



Pennsylvania Testing Procedure



A review of the organizational set-up, the manner of issuing instructions, and the records maintained to check that tests are being made at required intervals. General rules for the maintenance of signaling facilities

THE Pennsylvania, for a great many years, has maintained a well-organized personnel and a very complete series of instruction sheets for the inspection and testing of signal equipment and facilities. This road, with 10,377 miles of road operated, had in service, on January 1, 1939, a total of 6,651 miles of track equipped with automatic block systems, 516 interlockings maintained by the carrier, including 161 electro-mechanical plants, 126 electro-pneumatic, 111 electric, 100 mechanical, 1 automatic, and 17 other types; 151.6 miles of track operated under controlled manual block; 47.2 miles of track under centralized traffic control; 19.7 miles of track equipped for operation with automatic train stop or train control; and 3,249 miles of track equipped for cab signals in conjunction with automatic wayside signals without automatic train control. In addition to automatic block territory trains are operated by signal indication without train orders in one direction in manual block territory on 1,673.4 miles of track, and by signal indication without train orders in either direction on 581.8 miles of track. The rules, standards and instructions concerning signaling issued by the Interstate Commerce Commission effective September 1, 1939, required only minor revisions of the standard instructions and procedure in use on the Pennsylvania at that time. In addition to outlining the procedure followed on the Pennsylvania in making test information

readily available to the Commission inspectors at a moment's notice, this article will outline the Pennsylvania supervisory and testing organization, the manner of issuing testing instructions, and will explain the records and forms maintained in the field and the division and regional offices.

Organization

The Pennsylvania system signal department forces as a whole come under the general supervision of a system official with the title assistant chief engineer-signals. The road is divided into four principal geographical supervisory areas, the Western Region, the Central Region, the Eastern Region, and the New York Zone, each under the jurisdiction of a superintendent of telegraph and signals reporting to the chief engineer M. W. in their respective territories. Several "divisions" complete the subdivision of each Region or Zone, with supervisors, and on several divisions assistant supervisors, of signals in charge on each division. Engineers of telegraph and signals and "signal inspectors" are assigned to the regional, and zone offices. Foremen, or "inspectors of signals" are assigned on each division or portion of a division, and have charge of inspections and tests.

A foreman of tests or other designated individual co-ordinates and directs the megger and relay testing routine on each division. Tests are conducted in accordance with the accompanying schedule and are made by the maintainers, foremen, divisional inspectors or "testmen" as indicated thereon. Testmen may be men regularly or men not regularly assigned specifically to testing exclusively on particular divisions or portions of divisions, the only requirement other than seniority being that they must have "qualified" as being of proper calibre to conduct the tests normally assigned to "testmen" in the required manner and capable of assuming the responsibilities involved. In order to qualify for the position of testman, a man who has "bid in" one of these positions must pass an examination conducted by the supervisor of signals

of the division involved, indicating that he is capable of making *all* the tests assigned to the "testman" in the schedules which are required on the division or portion of the division on which the job is assigned. When extra men are required, qualified men, not normally engaged in testing work, may be assigned by the supervisor of signals on the division.

The foreman or inspector performs the following general functions: (a) Instructs testmen in methods of making tests; (b) makes certain of the prescribed tests himself and accompanies signal inspectors or other higher regional officials in making supervisory tests; (c) programs megger and relay testing; keeps records of these tests made on the division; (d) inspects records maintained by testmen; (e) and checks to see that testmen conduct tests properly.

New installations or additions to existing plant are always checked and tested by a representative of the superintendent of signals. Also, representatives of the assistant chief engineer-signals may be present when new installations or additions are tested, as well as visiting the various regional or zone areas when routine maintenance testing is being carried out.

Instructions

Instructions, general maintenance rules, and details of test procedure are issued in booklet and pamphlet form by the system office of the assistant chief engineer-signals and bear serial and letter number identification markings, as, for example, C.S.E.-23-C, C.E.-227-A; the first letters indicate the office of origination while the last letter, after the number, indicates the latest revised issue; test report forms are identified by similar designations. Meetings held under the jurisdiction of the assistant chief engineer-signals with the regional and zone superintendents of telegraph and signals, and meetings of divisional supervisors of telegraph and signals called by the superintendents of telegraph and signals form a clearing house for opinions regarding proposed improvements or modi-

*This article is general in nature. Details of specific tests of individual types of equipment as conducted on the Pennsylvania will be presented in subsequent issues of *Railway Signaling*.

