

Pennsylvania Testing Procedure

(Part III)*

HIGHLIGHTS of the detailed instructions issued by the Pennsylvania for making Tests 2, 3, 4, 5, 6, 7, 8, 9, 18, 22, 24, 25, 26, 27, 28, 29, 30 and 31 of the schedule of tests presented on page 36 of the January issue of *Railway Signaling* are presented in the following paragraphs. Due to space limitations certain portions have been omitted at various points; attention is called to this at those points. The general order of presentation is the same as was followed in Tests 1, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21 and 23 given in the March issue of *Railway Signaling*, i.e., the instructions appearing in C.E.227-A, "Tests of Signal Apparatus" are given first, followed by supplementary material (such as detailed instructions for specific tests) appearing in special pamphlet or other form and mentioned in C.E.227-A, the pertinent rules appearing in C.S.E.23-C, not included in the January issue of *Railway Signaling*, completing the assembly of material on each test.

Instructions for Making Aforementioned Tests of Signal Apparatus

TEST 2—Insulation Resistance:

The purpose of this test is to insure that the insulation of wires and connected apparatus meet the prescribed resistance values.

Tests shall be made in accordance with recognized Megger practice. Provisions of C.S.E. 23 covering the use of jumpers, the safeguarding of train movement, and other safety precautions, must be observed.

2(a)—Low Voltage Wires and Cables:

Minimum allowable resistance value —1 Megohm.

Test must not be made on control circuits except when completely disconnected from battery and common.

Where circuit to be tested embraces types of wires or cables of more than one class under 2(a)1, 2(a)2 and

2(a)3, and it is more convenient, the entire circuit may be tested in accordance with the class due for test most frequently.

2(b)—Lead Covered Signal Power Cables:

1. Aerial:

(No part of which is underground).

Reading should not be less than 100 megohms between sectionalizing switches. (The insulation resistance of cables exposed to extreme summer heat will be somewhat below the values shown for the same cable at lower temperatures).

2. Underground:

Reading should not be less than 1000 megohms between sectionalizing switches.

2(c)—Underground Signal Power Lines:

(Not lead sheath).

Reading for section tested should be not less than 40 megohms for voltages to and including 500 volts. For

Instructions for testing insulation resistance, electrolysis, foreign current, ground resistance, cross protection, d-c. relays, indicators, magnets, slots, etc., lightning arresters, and adjustment of contact springs and the quick switches on power machines, etc.

effect of electrolysis corrosion by the presence of currents passing from any point on the cable system to ground.

The most effective means of determining whether stray current is passing from a particular cable sheath to ground is to determine the direction of any potential difference that may exist between the sheath and small

LOCATION:-		CIRCUIT WIRE No.:-									
FROM —	TO										
MFG. KIND & SIZE											
CONDUCTOR No.											
DATE INSTALLED											
RESISTANCE	19	19	19	19	19	19	19	19	19	19	19
5,000											
1,000											
100											
40 +											
40											
35											
30											
25											
20											
15											
10											
5											
1											
OHMS											
750,000											
500,000											
250,000											
100,000											
50,000											
25,000											
P. PARKWAY	L. LEAD	TB. TAPE & BRAID	NM. NON-METALLIC								

C. E. 218—(a). Back of card ruled for notes. Card 3 in. by 5 in.

voltages exceeding 500 readings between sectionalizing switches should be not less than 1000 megohms.

TEST 3—Electrolysis, Lead Covered Cables—Except Where Protected by T. & T. Tests:

The purpose of this test is to determine whether deterioration of lead covered cables is occurring through

isolated piece of the same material in contact with damp earth in bottom of manhole. Where the sheath is found to be positive to this testing electrode, it is generally to be assumed that current is flowing from the sheath to ground, since the only condition under which current flow would not occur would be one where the cable sheath was effectively insulated from

*This is the concluding article covering the principal features of testing procedure on the Pennsylvania which was inaugurated in the January issue and continued in the March issue.

the earth, and such cases are rare. Observations of potential difference to nearby rails, pipes and other sub-surface metallic structures and observance of fall of potential along the sections of the cable sheath, should also be made in connection with the measurement of potential difference to earth and will serve to throw light upon what the stray current is doing. When measurements of this character have been made at all parts of the cable system and show that no current is flowing from the cable sheath to ground, except through drainage wires and that no excessive amount of stray current is flowing from ground to the sheath, it may safely be concluded that the cable system is not undergoing an electrolytic corrosion. If contrary indications are found, it is necessary to conclude that electrolytic corrosion is taking place and to adopt measures which will serve to mitigate its effects.

