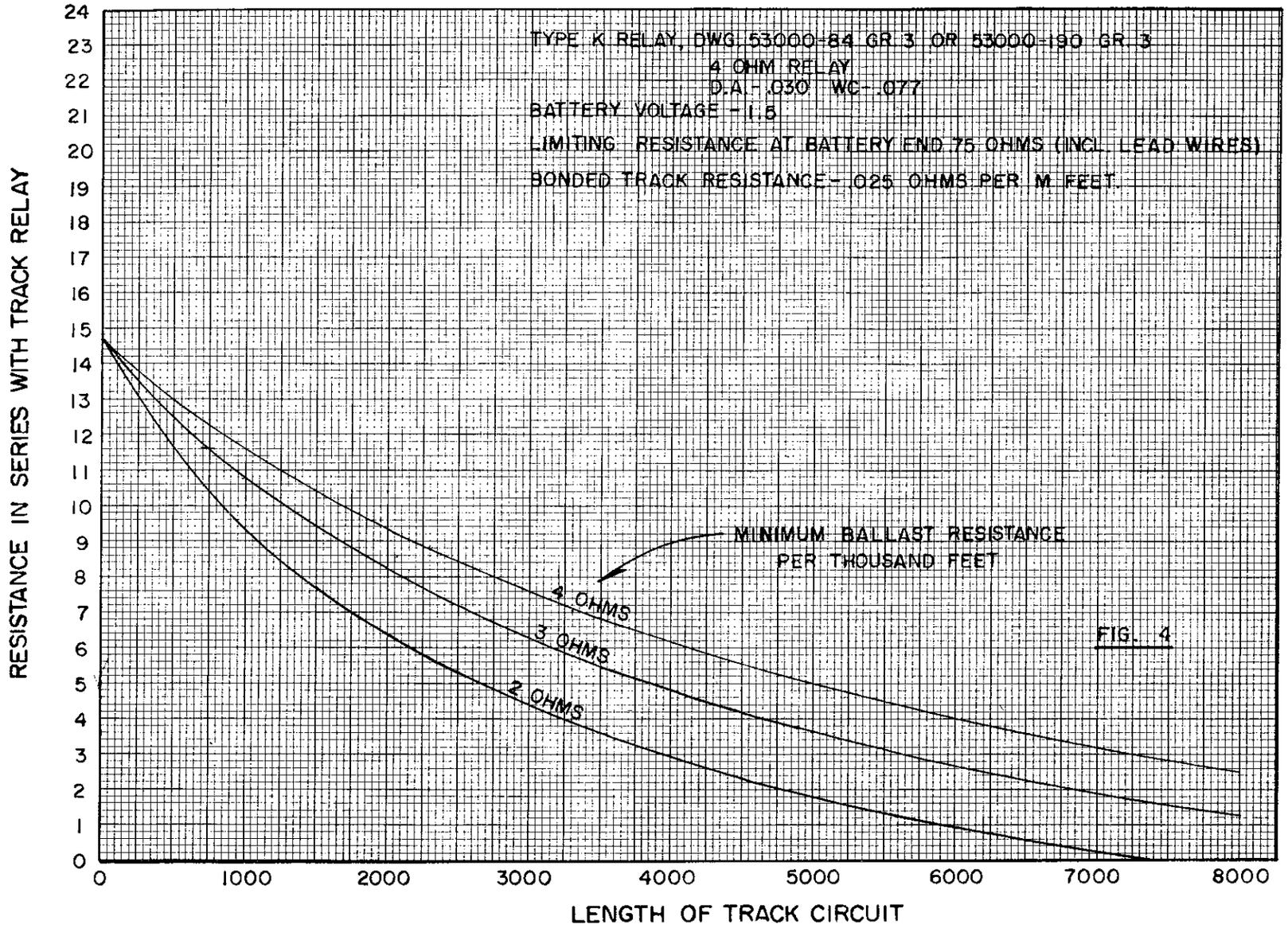


FIG. 4

S-441

Printed in U. S. A.