SCHEDULE OF TESTS OF SIGNAL APPARATUS

Test	To be Made at Least	By	Test	To be Made at Least	By
1—Mechanical locking in interlocking machines:			(b) Restoring :əɪnɪtʃɪŋ		
(a) Terminal Plants	Once in 2 yr.	Foreman, Inspector or Testman	1. E. P. switches with friction lock and electric switches.	Quarterly	Maintainer
(b) Other Plants	Once in 4 yr.	Foreman, Inspector or Testman	2. E. P. switches without friction lock.	Semi-monthly	Maintainer
2—Insulation resistance test:			(c) Lock magnet, PL.0953 Fig. A on electro-pneumatic switch valves.	Quarterly	Maintainer
(a) Low voltage wires and cables, except track wires.			(d) Valve test—E. P. switches.	Quarterly	Maintainer
1. Braided rubber insulated wires and cables, including those with metal tape but no lead sheath, and trenchlay (any part of which is underground or in trunking).	Annually	Testman	(e) Indication circuits—electro—mechanical and mechanical switches.	Semi-annually	Maintainer, Foreman or Inspector
2. Braided rubber insulation aerial wires and cables (no part of which is underground or in trunking).	Once in 4 yr.	Testman	(f) Indication circuits—Style CP Valves—Type F controller.	Semi-annually	Maintainer
3. Lead sheath and parkway cables with lead sheath.	Once in 4 yr.	Testman	13—Cross protection—Electric interlocking machines (GRS Co. and Federal Types). Main protection breaker and devices on all switches and signals so equipped.	Monthly	Maintainer
4. Local signal wiring:			14—Observe "SS" relays, opening when switches are operated.	Monthly	Maintainer
(a) Position light signals.	Once in 4 yr.	Testman	15—C. E. 40—Switch Obstruction Tests:		
(b) Semaphore signals.	Once in 2 yr.	Testman	(a) Bar test interlocked switches.	Semi-monthly	Maintainer, Track Foreman
(c) Lead covered signal power cables:			(b) Obstruction test:		
1. Aerial (No part of which is underground).	Once in 4 yr.	Testman	1. Interlocked switches.	Quarterly	Maintainer, Track Foreman
2. Underground.	Once in 2 yr.	Testman	2. Hand-operated switches:		
(c) Underground signal power lines. (Not lead sheath)	Semi-annually	Testman	(a) Facing point	Semi-monthly	Maintainer, Track Foreman
3—Electrolysis test on lead covered cables, except where protected by T. & T. tests.	Annually	Testman	(b) Trailing point	Monthly	
4—Foreign current tests, D.C. track circuits: (Except where foreign current protection is provided, where there is no source of stray direct current such as a trolley line, and where tests over a 3 yr. period show no evidence of foreign current).	Annually	Foreman or Inspector	16—Drawbridge locking:		
5—Relays, indicators, magnets, slots, etc.—field test:			(a) Mechanical locking.	Weekly	Maintainer
(a) A. C. apparatus.	Annually	Testman	(b) Adjustment and operation of circuit controllers and electric locks.	Quarterly	Foreman, Inspector
(b) D. C. apparatus.	Once in 2 yr.	Testman	17—Switch and traffic lever locking:		
(Exclusive of E. P. switch magnets, switch indication magnets with safety tooth, signal indication magnets with force-down feature and relays included under 6-(b). Note:—In congested territory, where the electrical field tests are not practicable, they may be omitted and more frequent shop tests as seem necessary substituted.			(a) Open lock circuit and move lever or latch against stop.	Quarterly	Maintainer
6—D. C. Relays and indicators—Shop Tests—unless field test indicates relay needs overhauling:			(b) With track occupied.	Quarterly	Maintainer
(a) D. C. Relays and indicators—except those included under 6-(b).	Once in 6 yr.	Testman	18—Friction torque tests on power operated semaphore signals.	Once in 2 yr.	Testman if necessary in terminals, Foreman or Inspector
(b) Code following relays, code modulators, interlocking and flasher relays.	Once in 2 yr.	Testman	19—Ground detector readings.	Daily	Maintainer or Operator
7—A. C. relays and indicators—Shop Tests—unless field test indicates relay needs overhauling:			20—Fouling circuits on switches: Test where fouling wires are not visible and inspect where visible.	Monthly	Maintainer
(a) Vane type, except Plate H-101 1/4, US & S Co.	Once in 4 yr.	Testman	21—Switch circuit controllers:		
(b) Centrifugal relays.	Once in 3 yr.	Testman	(a) Where connected direct to switch point.	Semi-monthly	Maintainer
(c) H-101 1/4 Vane type, code transmitting relays and other types.	Once in 2 yr.	Testman	(b) All others.	Monthly	Maintainer
8—Ground resistance tests:			22—Voltmeter tests for grounds where apparatus has been burned out by lightning.	When replacing apparatus	Maintainer
(a) When grounded to steel catenary structures.	Once in 4 yr.	Foreman, Inspector or Maintainer	23—(a) Adjustment of contact springs with relation to safety tooth on segments of power machines.	Annually	Testman if necessary in terminals, Foreman or Inspector
(b) Other ground connections—unless experience indicates more frequent tests in certain locations are necessary.	Once in 2 yr.	Foreman, Inspector or Maintainer	(b) Quick switch for stopping on center.	Annually	Testman if necessary in terminals, Foreman or Inspector
9—Lightning arresters (gas or vacuum type).	Annually	Foreman, Inspector or Maintainer	24—Interlocking, automatic signals, and highway crossing signals: Detail check of layout, locking and circuits.	Once in 4 yr.	Foreman, Asst. Foreman or Inspector
10—Signal indication lock circuit:			25—Track Circuits:		
(a) Light signals.	Once in 2 yr.	Foreman or Inspector	(a) Voltage at relay except A. C. track relays or other A. C. track apparatus of very low impedance for which current readings shall be taken.	Semi-annually	Maintainer or Testman
(b) Semaphore signals.	Semi-annually	Foreman or Inspector	(b) Polarity.	Annually	Maintainer or Testman
11—Approach and time locking.	Annually	Foreman or Inspector	26—Siding protection for inflammable liquids.	Quarterly	Maintainer
12—Switches:			27—Highway grade crossing signals.	Semi-annually	Foreman or Inspector
(a) Switch indication, power switches.	Monthly	Maintainer	28—Insulated rail joints and switch insulations.	Monthly	Maintainer
			29—Shunt test—hand operated switches in cab signal territory.	Quarterly	Foreman or Inspector
			30—Shunting efficiency—gas electric and similar single unit equipment, except where experience has indicated more frequent tests are required.	Annually	Foreman or Inspector
			31—Dragging equipment detector circuits. (Where actuations have occurred within designated period, test not required).	Annually	Foreman or Inspector
				Quarterly	Maintainer

fications in the instructions, procedure and report forms. The assistant chief engineer-signals often attends the meetings of the superintendents of telegraph and signals with their division supervisors of telegraph and signals in order to retain close contact with testing problems arising in the field. Tests for new items of material and new systems not previously in service originate in the system office.

General rules, standards and instructions are issued in two publications. One of these, C.E.-233, entitled "Requisites and Specifications for Signal and Interlocking Systems" covers the general features to be observed in the design and construction of signaling facilities. The second, C.S.E.-23, entitled "Special Instructions Governing Construction and Maintenance of Signals and Interlocking Plants," includes, primarily, general rules for the maintenance of signal equipment and instructions in reference to action to be taken by employees under unusual circumstances (as, for example, procedure to be followed if a switch or vital auxiliary apparatus is to be disconnected), as well as certain important specifications which must be met at all times in signal maintenance. (The principal sections of C.S.E.-23 on general maintenance procedure and instructions covering unusual circumstances, with the more definite specifications regarding maintenance clearances and tests removed, are presented in the latter portion of this article; the sections removed, which set up definite measurements to be observed, or definite testing procedure, will be assembled and published with test instructions for individual types or classes of apparatus in subsequent issues of *Railway Signaling*.)

Supplementary detailed instructions are issued for specific tests on individual types of apparatus, as, for example, C.E.-221, entitled "Instructions for Inspecting and Testing Direct Current Relays and Indicators," and C.E.-222, entitled "Instructions for Inspecting and Testing Alternating Current Relays and Indicators." Material of this nature had accumulated through a period of years, and as the signaling systems became more involved and many different types of equipment came into use the series covering detailed tests became quite voluminous. Therefore, in November of 1937, a new pamphlet of a general nature, which ranks in importance with C.E.-233 and C.S.E.-23 as part of the backbone of the system of instruction circulars, was issued. This pamphlet, C.E.-227, contains the schedule of tests previously issued as a separate

sheet and, in addition, test instructions with cross-references intended to co-ordinate the various forms issued governing detailed tests on the wide variety of equipment and signaling facilities; this pamphlet, therefore, is a combined schedule and index of tests which must be performed at regular intervals.

In the particular case of track switches, where co-operation with the track department is required, the instructions for conducting the tests are printed on the report form (C.E.-40) provided for that test; these instructions cover inspections of switch points, switch rods, lock rods, rail braces, stock rail, ties, gage, and switch lock (bar and obstruction) tests. The operation of auxiliary track switch apparatus, such as interlocking switch machines, switch circuit controllers, and pipe-connected derails, is checked by the proper signal department employee in accordance with instructions in C.E.-227.

Report Forms

Insofar as general maintenance is concerned the periodical tests are conducted by the maintainers, testmen, and inspectors of signals on each division. Each maintainer keeps, at his headquarters, a daily log book, C.E.-204, wherein he records daily each test made, as well as other entries of work performed, etc. In each instance a carbon is provided, the maintainer retaining the carbon and forwarding the original to the supervisor of telegraph and signals in charge of the division. Local divisional inspectors inspect these log books periodically. At one-week intervals a *running record* of the log book test entries is made on a special form, C.E.-247, entitled "Report of Tests of Signal Apparatus in Accordance with C.E.-227."

A variation is found in the case of the switch tests and inspections conducted as a joint affair with the track foremen; a separate form, the C.E.-

40 referred to previously, is made out by the maintainer and foreman jointly, one copy being forwarded to the supervisor of signals and one copy to the supervisor of track on the division involved. The maintainers are required to have these report forms with them when testing switches, and entries must be made at time of test; this is done to eliminate the possibility of a maintainer relying on his memory in making out a report later. Defects readily repaired are taken care of by the foreman of track and maintainer immediately. When the switch test reports are received, the supervisors of track and signals check them and arrange to make any major repairs or replacements not completed but reported by the track foreman and signal maintainer. Since the territory covered by a signal maintainer may include one or more track sections supervised by track foremen, these forms are made out on the basis of track sections rather than maintainers' sections; one maintainer may work jointly with three different track foremen in reporting on the condition of the switches on his territory. The switch tests are scheduled for definite days of the month and the supervisors of track and signals often make it a point to be present when the tests are made.