Readings should be taken as follows:

1. Difference of potential between points on the cable system and the adjacent earth.

2. Difference of potential between the cable system and electric railway rails, other cable systems, piping systems, metal bridges, steam railway rails, etc., at points where these cross the cable system or come in close proximity to it.

3. Measurements of current flowing in the cable sheath. Test to be made in accordance with Report of Committee on Protection Against Electrolysis, as adopted June, 1932, by the T. & T. Section, A.A.R.

Report results of test on Form C.T. 1517. (Omitted due to space limitations—Ed.)

TEST 4—Foreign Current—D-C. Track Circuits:

The purpose of this test is to determine the presence of foreign current and insure proper corrective action, to prevent interference with track circuits.

Where there is known to be a trolley line or other direct current exposure, test should be made and readings taken during periods in which the outside current is at or near maximum value.

This test shall be made by placing a milliammeter in series with the relay then disconnecting the wires from the battery and taking a reading, it being noticed at the same time whether the current is sufficient to pick up the relay. Where it is found that the relay picks up, this circuit should be considered one which should be carefully watched, and the results reported. If the relay does not pick up, a second test should be made in the same man-

ner as the first, but by placing a connection around first one and then the other of the insulated joints at the battery end of the circuit, so that one of the rails of the circuit being tested will be connected to one side of the relay and the other rail in the circuit, plus one of the rails in the next circuit, will be connected to the other side of the relay, thus unbalancing the circuit and making a severe test. If the relay picks up, this circuit should also be watched and reported. If any appreciable readings are obtained in either test, the following precautions shall be constantly observed:

1. Trolley and power companies requested to see that their bonding is as good as practicable.

2. Ballast kept clear from the rails.

3. Rail joints kept tight and insulated joints maintained in good condition.

4. Rail bonding carefully maintained.

Foreign current test need not be made where foreign current protection is provided; coded current is used for wayside signal control; where there is no apparent source of foreign current such as trolley lines, etc., or where tests for a 3-year period indicate no evidence of foreign current.

NOTE:—Under certain conditions there is a storage battery effect, between rails and ballast, that may have a current value sufficient to hold the relay closed several minutes after the battery feed wires have been disconnected. If such condition is observed, either short circuit the rails temporarily or wait a sufficient time for the amperage to drop before deciding that foreign current exists.

TEST 5—Relays, Indicators, Magnets, Slot, Etc.:

The purpose of this test is to insure that relays, indicators, magnets, slots, etc., are in proper condition to insure functioning as intended.

Field tests on a-c. and d-c. relays shall be made in accordance with C.E. 222 and C.E. 221, respectively.

Field tests on magnets, slots, etc., shall be made by observing, insofar as possible, the instructions in C.E. 221 and C.E. 222.

For apparatus not covered by P.R.R. instructions, instructions furnished by the manufacturer should be followed.

(C.E. 221 is given below; C.E. 222 omitted due to space limitations.—Ed.)

C. E. 221

Instructions for Inspecting and Testing Direct Current Relays and Indicators.*

Shop Tests and Inspections

Shopping

1. Relays must be shopped at least once every four years for shop tests, inspection and repairs.

2. Shopping should be done at a central shop or other building properly equipped for the purpose, preferably so located that relays will not have to be shipped. In many cases, repairs can be made at an interlocking cabin, but in no case should relays be disassembled in the field, except as provided in Instruction 190, Coils

10. At 68 deg. F. the percentage variation in the resistance of individual coils must not exceed:

(a) For 5 ohms or less, plus or minus, 5 per cent.

(b) Above 5 ohms, plus or minus, 10 per cent.

11. Coils must be rigidly fastened in place to prevent vibration.

Binding Posts

20. Left-hand coil terminal must be marked plus (+) and used for positive connections.

Flexible Connections

30. Flexible conductor connecting binding post and contact finger must be formed and attached so as not to affect the pick-up or drop-away of the armature, and shall be of conductivity to carry ten amperes without overheating.