ISSUED 5-6-57

SHEET 6 Cont'd on SH 7

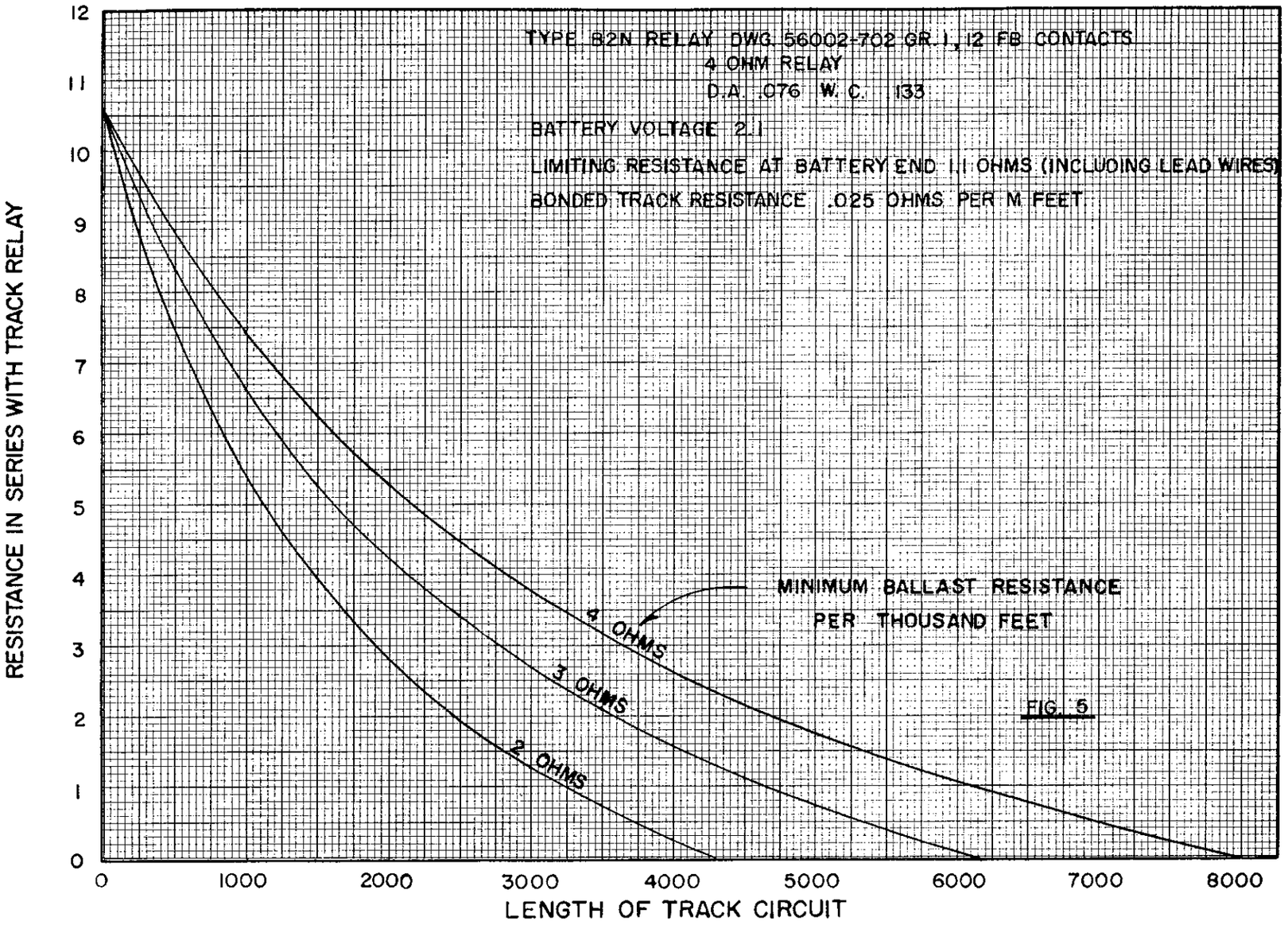


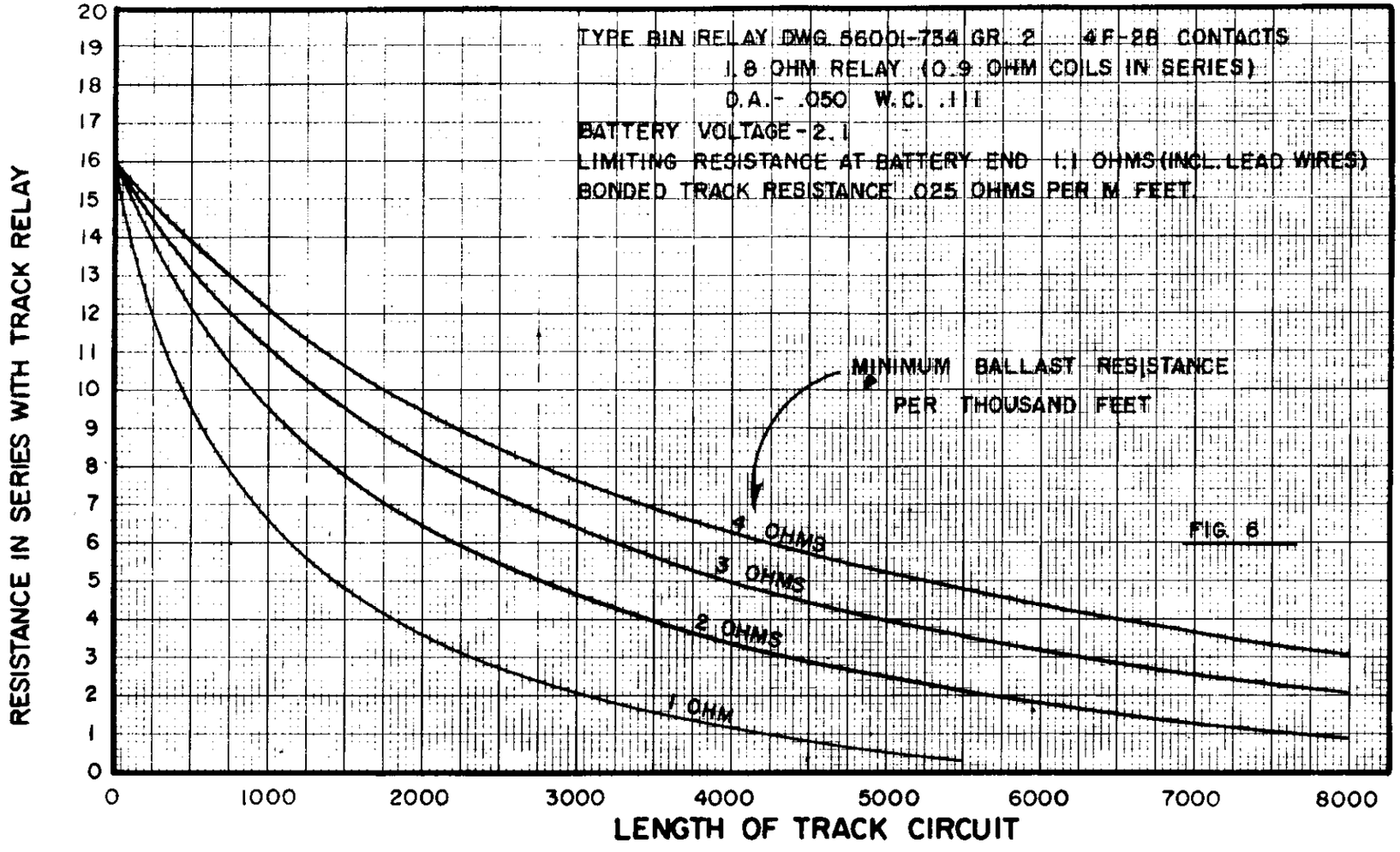
FIG. 5

S-441

Printed in U. S. A.