Another interesting variation is found in the case of highway crossing protection inspection and tests. Although not "part and parcel" of the tests required by the I.C.C., the Pennsylvania has a very complete system of tests and inspections for such installations, and since the report forms used are an essential part of the supervisory check that tests are being made (which is discussed below) it will be advisable to review the report procedure briefly. The maintainer is required to make special highway crossing protection tests at various intervals, and he must enter the information regarding his findings during the tests at each crossing in a log book (of the same type, C.E.-204, as

[illegible]

C.E.-204. Middle portion omitted. Form 7½ in. wide by 5½ in. high

up from the C.E.-247 reports submitted, from the Test 19 reports on the maintainers' daily log sheets, from the form illustrated in Fig. 1 for the switch obstruction tests, and from the form illustrated in Fig. 2 for the tests of highway crossing protection. As in Fig. 3, the tests are listed in the left-hand column, together with the required frequency, in the order of their periodicity, the most frequent being at the top and the least fre-

appropriate number of dividing lines under each section column. Tests to be made at intervals greater than one month are recorded in percentage form, while an "X" is used for completion. In the case of Test 19, the only daily test required, a similar procedure is followed. The forms shown in Fig. 1, 2, 3 and 4 are utilized primarily for supervisory checking purposes and are maintained and retained in the office of the supervisor of sig-

visor. As with Fig. 4, tests with periodicity greater than one month are recorded by using percentages with an "X" for completion. In the regional and zone offices the information on Fig. 5 for a particular division is copied on the same type of form, the copy being retained in the regional or zone office and the original being sent back to the supervisor on the division preparatory to his insertion of the records for the next

REPORT OF TESTS OF SIGNAL APPARATUS C. E. 227

X = COMPLETED

φ NONE ON DIVISION

.....Division

.....Region

KIND OF TEST	Test No.	To Be Made at Least	1938												REMARKS
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Ground Detector Readings	19	Daily													
Drawbridge Locking: Mechanical Locking (Maintainer)	16a	Weekly													
Switches—E.P. Restoring Feature Where not equipped with friction lock	12b2	Semi-Monthly													
C.E. 40—Switch Obstruction Tests: Bar Test Interlocked Switches	15a	Semi-Monthly													
C.E. 40—Switch Obstruction Tests: Hand Operated Switches: Facing Point	15b2a	Semi-Monthly													
Switch Circuit Controllers Connected direct to switch point	21a	Semi-Monthly													
Tests prescribed by C.S.E. 23-C, Instruction No. 80a (Maintainer)	27	Semi-Monthly													
Switches—Switch Indication Power Switches	12a	Monthly													
Cross Protection—Elec. Interlocking Machine—Main Protection Breaker and Devices on all Switches and Signals	13	Monthly													
SS Relays—Observe opening when switches are operated	14	Monthly													
C.E. 40—Switch Obstruction Tests: Hand Operated Switches: Trailing Point	15b2b	Monthly													
Drawbridge Locking: Adjustment and operation of circuit controllers and electric locks (Maintainer)	16b	Monthly													
Fouling Circuits on Switches: Test where fouling wires are not visible and inspect where visible	20	Monthly													
Switch Circuit Controllers—All except 21a	21b	Monthly													
Tests prescribed by C.S.E. 23-C, Instruction 80b (Maintainer)	27	Monthly													
Switches, E.P. Switch Valves Lock Magnet Pl. 0953—Fig. A	12c	Quarterly													
Inspection of the bonding, grounding of rails, piping, etc. at Oil Sidings—C.E. 10 (Maintainer)	26	Quarterly													
Switches, Restoring Feature, E.P. equipped with friction lock and electric switches	12b1	Quarterly													
Switches, E.P. Valve Test	12d	Quarterly													

Fig. 5—Top of master sheet for recording division, zone, and region testing activity. Form includes, at right, columns for 1939 and 1940 similar to those for 1938. Also, at extreme right columns are provided for yearly totals for 1937, 1938, 1939 and 1940

quent at the bottom. However, while the form in Fig. 3 covers a particular section handled by a testman, the form in Fig. 4 provides spacings for summarizing the activity on the comparatively smaller sections covered by maintainers. Also it only summarizes the activity over a particular quarter year, whereas the form in Fig. 3 covers three years. In Fig. 4, spaces are provided for recording activity in making tests of greater than quarterly frequency by providing an

nals on each division. However, in order that the system, regional and zone offices may be kept informed of the testing activity on the various divisions, the information shown on the forms in Figs. 3 and 4 is consolidated on a master sheet, illustrated in Fig. 5, and forwarded by the supervisor to the regional or zone offices each month, the form shuttling back and forth between the regional and division offices as additional monthly information is added by the super-

month's testing activity. In addition, from the copies of Fig. 5 for the various divisions comprising a region or zone, a new Fig. 5 is built up, the reports from the various divisions being consolidated, and the testing activity on the region on a whole is thereby summarized. Likewise, copies of the regional summaries are sent to the system offices.

The forms shown in Figs. 1, 2, 3, 4, and 5, thus perform the function of summarizing testing activity in a va-

riety of ways as required by different supervisory officers, all being utilized by the divisional supervisors, and the last by the regional and system offices to give a birds-eye view of testing activity on the respective territories over which those offices have jurisdiction. They are prepared as blueprints

and measure 21 in. by 17 in. with three-hole punch marks for binding.

Instructions issued by the Pennsylvania for making certain specific tests on individual types or classes of apparatus will be presented in articles in subsequent issues of *Railway Signaling*.

C. S. E. 23-C

Special Instructions Governing Construction and Maintenance of Signals and Interlocking Plants

1. Changes in C.S.E.-23 or its supplements must not be made to meet special conditions without approval of the superintendent of telegraph and signals.

2. Supervisors of telegraph and signals or telegraph and signal foremen must read over the C.S.E.-23-C with their men to insure that the various provisions are properly understood by all concerned.

3. In these instructions "superintendent of telegraph and signals" includes "engineer of telegraph and signals," New York Zone. "Supervisor of telegraph and signals" includes "assistant supervisor of telegraph and signals," "Telegraph and signal foreman" includes "inspector of telegraph and signals."

4. "Signalman" in these instructions refers to the employee who operates the block or interlocking station, commonly termed "operator."

5. Signalmen, before being assigned to work at interlocking plants or block stations, upon request of their supervisory officer, must be examined and qualified by the supervisor of telegraph and signals or his representative. This qualification must include proper knowledge of C.S.E.-23 and other instructions applicable at the plant in question.

The supervisor of telegraph and signals must keep the supervisory officer of the signalmen advised of any operating changes at interlocking plants and block stations.

6. Employees, except helpers and laborers, engaged in the construction or maintenance of signals and interlocking apparatus, must familiarize themselves with the current issues of timetable, book of rules, and C.S.E.-23.

7. Employees must instruct their subordinates as to the necessity for safety, efficiency and economy, and that all work must be done in accordance with authorized practices.