Contacts

40. Finger contacts must meet contact surfaces squarely and simultaneously.

41. Finger contacts must have a horizontal contact slide movement of not less than 1/32 in. against contact surfaces.

42. Metal support of the non-fusible contact element must be not less than 1/16 in. from the contact surface.

43. Opening between finger contact and back contact surface, with front contact just closed, must be not less than 0.020 in.

44. Front and polar contact openings for first range voltages** must be not less than 0.050 in.

45. Front contact opening for second range voltage must be not less than 0.090 in.

46. Back contact opening for first range voltage with "working current or voltage" applied must be not less than 0.040 in.

47. The initial cleaned contact resistance when relay is energized at "working current or voltage" must not exceed the following:

(a) Metal to metal—0.03 ohm per contact.

(b) Metal to carbon—0.18 ohm per contact.

(c) Carbon to carbon—0.40 ohm per contact.

Armature End Play

50. Armature end play must be not less than 0.010 in. and no more than 0.020 in. Air Gap†

60. Relays with adjustable stop pins:

(a) A minimum working magnetic air gap for the neutral armature of both neutral and polar relays, of 0.020 in. for a relay with two neutral contacts, and of 0.015 in. for a relay with three or four neutral contacts must be maintained by an adjustable hard-drawn phosphor-bronze stop pin

*The term "relay" where used in these instructions includes indicators other than switch indicators.

**First range voltage—30 volts and less.

Second range voltage—over 30 to and including 175 volts.

†The difference between the magnetic air gap and the physical air gap is to provide for the non-magnetic coating on the armature and cores.

101. Make repairs and adjustment.
102. Record test, C. E. 207. (C. E. 207 illustrated in accompanying diagram—Ed.)
103. The connection from the semaphore blades to the armatures on indicators must be separated, to permit the armature

[illegible]

	Shop Requirements		Field Requirements	
	Neutral Relay	Polarized Relay	Neutral Relay	Polarized Relay
<i>Initial charge</i>	Four times direct pick-up.	Four times direct pick-up.	Direct working current or voltage.	Reverse working current or voltage.
<i>Drop-away</i>	Not less than 90% of original marking nor less than 43% of direct pick-up.	Not less than 90% of original marking nor less than 43% of direct pick-up.	Not less than 75% of original marking nor less than 35% of direct pick-up.	Not less than 75% of original marking nor less than 35% of direct pick-up.
<i>Direct pick-up</i>	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.
<i>Reverse pick-up</i>	Not more than 25% greater than direct pick-up.	Not more than 25% greater than direct pick-up.		Not more than 30% greater than direct pick-up.
<i>Direct working current or voltage</i>	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.
<i>Reverse working current or voltage</i>	Not more than 10% greater than original marking.	Not more than 10% greater than original marking.		Not more than 10% greater than original marking.
<i>Polar pick-up</i>		Not more than 85% of direct pick-up of neutral armature.		Not more than 85% of direct pick-up of neutral armature.
<i>Polar working current or voltage</i>		Not more than 83.5% of direct working current of neutral armature.		Not more than 83.5% of direct working current of neutral armature.

taking voltage readings the voltmeter should be connected directly across the coils of the instruments.

113. A test for insulation resistance must be made between the binding posts and between the binding posts and relay top. This resistance must be not less than one megohm.

114. Tests required by C.E. 207 must be made and recorded at time relay is tested.

Inspection

120. Determine by actual operation that relay has a positive drop-away and relay contacts open without retardation of movement due to friction or external force.

121. Before the case is replaced, subject the relay to an air blast to remove any foreign matter, then check to see that all parts are in proper position and in good condition, being particularly careful to see that no particles of foreign matter remain in the relay or case.

Sealing

130. Relay case must be sealed.

Final Test

140. After relay is sealed, final drop-away, pick-up and working current or voltage test should be made. The values obtained should not vary more than 2 per cent from those of the previous test.

Shipping

150. Relays must be tested and must meet shop requirements before shipment.

151. Each relay must be put in a separate carton or suitably wrapped before being placed in packing boxes. Not more than two relays to be placed in same packing box.

Field Tests and Inspections

Meter Calibration

160. Meters must be calibrated or checked by a meter known to be correct, before each cycle of test, and as often as necessary for field use.