ISSUED 5-6-57

SHEET 7 Cont'd on SH 8

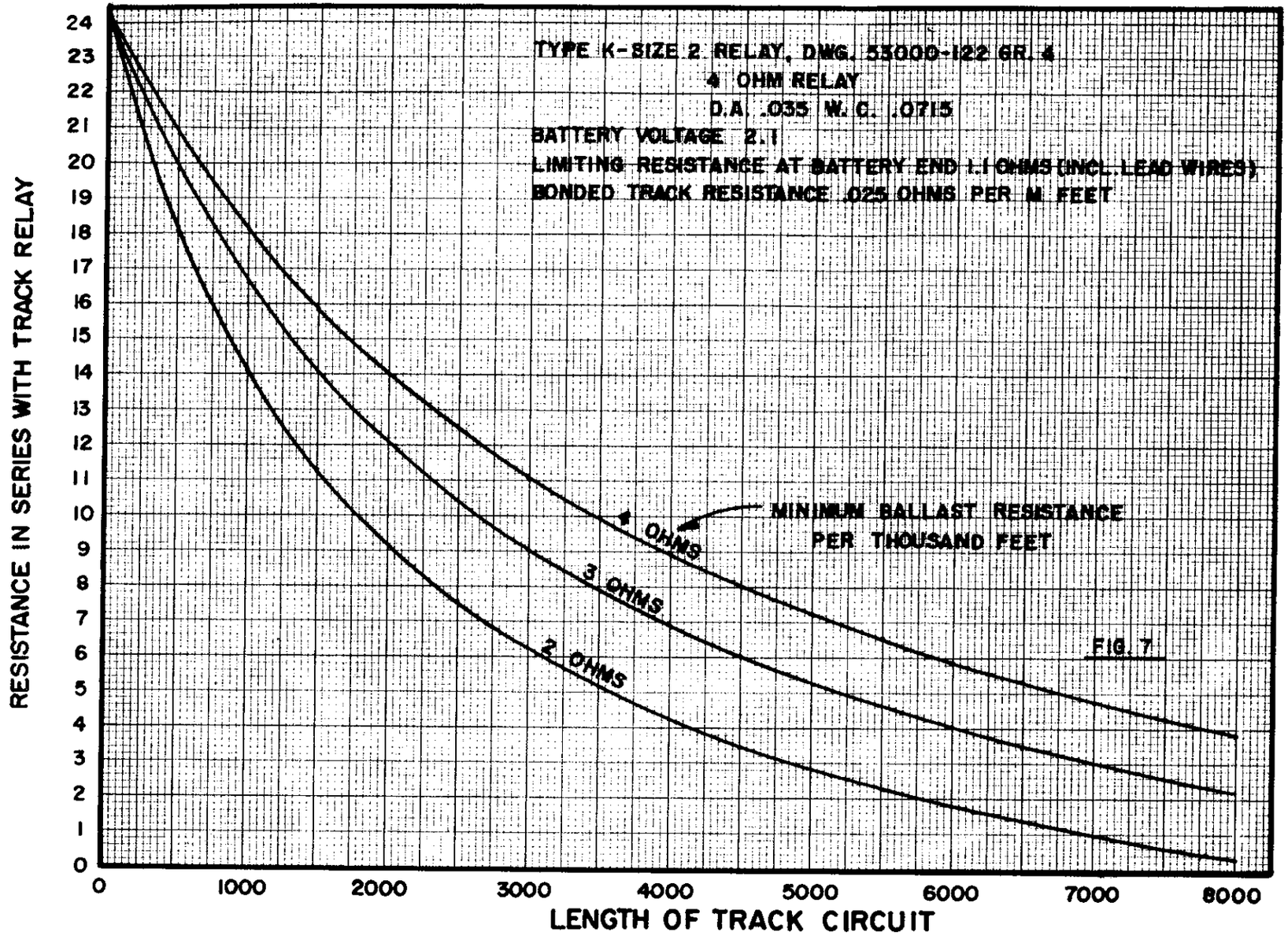


S-441

Printed in U.S.A.