8. Employees are responsible for the inspection, adjustment and proper maintenance of all signal and interlocking apparatus assigned to their care. They must promptly report to their superior any condition requiring his attention.

Instructions issued from time to time covering the inspection and testing of relays, indicators, electric locks, magnets and other apparatus, must be observed.

9. Alterations must not be made to any of the apparatus or circuits unless properly authorized.

10. Installation of experimental devices, or trial of unapproved material, must not be made unless specifically authorized.

11. When necessary to remove or disconnect any essential apparatus for replacement, repairs, inspection, testing or cleaning, train or engine movement must not be permitted over the route involved, unless levers and operating units affected are properly secured, or until the apparatus has been restored and the devices are known to be in proper working order.

12. In case of changes in, failure of or

damage to an interlocking or highway crossing warning device, the employee in charge must give the signalman or crossing watchman full information concerning the apparatus affected, and arrange with him for the safe movement of traffic until repairs are completed.

13. Should a failure of switch, signal or device used in connection therewith be reported, and no cause found, the apparatus must be observed for a sufficient period to insure that it is operating properly. If the condition reported is of such a nature that the safety of operation is affected, precautions must be taken as outlined in Instruction No. 14. Tests and reports must be made under the direction of the supervisor of telegraph and signals.

14. In case of train accident, immediate action must be taken as follows, and a record shall be made of such action on Form C.E.-204.

(a) Secure all signals, including distant signals, governing movements into that portion of track or tracks which is or may be occupied or fouled by derailed or damaged equipment, so as to display their most restrictive indications, by disconnecting local controls at each signal, and seal the housings enclosing apparatus which may have been involved in the accident. After tracks have been cleared, signals may be restored to service under the direction of the supervisor of telegraph and signals or his representative.

(b) If signals are found to have given false indication or if switches or other apparatus have not functioned properly, through failure of mechanism or controlling device, defective mechanism or device must be replaced under the direction of the supervisor of telegraph and signals, and reserved under seal, without change or repairs, until inspected or otherwise directed by the superintendent of telegraph and signals, or his representative. If the trouble is due to defective wiring or defective wires, they must not be removed, but may be disconnected from the terminals, and, after new wires are installed, housing must be sealed and evidence of failure preserved until the superintendent of telegraph and signals or his representative, has had an opportunity to make the desired inspection or test.

(c) If the proper sealing iron and seals are not immediately available to place the apparatus under seal, a competent person must be assigned to see that the apparatus, wiring or wires are not tampered with until seals are applied.

16. Whenever electrical storms occur, maintainer of telegraph and signals must immediately, if on duty, or as soon as possible after coming on duty, check ground meter readings, and, on extended section, make a general survey of his territory by telephone,

to signalmen or other employees, to determine general condition of plant or section. Corrective action must be taken as necessary.

17. If track is found unsafe, due to broken rail, wide gage, obstruction, or other conditions, signals governing over it must be secured to display their most restrictive indication, and immediate action taken to protect trains by flag, notifying the track foreman and proper authorities; a record shall be made of such action on Form C.E.-204.

18. Where snow-melting oil or any heating device is used for melting snow and ice, extreme care must be exercised to avoid damage to wire ways, wires, insulations at switches, etc. When there is the appearance of damage or damage is known to have been done, a report must immediately be made to the signalman and maintainer of telegraph and signals and action taken to prevent any irregular operation of switches and signals that may result.

19. All binding posts and wire terminals in place must have their full complement of nuts and washers, which must be kept jammed. Care must be used to avoid undue strain or damage to threads on binding posts, small machine screws and bolts.

20. Doors of housings, containing signals and interlocking devices, must be kept tight when closed to prevent water from entering; all unused openings must be filled to prevent the entrance of rodents or insects. Ventilators must be kept in good condition and clean, to allow free circulation of air.

21. Trunking and other wire conduits must be kept in such condition as to prevent mechanical injury to the insulated wires and cables and to exclude rodents insofar as practicable. Vacant spaces in wire inlets and outlets of instrument cases, etc., must be packed tightly with genuine mineral wool. Wire and cable openings through floors, and other wire ways which would act as a flue to spread any fire which might occur, must be sealed with approved asbestos cement.

22. Extreme care must be used when drilling, filing or chipping metal parts in or near spring combination or other exposed electrical connections, and suitable safeguards provided to prevent particles lodging in apparatus and producing an unsafe condition. Care must also be used to prevent tools or other metal articles coming in contact with adjacent electrical connections. Broom straw or other non-conducting material must be used for the purpose of tracing or locating contacts in spring combination or other electrical apparatus.

23. Correct track layout plan, circuit plan, locking sheet, and dog chart, in good condition, shall be kept at each interlocking station and at each place where their use is required.

24. Defective apparatus or parts shall be promptly replaced and record made of such replacement on Form C.E.-204.

25. Circuit shall not be opened or shunted or other action taken which may cause operation of signal or other apparatus at a time when such action may affect safety of train operation.

26. In case of severe storm, inspection shall be made as soon as practicable and any trouble corrected.

29. Outside signal and instrument cases shall be locked except where it is established to be undesirable. Power interlocking machine cabinets, time releases, and electric locks shall be locked or sealed.

30. The apparatus shall be so installed and maintained that it will not constitute a source of danger to trainmen, other employees, or passengers.

31. Pole line shall be inspected once every two years to insure that it is in good condition.

32. Interlocking or control machine, switch movements, and other appurtenances shall be

kept in good condition, free from excessive lost motion, rust, grease and dirt. Levers and locking shall be kept clean. All bearing parts shall be kept lubricated but excessive lubrication should be avoided. Bolts and dowel pins shall be kept tight, cotters properly spread, and sufficient tension in latch springs. Contacts shall be kept clean and properly adjusted.

35. Battery shall be installed in suitable housing, shall be of sufficient capacity for the service required, and shall be kept sufficiently charged or renewed as often as necessary to insure safe and reliable operation. Connections shall be kept clean and tight, and cracked or broken jars shall be replaced.

36. Wires shall be properly identified. Tags in instrument, mechanism, and terminal cases shall be made of insulating material and so placed that they will not interfere with moving parts of apparatus. (See footnote).

Interlocking Machines

51. If units become in any way inoperative or are disconnected, the signalman must secure the controlling lever or levers by approved blocking devices and notify the maintainer of telegraph and signals. When necessary to apply blocking devices on levers of electro-mechanical machines, they must be applied to both large and small levers.

52. Mechanical locking must not be removed or made ineffective, nor locking caps removed, unless properly authorized. When necessary to remove or change mechanical locking and until locking has been restored and is known to be correct, unless otherwise authorized by the division superintendent, switches must be wedged and spiked, routes patrolled before any train or engine movement is permitted over them, the clear controls for the distant signals disconnected and all trains stopped at the home signal. If a defect develops, requiring the immediate removal of or change in the mechanical locking, the division superintendent and supervisor of telegraph and signals must be notified at once.

53. State or other Governmental regulations applying to changes in interlocking must be observed.

54. Unless otherwise secured, the top of trunnions for swing dogs in mechanical locking of the S. & F. type must be slightly center punched to prevent the dogs from springing off the trunnions.

55. Machine parts, connections and devices affecting the operation of mechanical locking must be renewed as frequently as necessary to insure reliable operation.

56. Quick switches must not be operated by hand for the purpose of permitting lever to be restored to previous position in the event of failure.