Testing

170. Tests required by Instruction 110, 113 and 120 must be made annually.

Inspection

180. Relays must meet shop requirements when placed in service, except in emergency, when relays meeting field requirements may be used.

181. It must be determined by observation that sufficient front, back and polar contact opening exists.

182. Determine by observing operation of relay, that sufficient clearance exists between case and movable parts.

183. Parts enclosed must be free from foreign matter, in proper position and in good condition.

184. Relays not meeting field requirements of Table 1 must be taken from service as promptly as possible.

Repairing

190. Repairs and adjustment to insure positive operation of relay, for temporary use in emergency, may be made in the field by an authorized relay inspector.

Recording

200. Relays must be identified by serial number, which must be recorded. Manufacturer's serial number must be used if available.

201. Inspectors must re-mark indistinct serial numbers.

202. Relays that have illegible or no serial number must be assigned serial number, preceded by a letter. The letter to be

used will be assigned by the assistant chief engineer-signals.

203. Inspector must immediately record field readings.

204. Records made in the field must be transferred at least once each week to forms C.E. 207. One form C.E. 207 must be used for each relay.

Maintainer's Test and Inspections

210. When making regular inspections, maintainers must also make tests and inspections in Instructions 104, 120, 181, 182 and 183.

211. Defective relays or relays due for shop tests and inspection in accordance with Instruction 1 must be shipped to place designated by supervisor of telegraph and signals. Repair Tag, Form C.S.E. 17, properly filled in must be attached to each defective or shopped relay.

TEST 6—D.C. Relays and Indicators—Shop Tests:

This test shall be performed in accordance with C.E. 221.

For apparatus not covered by P.R.R. Instructions, instructions furnished by the manufacturer should be followed.

TEST 7—A.C. Relays and Indicators—Shop Tests:

This test shall be performed in accordance with C.E. 222.

For apparatus not covered by P.R.R. Instructions, instructions furnished by the manufacturer should be followed.

TEST 8—Ground Resistance:

The purpose of this test is to insure that grounds are maintained at sufficiently low resistance, so that protection may function as intended.

Resistance of grounds shall not exceed 15 ohms. Where a resistance of 15 ohms or less seems impracticable, it should be reported promptly to the supervisor of telegraph and signals.

Tests shall be made in accordance with A.A.R. Drawing 1377 or Plan S-817.

A record of each ground in use should be kept, readings to be recorded as tests are made. When ground resistance is found to be above limits specified, corrective action must be taken. In testing protector grounds on power lines, test apparatus shall be connected at the ground rod, and careful visual inspection shall be made of the ground wire. In test of other protector grounds, connections shall be made at the arrester, instead of at the ground rod, for the purpose of checking the wire and connection, in addition to the actual ground.

TEST 9—Lightning Arresters—Gas or Vacuum Type:

The purpose of this test is to insure that arresters are in condition to provide the desired protection.

Test shall be conducted on all ar-

resters of the type involved, in accordance with instructions with the test set furnished for this purpose.

TEST 18—Friction Torque, Power Operated Semaphore Signals:

The purpose of this test is to insure that power operated semaphore signals are free from friction or other interference which might prevent return to most restrictive aspect.

Test must be made in accordance with C.E.231. (Omitted on account of space limitations.—Ed.)

C.S.E.23-C Instruction 76b—Lamp bracket shall be securely fastened and all parts of lamp shall clear spectacle not less than $\frac{1}{2}$ in.

C.S.E.23-C Instruction 78d—Slot armature side play measured at lower end of armature shall not exceed $\frac{1}{8}$ in.

TEST 22—Voltmeter Tests for Grounds Where Apparatus Has Been Burned Out By Lightning:

The purpose of this test is to detect any grounds which may have developed and prevent subsequent signal failures.

When apparatus has been burned out by lightning, voltmeter readings shall be taken on all associated wiring and apparatus to determine if grounds exist.

TEST 24—Interlockings, Automatic Signals and Highway Crossing Signals:

The purpose of this test is to insure good physical condition and satisfactory operation of the signal plant, proper application and maintenance of suitable material and devices, and that work in service agrees with approved plans and specifications.

Layout Plan: Check conditions on the ground for agreement with plan as to track arrangement; number, location and frog angle of cross-overs and turnouts; location, type, aspects and routing of signals; location of tower and other structures which affect signaling.