ISSUED 4-20-64

SHEET 8 Cont'd. on SH. 9

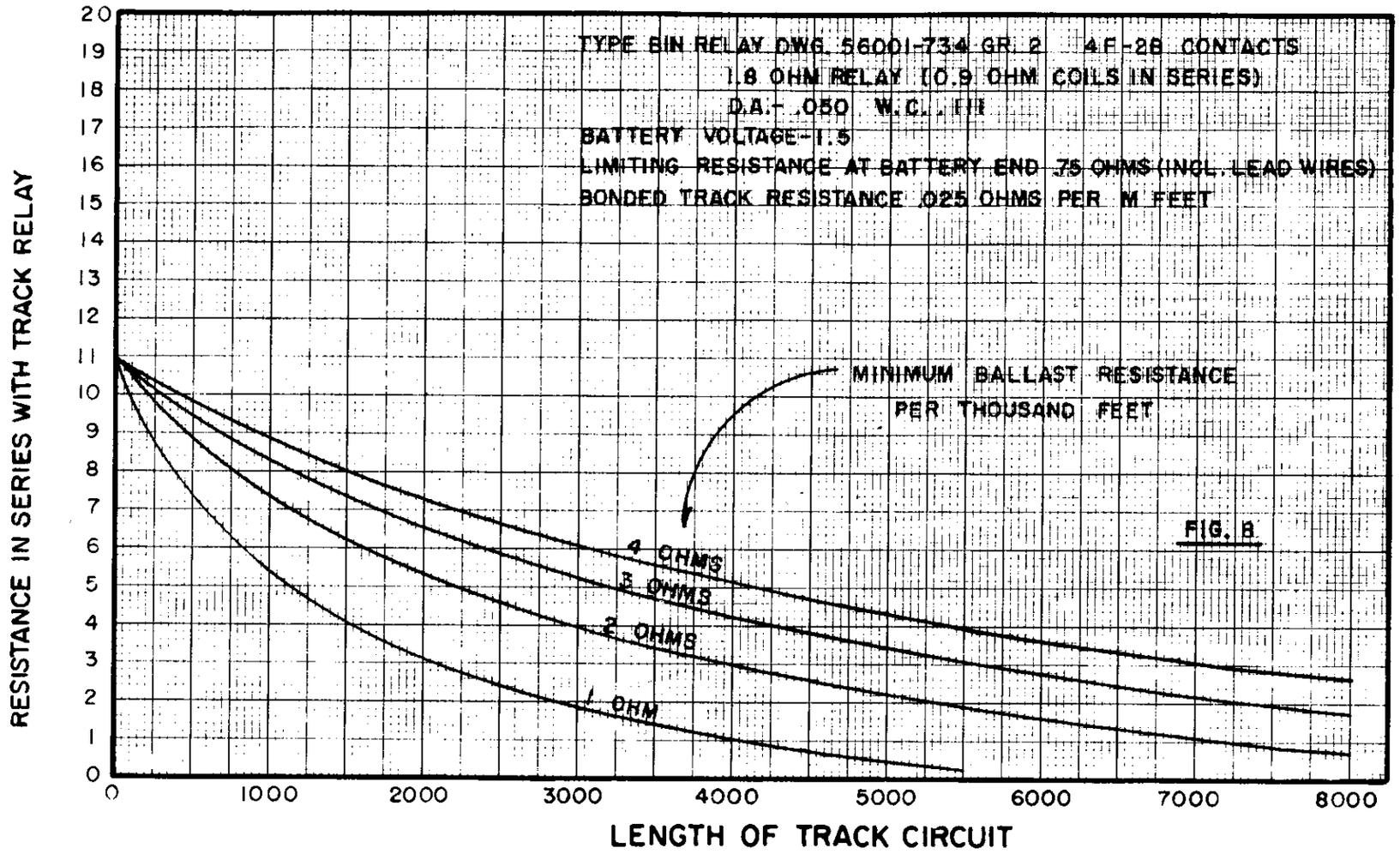


S-441

Printed in U. S. A.