59. Electric locks on interlocking machine must not be released by hand, except in cases of emergency, or when necessary on account of repairs, and then only upon authority from the division superintendent or supervisor of telegraph and signals. Whenever an electric lock is released by hand, notation must be made by the train dispatcher on the train sheet and by the signalman on the block sheet. The maintainer of telegraph and signals must make a detailed report on his daily report sheet. After authority has been received to release a lock by hand, notation must be made by the train dispatcher on the train sheet and by the signalman on the block sheet. The maintainer of telegraph and signals must make a detailed report on his daily report sheet. After authority has been received to release a lock by hand, the following precautions must be taken:

Signal Indication Locks

(a) If a signal lever cannot be restored to its normal position on account of the signal indication lock holding, the lock must not be released until the maintainer of telegraph and

signals or signalman knows that all signals directly controlled by the lever are in "Stop" position and all signals governing the approach to these signals are in their normal or a more restrictive position, except where the following precautions are taken:

1. If the maintainer of telegraph and signals or signalman knows that the home signals controlling the affected lock are in the "Stop" position, an arrangement may be made by the train dispatcher to notify all trains governed by the distant signal controlling the lock affected that the signals are out of order, and to proceed as though the most restrictive indications were displayed, until examination has been made. Lock may then be released.
2. Examination must be made as soon as possible to determine whether the lock failed to release on account of signal failing at "Clear" or because of a defect in the indication circuit.

Switch Indication Locks

(b) Switch indication locks may be released by hand after the switches have been properly secured and checked as prescribed by Instructions 104, 105 and 106.

Switch Lever Locks (Detector Locks)

(c) Electric switch lever locks (detector locks) may be released by hand after being certain that there is no train or engine on or approaching the switches controlled by the levers affected. Signal more favorable than Caution-slow-speed* must not be displayed after the locks have been released until the track has been inspected, unless the switch lever light indicators show that the track is clear.

Traffic Lever Locks

(d) Traffic lever locks may be released by hand after arrangements have been made with the train dispatcher to safeguard the movement of trains in the territory affected.

Electric Locks on Hand Operated Switches

(e) Electric locks on hand operated switches may be released by hand after permission is procured from the train dispatcher.

63. Cases on power and electro-mechanical machines and electric locks on mechanical machines must be kept locked. Guards and shields on electric locks, to prevent false manipulation, must be kept in proper position.

64. Keys to machine cases or apparatus, or seals on electric locks to make them available for manipulation by signalmen, must not be provided, except those specifically authorized by the superintendent and approved by the superintendent of telegraph and signals.

65. The use of oil on latches, segments or trunnions of electric locks is prohibited.

66. The spring combination on electro-pneumatic and similar machines and the adjustment of contact springs and bands with relation to indication and electric locking must be carefully maintained as follows:

- (a) Only contact springs with a sharp (V-shape) bend instead of a gradual curve at contact point must be used, and the main stem of the spring must be straight so that any accidental bending during cleaning, or otherwise, will draw back rather than push forward the point of contact. All springs must be secured to the hard rubber bed plates by bolts that pass through the bed plate, and not more than two wires are to be connected to the same spring combination terminal post.
- (b) Contact bands and springs must be cleaned periodically by wiping thoroughly with a clean dry cloth free from lint. Approved commercial cleaning cloths or cham-
mois, moistened with oil, must be used as

*Equivalent of A.A.R. "Restricting" aspect.
—Ed.

necessary to maintain clean contacts. Oil must be used very sparingly at relatively long intervals on the roller shaft bearings and must never be used on the bevel gears. (c) Contact and roller surfaces which inadvertently become covered with an oil film must be cleaned by wiping with a clean cloth free from lint, to which a small amount of cleaning fluid, such as trichloroethylene, carbon-tetrachloride or benzol has been added. These surfaces must then be rubbed carefully with a clean dry cloth, free from lint, to remove all traces of the cleaner and any remaining residue.

(d) Contact part of springs must meet the contact bands evenly and squarely in order to provide maximum contact. They must have sufficient pressure to provide good contact, but not enough to interfere with proper operation, especially of the quick switch. Checks must be made periodically to insure that all springs are closed or opened at the proper point in the lever movement.

(e) On levers with 60 degree roller travel, the normal and reverse switch control bands and NX and RY bands, for the control of switch repeating relays, must be on enlarged roller sections.

Signals

75. Signals must not be operated by hand for the movement of trains, except on written authority of the superintendent. When necessary to operate signals by hand for tests, inspections or repairs, permission must be obtained from the train dispatcher.

76. (a) Signal blade, lens, roundels, glass, and lamp shall be cleaned as often as necessary to insure good indications.

(c) Ladder, hand railing, and platform shall be kept in good condition and securely fastened.

77. (a) Movable parts of signal shall move freely under all weather conditions which permit the operation of trains.

(b) Semaphore spectacle casting shall rest against the stop provided for that purpose, allowing slot arms and vertical connections to be free from downward pressure when in the most restrictive position.

(c) Semaphore signal shall not be placed in service until bearings have been cleaned, and oil, dirt and grease removed from the armature and poles of slot magnets and gears, all parts lubricated, and preferably after electrical torque tests have been made.

(d) Bearings shall be lubricated and kept free from grit and dirt.

78. (a) Mechanism shall be kept in proper adjustment. Excessively worn or defective parts shall be replaced.

(b) Buffing or snubbing of signal shall be effective to eliminate undue strain on mechanism. Buffers shall be cleaned and lubricated once each year, and repacked or refilled as often as necessary to maintain proper buffing.

(c) On signal employing a toggle arrangement, the slot toggle adjustment shall not be changed from its original setting. If adjustment of toggle changes due to wear, toggle or slot arm shall be replaced.

(e) Tooth disc on motor armature or pawl in retaining mechanism which has become worn or burled shall be replaced.

79. (a) Action shall be taken when necessary to prevent phantom indications from reflected external sources.

(b) Deflecting prisms shall be assembled and maintained to spread the light in the proper direction.

(c) In light signals other than the search-light type, changes in the internal parts, including the lamp receptacle shall not be made from their original settings, except where provision has been made for focusing.

81. A maintainer of telegraph and signals being assigned a new section or additional territory, or temporarily relieving another

maintainer of telegraph and signals must make immediate study of highway crossing signal conditions.

82. Whenever severe electrical storms occur, an inspection of the highway crossing signals must be made by maintainer or other telegraph and signal employee, under the direction of the supervisor of telegraph and signals, or telegraph and signal foreman, as promptly as consistent, to check all apparatus and power supply.

83. When highway crossing signals fail to properly indicate approach of trains, manual crossing protection must be provided promptly and maintained until necessary repairs are made.

84. When there is an accident at a crossing protected by highway crossing signals, manual protection must be provided as soon as possible. The maintainer of telegraph and signals must make necessary observations and tests, without opening the instrument case, to determine if the signals are working properly, and report conditions to the supervisor of telegraph and signals. The maintainer of telegraph and signals should, if possible, obtain the name and address of the person or persons injured, and of as many witnesses as possible. He must also obtain the license number of the vehicle involved.

Switch Layouts

101. Employees must not unlock switches that will in any way affect trains closely approaching or passing. Non-interlocked switches in main tracks, or leading to main tracks, when not in use, must be locked in normal position.

102. When parts of switch layouts, which may affect the adjustment and facing point locking of the switch, are repaired or replaced, or when adjustments are made in connection therewith, bar or obstruction test, in accordance with C.E.-40, must be made before switch is restored to normal service.