Inspect physical condition of tracks and switches, signals, signal bridges, foundations, pipe lines, machine, tower and many other buildings involved. Check tower and other buildings for fire hazard.

Locking and Dog Sheets: Test in accordance with Test No. 1.

Circuit Plans: Check should be made as to condition and location of insulated joints, fouling wires, battery, transformer and relay connections, wires and cables, switch circuit controllers and rods, transformers, relay locations, switch movements, electric switch locks, and other apparatus on or about the tracks.

Check should be made of each relay location, including tower case, to see that it contains all the apparatus called for on plans and that there is no excess apparatus or foreign material, that apparatus is of proper type and has proper inspection dates, and that power and battery supplies are provided, and fused and designated according to plan.

Check should be made of ground-meter readings and volt and ampere readings as may be necessary.

Check should be made of the number in use, kind, condition and adjustment of contacts in relays, electric locks, circuit controllers, releases, and similar devices, and tagging and wire numbering of wires to controls and contacts.

Check should be made of interlocking machine spring combination condition and adjustment, type of quadrants, type and adjustment of segments, and cutting and adjustments of segments in electric locks.

Test should be made of all circuits to insure that the opening of each contact in a control circuit cuts off the control current under conditions shown on plan, following through all multiple circuits and cut arounds. When a circuit is broken over a relay twice, or when it is broken over some other contact that will be opened by opening the relay the wires in the circuit must be disconnected for the test in addition to the opening of the relay.

Where conditions are found that are not in accordance with approved plans these shall be corrected at once or steps taken for a revision of the plans to agree with the work.

When making this check and test, if conditions are observed in which the approved plans do not seem to provide proper protection or flexibility of operation, such conditions shall be reported to the supervisor of telegraph and signals.

TEST 25—Track circuits.

(a)—Voltage at Relay.

The purpose of this test is to insure that track relays are not overenergized in accordance with instructions in C.E.232 or subsequent instructions: (C.E.232 omitted due to space limitations.—Ed.)

Read track circuit voltage at relay terminals, record on proper forms, and arrange for prompt correction where voltage is high.

(b)—Polarity.

The purpose of this test is to insure that the polarities of adjoining track circuits are in accordance with approved plan or specification, and so arranged that least favorable signal indications will result from broken down insulated joints.

D-c. track circuits shall be tested

by voltmeter which will show the actual polarity of the circuit.

A-c. track circuits shall be tested by polarity meter which will show the relative polarity (like or staggered) of the two adjoining track circuits.

Arrange for prompt correction where necessary.

NOTE:—In electrified territory where centrifugal relays are fed through resistor or reactor, or both, the polarity meter may not give definite indication. Under these conditions disconnect feed end of circuit being tested or place a good shunt across the track circuit at least 500 ft. from the relay end and after the relay rotor has come to rest, bridge each insulated joint, separately, observing relay. If rotor turns backward toward or against the stop the polarity is satisfactory.

C.S.E.23-C Instruction 155—The voltage or current on track relays must not exceed the maximum specified in CE.232. A check must be made when tracks are raised or cleaned.

TEST 26—Siding Protection for Inflammable Liquids:

The purpose of this test is to determine if the protective apparatus installed is operative and in good condition.

Ascertain by observation and tests that insulated rail joints, ground wires and other protective apparatus are intact and functioning as intended.

C.S.E.23C Instruction 15—Regular inspection of protective features provided at sidings where inflammable liquids are loaded or unloaded must be made to insure that they are properly maintained to function as

section with each installation is in good order and functioning as intended.

Make inspections and tests as prescribed in Instruction 80, Special Instructions Governing Construction and Maintenance of Signals and Interlocking Plants, Form C.S.E.23.

C.S.E.23-C Instruction 80—The maintainer of telegraph and signals must inspect and test highway grade crossing signal apparatus in accordance with outline given below. He must record on his regular C.E.204 daily report where and when inspections are made, and must also record the tests and inspections shown below, conditions found and any corrective action taken, by number, in the C.E. 204 book located at the crossing (carbon copy to the supervisor of telegraph and signals).

(a) At least once each two weeks.

1. Inspect main and track batteries for height of electrolyte, condition of plates, connections and cleanliness.

2. Check degree of exhaustion of primary batteries, main and track.

3. Measure voltages of storage batteries, individual cell and overall, with charge on and signal not operating. (Designate cells 1, 2, 3, etc., from positive end of battery.)