ISSUED 6-16-58

SHEET 9 Cont'd. on SH. 10



Printed in U.S.A.

ISSUED 4-20-64

SHEET 10 Cont'd. on SH. 11

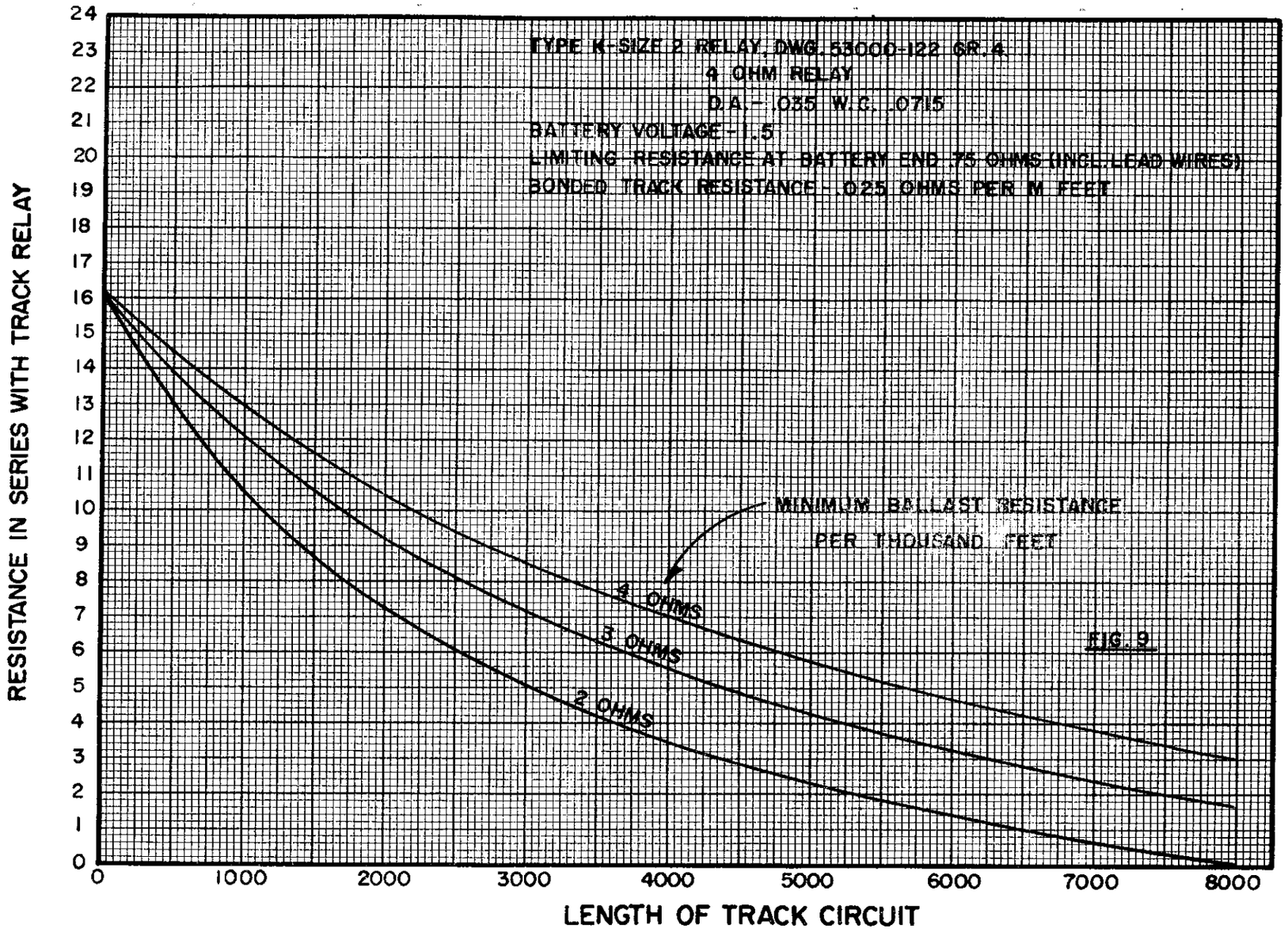


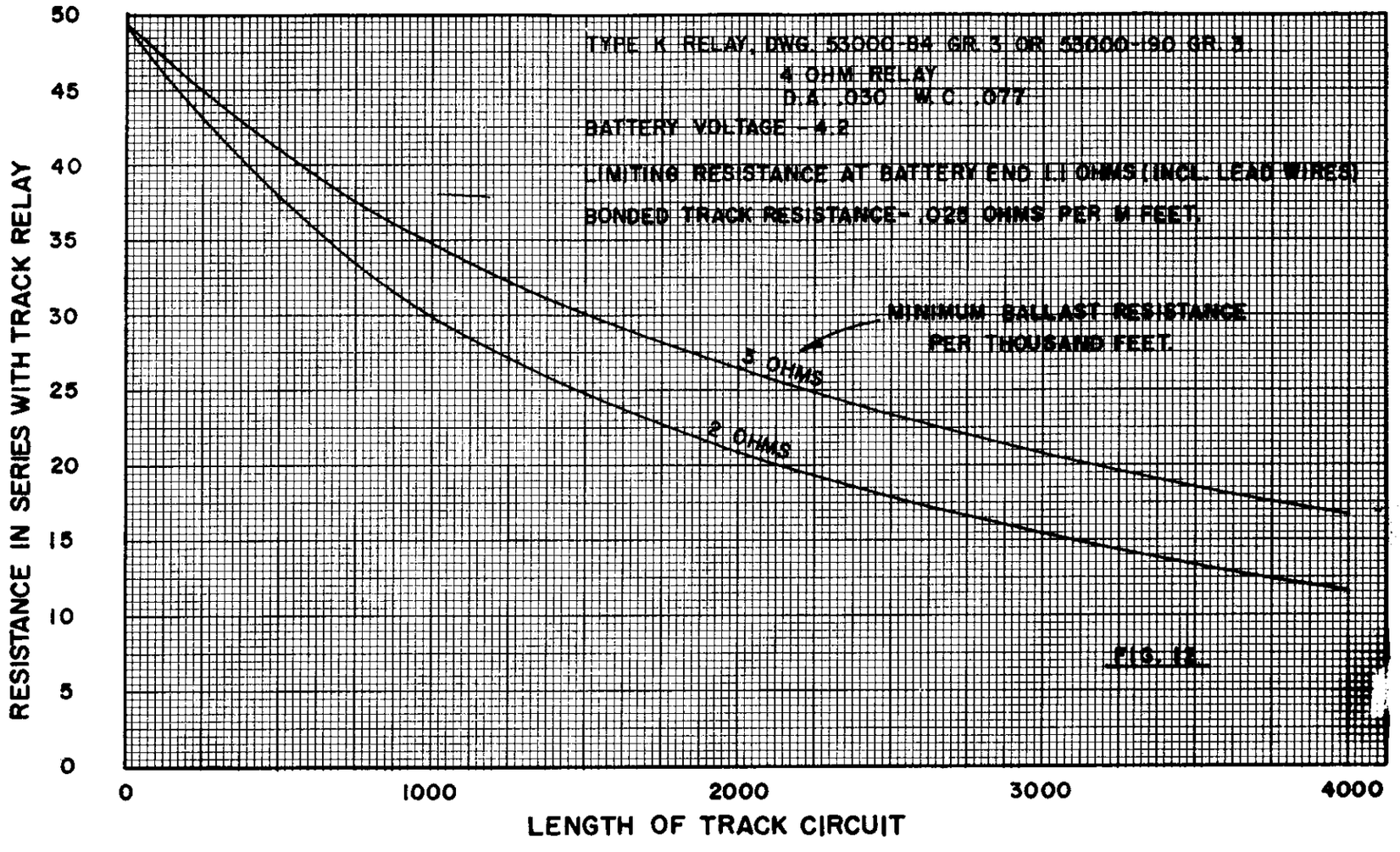
FIG. 9

S-441

Printed in U. S. A.