104. When necessary to disconnect a switch, movable frog-point or derail (hereinafter called switch) from its operating mechanism, or to disconnect No. 1 switch rod, the following, in addition to providing complete protection for trains, must be done:

(a) The closed point must be held securely against the stock or knuckle rail, by a spike driven in each of the first two ties back of the point, and where possible the spikes must pass through the tie plates.

(b) A standard wooden wedge must be driven between the open point and the stock or knuckle rail and be secured by, (1) a lag screw or heavy nail through one of the clip bolt holes, or (2) a piece of wood spiked to the first and second ties ahead of the point, or (3) a light flat headed bolt through a hole in the wedge adjacent to the side of the first tie under the point and between this tie and No. 1 or head rod. The bolt must be secured in place by a cotter pin or split key below the bottom of wedge.

(c) If necessary to disconnect both No. 1 and No. 2 switch rods, train movements must not be made over the switch until one or both rods are properly connected to the switch points and the switch has been secured in accordance with 104 (a) and (b). If the open point is removed, trailing movement may be made after the closed point has been secured in accordance with 104(a). For facing movements end of lead rail must be moved away from the running rail to provide at least five inches clearance and be provided with a riser wedge fastened to the tie and movements restricted to slow speed.

(d) If necessary to disconnect the switch rods of a switch in an interlocking, or if switch is in automatic territory, or is connected with a distant switch signal or switch indicator, the work must be done in charge

of the track foreman in co-operation with the maintainer of telegraph and signals.

(e) If switch is in an interlocking, the following also must be done:

1. The locking dog or plunger must be inserted through lock rod if possible.

2. The controlling lever of an interlocking machine, or the lever in a centralized traffic control machine, must be placed in the position corresponding to that of the switch. Interlocking levers must be secured by lever blocking devices which must not be removed nor levers operated until instructions to do so are received from the one in charge.

Switches equipped with dual control mechanism are essentially hand operated after the selector lever is placed in the hand operating position, and Instructions 104(e) do not apply. Before the selector lever is placed in the hand operating position the hand operating lever and the switch must correspond in position.

3. The power for power-operated switches must be cut off.

4. At a pneumatic switch a blow-off cock or union must be opened to prevent possible accumulation of pressure through leaky valves.

5. At an electric switch the motor brushes must be removed and the brush holders so secured that they cannot come in contact with the commutator, or, in lieu thereof, the fuse must be removed from the circuit supplying power to the master controller.

6. Power-operated switches must be kept spiked and wedged until the power is again turned on so that an accidental change in the position of the valves or controlling apparatus or connections cannot cause the switch to go to the wrong position.

(f) When necessary to disconnect switch, derail, or other unit, it should be done at the crank nearest the unit.

105. When necessary to disconnect locks, detector bars, circuits, or other safeguards in an interlocking, except mechanical locking (See Instruction 52), all switches affected must be safely secured before any train or engine is permitted to pass over them, as follows:

(a) The closed point must be held against the stock or knuckle rail by a spike in the head tie, and where possible, the spike must pass through the tie plate.

(b) A standard wooden wedge must be driven between the open point and the stock or knuckle rail.

(c) Special Instructions 104(e) must be followed.

(d) The telegraph and signal foreman, maintainer of telegraph and signals, or other telegraph and signal department employee in charge will be held solely responsible for carrying out the above instructions.

(e) No movements are to be made over switches affected without the consent of the one in charge, and he must, upon completion of repairs, test levers by manipulation before surrendering jurisdiction over the machine.

106. Should any of the apparatus referred to in Instructions 104 and 105 fail to function properly, signalman shall restore any power operated switch lever, which after several trials, has failed to go to the desired position, as far as possible toward the original position where it shall remain until instructions are received from the maintainer of telegraph and signals. If no maintainer is available signalman shall notify the dispatcher and be governed by local divisional instructions. If, on electric switches, the ammeter indicates excessively heavy current, the lever shall be placed and left in the center position, except at electric interlockings where master controllers are used.

Unless the failure is very clearly of such a nature that repairs can be made by the maintainer in less time than necessary to

secure the switches in accordance with Instructions 105-(a), (b), and (c), the units involved must be secured in accordance with these instructions, except that where, due to excessive distance from the switch to the control point, it is impracticable to get the lever to correspond with the position of the switch, the lever must be put as far as possible toward the desired position and lever blocking devices applied.

After securing the switch, or switches, the routes affected must be patrolled through the group of switches adjacent thereto to ascertain that the route is properly set, each switch is secured and in safe condition for train movement and that there are no conflicting routes.

107. When, due to failure, switches have been secured, movements over routes must be made at slow speed (until leading maintainer or higher authority has investigated conditions and authorized normal speed) as follows:

(a) Where mechanically operated signals are in service—by clearance card.

(b) Where power operated signals are in service—by a signal not more favorable than Caution-slow-speed (Rule 278), which will necessitate opening the control of the track indicating relay where high or restricted speed routes are involved.

108. If necessary to disconnect a locking switch stand, switch circuit controller, combined plunger lock and circuit controller, or similar apparatus, from a non-interlocked switch, unless the switch is wedged and spiked in its normal position in accordance with Paragraph 104(a) and (b), or when such switches are open for inspection, adjustment or repair of such apparatus or of pipe-connected derrails, the following precautions must be taken:

(a) Control circuits or connections for signals involved must be so arranged that signals will display their most restrictive indications.

(b) Where telephone is available, arrange with signalman to protect against train movements in both directions; where telephone is not available provide flag protection in both directions.

109. Electric locks on Type "G" and hand-operated switch mechanisms must be regularly inspected to insure that all parts are intact and that working parts move freely.

110. Electric switch locks having indication circuits must be carefully inspected for missing or worn parts, which might render the lock-out feature inoperative; and the indication circuits must be tested in accordance with instructions for testing signal lock circuits insofar as these instructions apply.

113. Where it is required that switches or derrails be mechanically locked in one position only, the lock rod must be arranged with one locking opening.

118. When necessary to repair switch and signal valves and cylinders, they shall be removed from service and the work performed in a shop.

119. (a) Overload relay and magnet brake on electric switch and lock movement shall be checked frequently enough to insure proper operation.

(b) Pole changer on electric switch operating mechanism shall be maintained to insure that switch mechanism follows movement of lever.

(Instructions in C.S.E.23-C on batteries omitted here—Ed.)

Mechanical Pipe and Wire Lines

141. Pipe casing through which wires and pipes are run must be free from water and kept filled with non-freezing oil. Stuffing boxes must be properly adjusted.

144. Cranks, compensators, and other mechanical connections shall work freely, but

shall not have excessive lost motion in moving parts. They shall be kept clean, properly centered, lubricated and in alignment.

Track Circuits

151. Where track circuits are in use, the rails, rail fastenings, switch rods and connections must be kept clear of ballast and cinders.

152. When the head of the rail in track circuit territory is covered with rust, sand, coal, or any other material which may interfere with the proper shunting of the track circuit, and which cannot be immediately cleared, the maintainer of telegraph and signals must notify the signalman, in writing, that such track circuits cannot be depended upon for the locking of specified switches, and that lever lights on levers involved must not be accepted as indicating that these track sections are clear.

Such levers must be secured by lever blocking devices in normal or reverse positions at all times, except during lever operation, and a "Rusty Rail" sign must be attached. Blocking devices must not be removed nor levers operated until it is known that train or engine movements are clear of the switches.