4. Measure total voltage of primary batteries after continuous load for five minutes.

5. Check a-c. power supply, including fuses.

6. Check operation of power-off relay.

7. Check operation of highway crossing signals for each track in each direction, and, after tests are com-

STATION _____ NAME OF CROSSING _____ MONTH _____ 19 _____

DATE	TIME		CONDITION		OBSERVED BY	DATE	TIME		CONDITION		OBSERVED BY
	A.M.	P.M.	O.K.	Out of Order			A.M.	P.M.	O.K.	Out of Order	

In addition to the tests prescribed by C.S.E.23-C Instruction 80, the form above, known as C.S.E.42-A, is in general use with instructions on the back which read as follows: "The employee designated to observe crossing signals must make observations in a manner and at intervals prescribed for each location, record on card provided and forward card at the end of each month. If the signal is out of order, he must notify the superintendent, track foreman, and T. & S. maintainer at once, and, if signal fails to operate to give warning when it should, must protect crossing." The card, which is 5½ in. by 7 in. wide, may be folded, and has an address form, in addition to the above instructions, on the back.

intended. Inspection should be made at least once a month by the maintainer of telegraph and signals and at least quarterly by the telegraph and signal foreman unless otherwise provided.

TEST 27—Highway Grade Crossing Signals:

The purpose of this test is to be certain that all the equipment in con-

pleted, observe that both armatures of the interlocking relay are picked up.

(b) At least once each month.

1. Check charging rate of main and track storage batteries simultaneously with power supply voltages.

2. Record on battery record card, water consumption, readings of voltages and charging rate.

(c) At least once every three months.

1. Check number of flashes per minute.
2. Check flasher contacts by observing if at least one lamp on each

off and with a shunt of approximately 2 ohms across the storage battery after this shunt has been in place for approximately 10 minutes. Voltage

the switch at which an engine receives a more favorable indication than caution-slow-speed. The distance in no case should exceed 100 ft. When shunt is not properly effective, corrective action must be taken promptly.

TEST 30—Shunt Efficiency— Gas and Electric and Similar Single Unit Equipment:

The purpose of this test is to insure that track circuits are effectively shunted by light weight equipment and must be made not less frequently than indicated at points where it is known that trouble may be experienced due to poor shunting.

Tests should be made by observing proper electrical meter connected in the circuit when the track is occupied by the light weight equipment moving through the entire circuit.

TEST 31—Dragging Equipment Detector Circuits:

The purpose of this test is to insure that the dragging equipment detector circuits are in proper order to sound alarm and display restrictive signal aspects.

Disconnect battery wire at the detector unit and check that alarm is sounded, that proper wayside signal aspects are displayed and that the proper code is fed to the track circuits involved. Any improper operation must be corrected at once.

Mechanical Pipe and Wire Lines

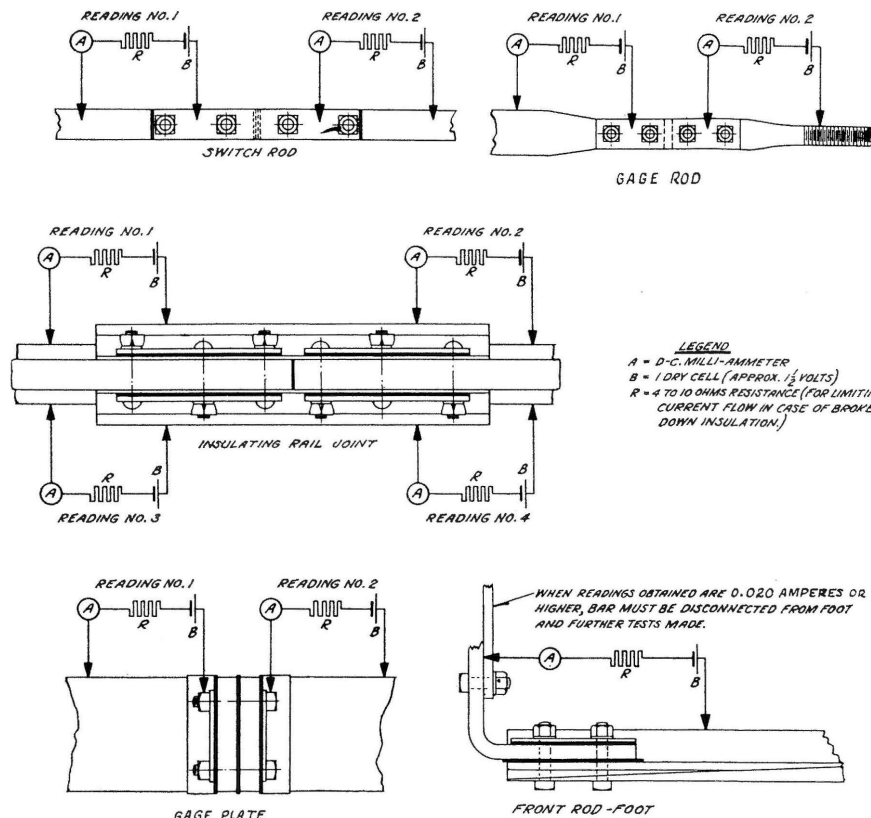
C.S.E.23-C Instruction 140—Joints in pipe lines must be kept tight and properly riveted, and not more than one joint must be made in the same pipe between any two supports. With the lever in the center position of its stroke, the couplings must be located not less than 12 in. from pipe carriers.