[redacted] ISSUED 5-21-57

SHEET 11 Cont'd on SH

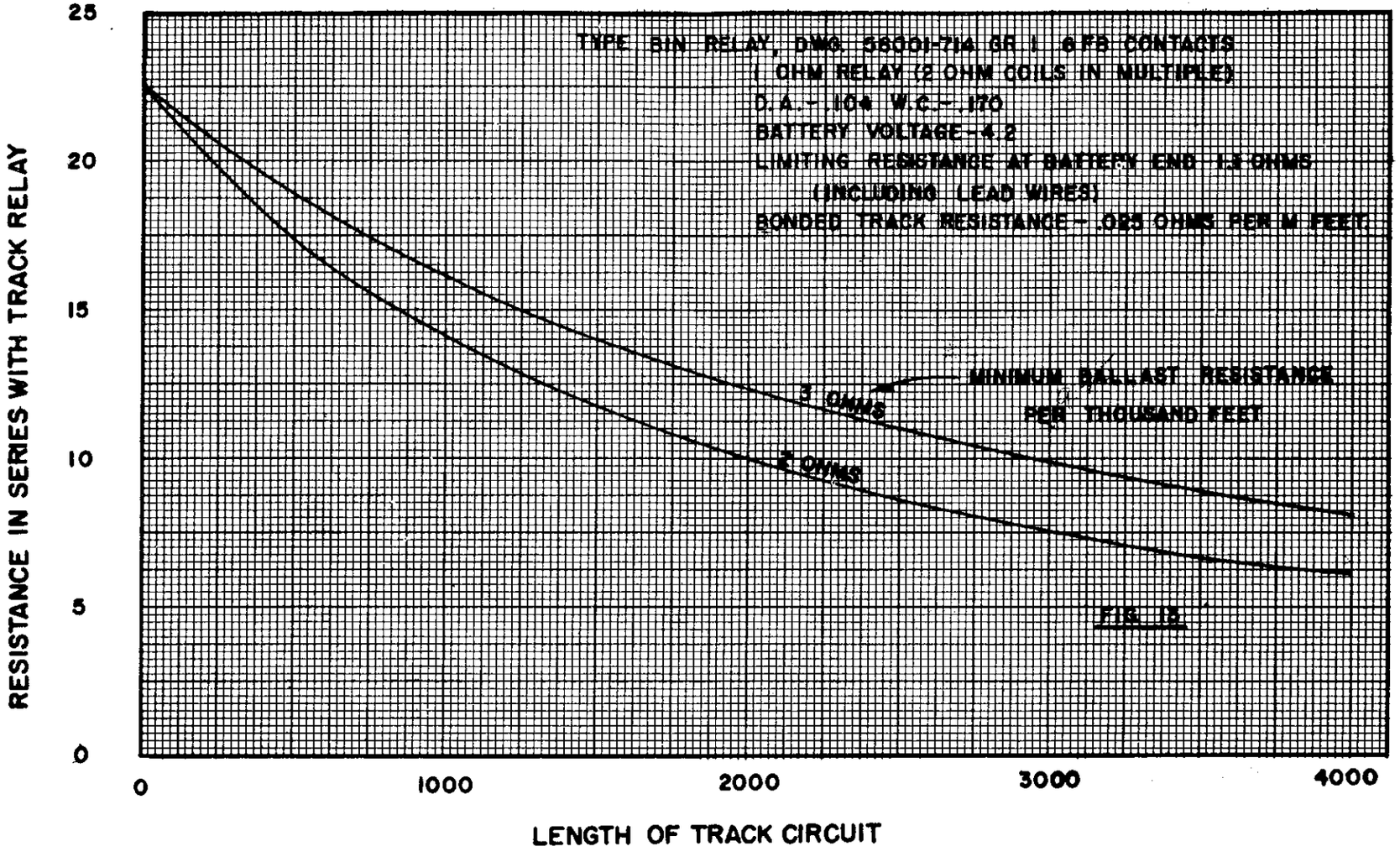


S-441

Printed in U.S.A.

ISSUED 12-15-58

SHEET 14 Cont'd. on SH 15


TYPE BIN RELAY, DWG. 56001-714 GR 1 6 FB CONTACTS
1 OHM RELAY (2 OHM COILS IN MULTIPLE)
D.A. - .104 W.C. - .170
BATTERY VOLTAGE - 4.2
LIMITING RESISTANCE AT BATTERY END 1.3 OHMS
(INCLUDING LEAD WIRES)
BONDED TRACK RESISTANCE - .085 OHMS PER M FEET
MINIMUM BALLAST RESISTANCE
PER THOUSAND FEET
3 OHMS
4 OHMS
FIG. 12
RESISTANCE IN SERIES WITH TRACK RELAY
25
20
15
10
5
0
0
1000
2000
3000
4000
LENGTH OF TRACK CIRCUIT

S-441

The purpose of this instruction is to establish uniform procedures in the adjustment of coded D.C. detection track circuits employing a standard code responsive track relay fed from two cells of lead storage battery for use on circuits of 6000 to 15,000 feet. This instruction does not cover the adjustment of track circuits with inverse codes.

Battery End

The limiting resistance is to be adjusted to obtain the short circuit current specified for length of circuit and the desired minimum ballast setting. The short circuit current should be read with a low resistance ammeter, 15 ampere scale, when the batteries are not being charged and when temporary connections have been made to supply steady energy to the track. Ammeter leads should be as short as practicable. A low resistance shunt, No. 6 AWG wire or larger, should be connected across the rails by means of clamps to complete the circuit.

Relay End

The coils of the relay should be connected in series and the relay series resistor adjusted so that the total circulating resistance, including leads, is equal to 1.2 ohms. This adjustment is fixed for all lengths of circuit and all minimum ballast settings. The circulating resistance may be read directly with an ohmmeter provided the feed energy is removed from the track relay by placing a low resistance shunt (No. 6 AWG copper or larger) across the rails by means of clamps. Or the circulating resistance may be measured by dividing the voltage at the rails by the relay current when steady D.C. energy is applied to the track.

Use of Adjustment Curves

The adjustment curves show the values of short circuit current at the feed end for circuits of 6000 to 15,000 feet at minimum ballast resistances of 3, 4, and 5 ohms per thousand feet.