153. When rails, switch points, or frogs are removed, the signal forces must secure the signals governing over them, so that they will display their most restrictive indications, and flag protection must be provided. Except for minor replacements (one or two rails, frogs or switch point) the regular working order must not be restored until it is known that the track is safe and that rust does not prevent shunting of track circuits. This requirement will be met if the maintainer of telegraph and signals, after track is ready for service and after assuring himself that block is clear, connects up the track relay and carefully observes its performance on the passage of trains and when trains are running through the block. The control wire for the relay should be held on the relay binding post so that circuit can be quickly opened on the passage of train should rust prevent the relay from operating properly. The relay must be observed a sufficient number of times to positively insure that it opens properly and remains open while the train is passing through the block.

154. Insulating rail joints must be kept clean and free from steel dust, and such tests made as may be specified to determine failure of insulation.

156. In electric traction territory the paths for the return of traction current must be opened only as authorized by proper authority. All paths must never be opened at the same time. When making renewals or repairs a return circuit for traction current must always be maintained.

157. Signal rail bonds removed from service on account of rail renewals and those removed on account of breakage, must be collected promptly, tied together in small bundles and disposed of as scrap.

158. When cars are stored on a track protected by automatic block signals, the signalman handling the movement must notify the maintainer of telegraph and signals, advising him of the limits of track on which traffic will be suspended as a result of the stored cars. The maintainer of telegraph and signals must disconnect the track relays and track feeds within these limits as promptly as possible and also the control circuits of all high and restricted speed signals within the limits specified. In cab signal territory he must also disconnect the code transmitter control wire from the code control relay for each track circuit occupied.

When the cars have been removed, the maintainer of telegraph and signals must assure himself that the relays shunt properly and that the signals function as desired, before restoring normal operation.

159. When cars are stored within the limits of an interlocking, the signalman must, with the blocking devices, secure the levers controlling the track units and signals affected, in their proper position, and also the levers of such other units as may be necessary to insure that a signal cannot be given leading to the track or tracks involved. The maintainer of telegraph and signals must be notified as promptly as possible and he must disconnect the track relays and feed wires to the track circuits, if used, and also the control wires to all high and restricted speed signals governing to such tracks.

When cars are being removed from the plant the signalman must arrange for sufficient movement over the bonded section to insure proper shunting of the circuits. After the maintainer of telegraph and signals has assured himself, by careful inspection, that normal conditions have been restored, he must so notify the signalman, who may then remove the blocking devices and make such reports as are required.

160. When stored cars will affect the circuits of highway crossing protection, approach locking, annunciators, etc., the maintainer of telegraph and signals must take all necessary precautions to safeguard the highway crossings affected and to insure safe operation. When cars are removed, the maintainer of telegraph and signals must restore normal working conditions as promptly as possible, after assuring himself that all the apparatus affected functions properly.

161. When stored cars are being removed from a storage track and the switch at the exit end of this track is interlocked or located near an interlocking, the levers in the route involved must be secured by blocking devices until movement is completed, to avoid improper operation due to false track circuit indication resulting from rusty wheels.

162. Fouling circuit on switch shall be inspected frequently and tested quarterly where visible, and monthly where not visible, to insure that fouling wires are intact and that fouling circuit shunts properly.

163. (a) Bonding shall be maintained and in condition to insure low resistance.

164. Track circuits shall, so far as possible, be so installed and maintained that the track relay will be in de-energized position whenever any of the following conditions exist, and the track circuit of an automatic train stop, train control or cab signal system will be de-energized in the rear of the point where any of the following conditions exist:

(a) A rail is broken or a rail or frog is removed.

(b) A train, engine, or car occupies any part of a track section including fouling section of turnout or crossover.

(c) Where switch shunting circuit is used—

1. A switch is misplaced or its points not in proper position.

2. A switch is not properly locked where facing point lock with circuit controller is used.

3. An independently operated fouling point derail equipped with switch circuit controller is misplaced or not in derailing position.

165. (a) Where relayed cut-section is used, the track relay at cut-section shall, when in de-energized position, open the track energy supply for the adjacent track circuit, and in noncoded direct current territory shunt the adjacent track circuit.

(b) At grade crossing with an electric railroad where tests indicate presence of foreign current, the electric energy for noncoded direct current track circuit shall be connected to feed away from the crossing.

Circuit Changes and Tests Incident Thereto

166. Alterations must not be made to any apparatus or circuits without proper authority. Revised plans must be procured from the

superintendent of telegraph and signals.

167. All changes must be made under direct supervision of a designated competent employee, who is personally responsible for work under paragraphs 168, 170 and 171, and must know that the employees making wire changes and connections are thoroughly qualified for and have full understanding of the work assigned them.

The man in charge must be responsible for the necessary local wiring diagrams, on which must be clearly indicated the apparatus wiring, etc., that is in service and that which is to be added. Points at which new circuits tie in with those in service must be plainly marked.

168. Any necessary relocation of apparatus and wiring in service, either permanent or temporary, must be made under the personal direction of the one in charge, and all circuits interfered with in any way must be thoroughly tested immediately after relocation and before circuits are allowed to function for normal operation.

169. New apparatus must be located and new wiring placed and connected to the new apparatus, without disturbing work in service where possible.

170. New wiring through apparatus in service or tying to wiring in service must be handled under the personal direction of the man in charge. All wiring tied in to existing apparatus and circuits must be tested before tying in, to insure no interference with work in service.

171. Before final cut-over, all circuits must be thoroughly tested as far as possible, and final arrangement must be tested in entirety before being allowed to function for normal operation. This work must be handled under the personal direction of man in charge.

172. The man in charge must make necessary notations on wiring diagram to show any new wiring which is connected to working circuits or apparatus, and must clearly mark on his diagrams connections required for final arrangement which cannot be made prior to cut-over without interfering with work in service. Wires which are to be connected at cut-over must be marked with yellow tags. Wires which are to be removed at cut-over must be marked with red tags. Wires which, for any particular reason, cannot be hooked up without special arrangement, must be marked with green tags. Wires bearing green tags must be connected only by the man in charge or under his specific instructions which shall definitely state that "green tag wires" are to be connected. On completion of changes, all colored tags must be removed.

173. When a revision involves additional levers in a machine, such levers must be secured against improper or unintentional operation.

174. The men engaged in making or testing circuit changes must have full understanding with signalman as to any interference with working units, must obtain permission for necessary use of switches or signals, and must secure switches in accordance with Paragraph 105.

The man in charge of changes must cooperate with maintainer of telegraph and signals so that the latter may be posted at all times as to the condition of the plant.

All work done in connection with making or testing signal and circuit changes must be in accordance with the other provisions of C.S.E.-23 insofar as they apply.

175. To provide a check against misunderstanding when the man in charge directs another to make or break wire connections to wiring or apparatus in service, he must state specifically what is required, using wire number or other definite description, and, when possible, must indicate on the circuit plan or the wiring diagram the connection that is to be made or broken. If the open circuit is protected by a green tag, the one in charge must so state. The one who is to carry out the instruction must repeat the order exactly as

received, must not attach wires protected by green tag unless specifically directed, and after carrying out the order must advise in detail, using wire numbers, etc.

176. When circuits are to be closed only for test, the one assigned to this work should preferably remain at that point until the test is completed and then again open the circuit, reporting to the one in charge the exact conditions. The one in charge must, at the earliest opportunity, and before leaving the work, verify the conditions as reported.

177. All changes in interlocking and signal circuits must be given a detail check and all except very minor changes must be given a detail check by a supervisory employee, other than the employee in charge.