C.S.E.23-C Instruction 142—2-in. more throw must be maintained in the back wire than in the pull wire of wire-pulled signals.

C.S.E.23-C Instruction 143—Pipe line under rail shall clear base of rail at least 1 in.

Automatic Train Stops

C.S.E.23-C Instruction 34—Trip arm of automatic train stop device of the mechanical trip type when in stop position shall be maintained at $3\frac{1}{8}$ in. above the plane of the tops of the rails, and at a horizontal distance from its center line of $12\frac{1}{4}$ in. to gage of rail. They shall be inspected frequently enough to insure that they are in good condition. They shall be gaged monthly for height and alinement, and shall be tested semi-annually to insure that they are in condition for reliable and safe operation. Roadway elements found to be defective shall be replaced with elements known to be in good condition.



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NOTE: 1. When readings obtained are 0.020 amperes or higher, insulation shall be renewed, except for insulating rail joints. 2. On insulating rail joints, when total readings, as determined from Note 3, are 0.020 amperes or higher, the insulating rail joint shall be taken apart and rust thoroughly cleaned with a wire brush and defective insulation and insulating bushings renewed. 3. To determine total reading on insulating rail joint add the higher current reading obtained from reading No. 1 and No. 2 to the higher current reading obtained from reading No. 3 and No. 4. 4. On mechanically-operated switches—When readings obtained are 0.020 amperes or higher, pipe line must be disconnected from switch and further readings taken. 5. Flexible metallic conduit connected to any grounded apparatus, such as E. P. valves, switch mechanisms, etc., shall be free from metallic contact with mechanism while test is being made.

cross arm is burning with flasher relay at rest.

3. Take hydrometer reading of main and track storage battery cells of lead plate type, starting with No. 1 cell. Record specific gravity on battery record card.

4. Check visibility and focus of signals, and visibility and condition of signs (including R.R. advance warning signs on the highway).

5. Inspect all lamps for blackening of glass, replacing as required.

6. Check voltage at each lamp unit with normal power supply, lamps flashing. Voltage should not be less than 10 nor more than 13 volts.

(d) At least once every six months.

The telegraph and signal foreman, with the maintainer of telegraph and signals, must make all the above inspections and tests and, in addition, must:

1. Check voltage at the two lamps having lowest voltage reading under Tests (c)-6 with a-c. power supply

at lamps should not be below 10 with lamps flashing.

2. Check back-flow of current through rectifier with power off.

TEST 28—Insulated Rail Joints and Switch Insulation:

The purpose of this test is to insure that all fibre insulation is in good condition and test shall be made as indicated on Plan S-818. (See S-818 in accompanying illustration.—Ed.)

C.S.E.23-C Instruction 163b—Insulated rail joints shall be inspected monthly to insure that they are in good condition.

TEST 29—Shunt Test—Hand-Operated Switches in Cab Signal Territory:

The purpose of this test is to insure that cab signals are operating efficiently approaching non-interlocked switches in the unlocked or open position in coded track circuit territory, to develop the distance from