The 5 ohm per thousand feet minimum ballast setting is the preferred setting in order to keep the short circuit current as low as practicable. When ballast conditions and ties are below average, it may be necessary to increase the short circuit current to the 4 ohm or 3 ohm setting. However, the short circuit current should never exceed 5 amperes.

It is not necessary to measure existing rail and ballast resistances to use the adjustment curves. If an abnormal condition is suspected, the actual rail and ballast resistances may be determined by following the procedure outlined in Instruction S441.

NEW YORK CENTRAL SYSTEM
SIGNAL DEPARTMENT
TRACK CIRCUIT ADJUSTMENT
INSTRUCTIONS

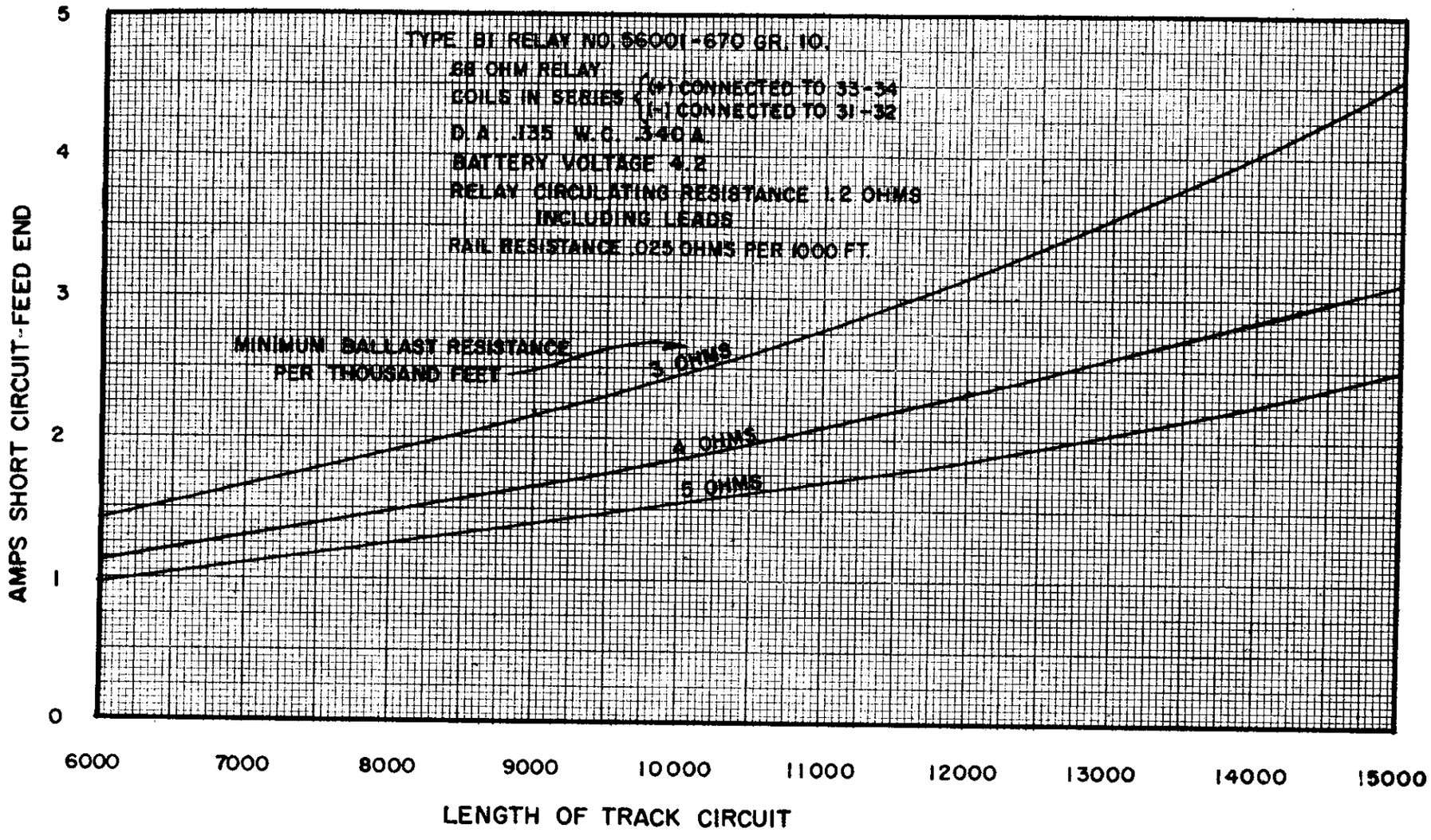
Approved L. J. Pottinelli
Chief Signal Engineer

S-442

Printed in U.S.A.

ISSUED 11-1-61

SHEET 1 Cont'd on Sh. 2



S-442

Printed in U.S.A.

ISSUED 11-1-61

SHEET 2 Cont'd on SH 3