Insulated Wires and Cables

190. In order to avoid the possibility of damage to insulation, wires must not be crowded or jammed.

191. The insulation of wire must not be punctured for testing purposes.

192. Wire connections must be kept tight and clean, and wires properly marked, in accordance with authorized practice. Wires must be so arranged that they cannot foul moving parts.

193. Wires and cables, without metal sheath, in trunking and other open conduits, must be examined to detect physical damage, semi-annually in territory where trouble due to rats and mice has been experienced, and annually at other points.

194. Braided aerial cables and messengers must be painted not less frequently than once every five years.

Relays, Indicators and Circuit Controllers

201. The inverting of relays or otherwise tilting them in order to close the contacts, or holding or fastening the contacts of indicators closed, is prohibited.

202. The bridging of contacts on relays, indicators, or any circuit controlling device, or energizing relays or indicators direct from any source, which will in any way impair the protection of such circuit controlling device, must be done in accordance with the following instructions.

(a) The use of jumpers for the bridging of contacts is restricted to cases of absolute necessity, as when a switch and signal wire or apparatus is damaged, resulting from a wreck, dragging equipment, or similar occurrence; when a-c. signal power line trouble occurs; when signal power line is being tested; when necessary in connection with tests specified in C.E.-227, and when renewal of track structure cannot be taken care of otherwise, and then only to avoid unnecessary delay to trains. Generally, jumpers must not be used in connection with ordinary maintenance.

(b) When a condition, such as outlined, arises, making it necessary to use jumpers, the supervisors and assistant supervisors of telegraph and signals and the telegraph and signal foremen, in the territory mentioned below, are permitted to authorize the use of jumpers after receiving authority from the superintendent. (Certain interlockings in terminal areas in C.S.E.23-C omitted here—Ed.)

(c) When a condition arises in territory other than that designated necessitating the use of jumpers, their use must be authorized by the supervisor or assistant supervisor of telegraph and signals, after receiving authority from the superintendent.

(d) Before jumpers are applied to bridge any contacts, or to energize a relay or indicator by power direct from any source, either within or outside of interlocking limits, the telegraph and signal employee authorizing the placing of the jumpers must obtain the approval of the superintendent. Whenever authority is given by the superintendent

for the application of jumpers, the train dispatcher or train director must make notation on the train sheet and the signalman on the block sheet, and a blocking device placed on each interlocking switch and signal lever affected. Before jumpers are placed in territory outside of interlocking limits, the signalman on each side of the location affected by the use of jumpers must, in addition to the train dispatcher or train director, have full knowledge that jumpers are to be applied and notations on the block sheet of their application must be made. When jumpers are used, either within or outside of interlocking limits, the signalman must make a message memorandum of the condition, explaining it to the leverman, and post the memorandum in a conspicuous place. If going off duty while the abnormal condition exists, he must bring it to the attention of the signalman and leverman who relieve him, fully explaining the condition to them. The memorandum sheet must not be filed until the telegraph and signal employee authorizing the use of jumpers has reported that normal conditions have been restored.

(c) When a telegraph and signal employee is instructed to place jumpers, he must remove jumpers immediately after the emergency no longer exists, and then he must report to the party giving the authority for the application of the jumpers that they have been removed, advising that normal conditions have been restored. The employee securing authority from the superintendent for the application of jumpers must advise the train dispatcher or train director, and any other interested employee, that the jumpers have been removed and the switch and signal circuits restored to normal condition. Notation must be made by the train dispatcher or train director on the train sheet, and by the signalman on the block sheet, of the removal of the jumpers.

(f) The telegraph and signal employee securing authority for the use of jumpers must make sure that they are not used for a longer period than necessary. The telegraph and signal employee instructed to apply the jumpers will be held personally responsible for their removal and must know that the switch and signal circuits have been restored to normal condition.

203. When applying jumpers for testing power line in a-c. automatic signal territory two (2) or more qualified employees must co-operate in their application and all must know that they have been removed.

204. Jumpers must be not less than eight (8) feet in length, of flexible wire not smaller than No. 16 A.W.G. and must not be coiled when applied. When not in use, they must be kept in a designated place and a check made to insure their having been returned each time they have been used.

205. The greatest possible care must be used in applying a jumper to keep to a minimum the amount of protection cut out by its use.

NOTE: The intention of these instructions is two-fold: first, to guard against improper use of jumpers; second, to insure their removal, even though precautions have been taken to render conditions entirely safe during their use. These instructions, therefore, apply regardless of whatever else may be done; such as disconnecting circuits, setting signals at "Stop," securing switches and levers, or other precautionary measures.

206. The insertion of insulating material between the contacts of circuit controllers to prevent shunting of track circuit, or the insertion of similar material in other contacts, which would in any way impair any protective feature of any circuit, is prohibited.

207. The seals on relays and other similar apparatus must in no case be broken except by an authorized person. Relays removed from service, due to defect, must have a tag attached, stating defect, if known, and marked "not fit for service." They must not be used

again until a tag is attached by testman, stating "O.K. for Service."

208. Contact openings must be observed frequently and, if found more or less than normal, or otherwise defective, prompt replacement must be made.

209. "SS" relays and indicators must be observed as prescribed by current issue of C.E.-227, to determine if they are operating properly and promptly while the switch levers are being moved.

210. The following relays must operate as indicated for the normal position—where signals are controlled, the normal position must control the "clear" position of the signal.

(a) Model 15 Vane Relay—Vane must be up.

(b) Style TV-30 relays—Vane must rotate counter-clockwise.

(c) Radial Polyphase relay—Porcelain contact block must rotate counter-clockwise.

(d) D-C. Polar Relay:—

1. With polar armature operating in a horizontal plane—contacts must rotate counter-clockwise, viewed from above.

2. With polar armature operating in a vertical plane—contacts must rotate clockwise, viewed from the front.

211. The rotor and stator of radial polyphase relays must be examined frequently to note that there is sufficient clearance when relay is de-energized and in both energized positions; also note that the tape on the field coils and magnets is not loose and liable to foul moving parts, and that no cracks have developed in the frames.

213. All circuit controllers must be kept clean and properly adjusted, and the original sets or bends of contact springs must, as far as possible, be maintained, and any excessive setting or bending which may produce an unsafe condition is prohibited.

214. When work is being done on polarized circuits, on relays or circuit controllers, only one wire must be off the binding posts at a time, or wires and posts must be clearly marked to avoid any possibility of reversing the circuit.

After wires are restored, circuit must be checked immediately to see that all apparatus involved is working properly and that proper polarity of circuits has been retained.

Tests

251. Periodical tests of signaling and interlocking devices must be made regularly. The frequency of tests specified in current issue of form C.E.-227 represents the maximum interval between tests. Local conditions may make more frequent tests advisable, in which case supplementary instructions will be issued by the superintendent of telegraph and signals.

252. Other tests that may be designated from time to time must be made in accordance with instructions that will be issued in connection therewith.

253. When making electrical tests of switch and signal circuits, the proper meters must be used, and it must be known that no unsafe conditions are set up by the application of such testing apparatus.

When using switch or signal circuits for temporary telephone, it must be known that the use of the telephones will not, in any way, affect the circuits.

Footnote

From and after the first day of September 1939, section 36 will become effective with respect to installations subsequently made; in order to bring existing installations into conformity with the requirements of the foregoing listed section, a period of two years will be allowed unless further extension of time is granted by the Interstate Commerce Commission with respect to this section upon application by individual carrier or carriers.