

W1.35: 55-275

My 44

TM 55-275

WAR DEPARTMENT TECHNICAL MANUAL

MAINTENANCE OF WAY RULES

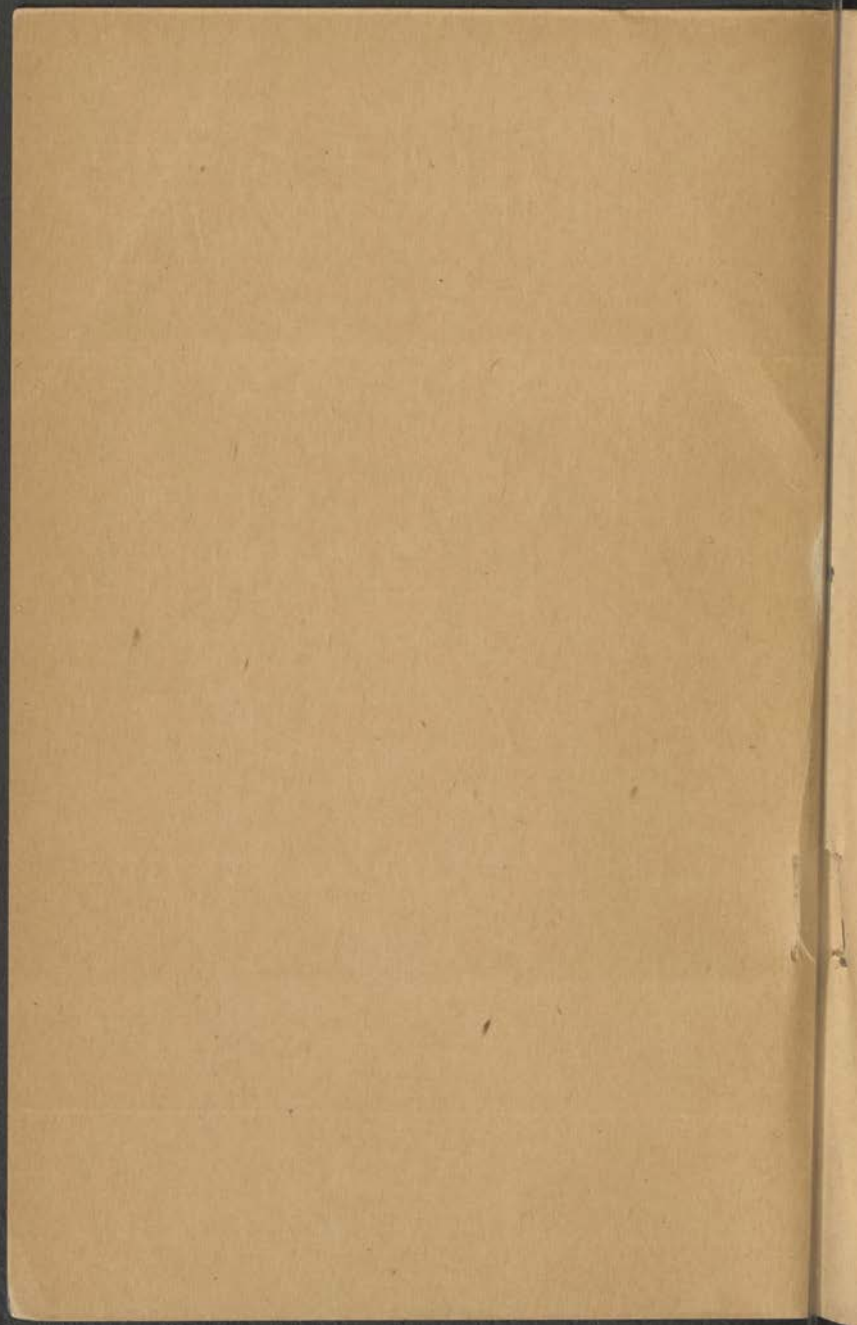
MILITARY RAILWAY SERVICE

U. S. DEPT.
OF THE ARMY
LIBRARIES

OCT 05 2007

GIFT

WAR DEPARTMENT • 4 FEBRUARY 1944



WAR DEPARTMENT TECHNICAL MANUAL

TM 55-275

MAINTENANCE
OF WAY RULES
MILITARY RAILWAY SERVICE



WAR DEPARTMENT • 4 FEBRUARY 1944

United States Government Printing Office
Washington. 1944

WAR DEPARTMENT,
WASHINGTON 25, D. C., 4 February 1944.

TM 55-275, Maintenance of Way Rules, Military Railway Service, is published for the information and guidance of all concerned.

[A. G. 300.7 (11 Jun 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
*Major General,
The Adjutant General.*

DISTRIBUTION:

ID 55 (15); IBn 55 (75); IC 55 (15); X.

(For explanation of symbols see FM 21-6.)

CONTENTS

	<i>Rule</i>	<i>Page</i>
General Notice		1
General Rules	A-N	2
Definitions		4
Operating Rules	1-108	8
General Instructions	109-139	36
Flagging	140-156	41
Work Equipment	157-167	45
Welding	168-171	48
Track Cars	172-221	50
Inspections	222-225	58
Tools and Material	226-234	59
Roadbed and Drainage	235-248	61
Ballast	249-253	64
Rail	254-265	65
Ties	266-282	68
Spiking	283-288	71
Tie Plates	289-290	72
Joints	291	73
Turnouts	292-305	74
Lining and Surfacing	306-313	77
Railroad Crossings	314-315	79
Bridges and Culverts	316-319	80
Signals, Telephone and Telegraph ..	320-326	81
General Rules for Supervisory Officers and Foremen	327-330	87
Duties of Personnel		
Engineer, maintenance of way ..	331	88

	<i>Rule</i>	<i>Page</i>
Assistant engineer, maintenance of way	332	88
Supervisor of bridges and build- ings	333	88
Track supervisor	334	89
Signal and communication engi- neer	335	89
Assistant to supervisor of bridges and buildings	336	90
Water service foreman.....	337	90
Bridge inspector	338	91
Bridge and building foreman...	339	91
Assistant track supervisor	340	92
Track maintenance sergeant....	341	92
Section foreman	342	92
Assistant signal and communi- cation supervisor.....	343	92
Signal telephone and telegraph maintainers	344	93
Water service mechanics.....	345	94
Block Signals and Interlocking.....		95
Tables, Diagrams and Miscellaneous Information		97

GENERAL NOTICE

The mission of the Military Railway Service is to provide prompt and dependable transportation by rail of troops and supplies required by the military forces in the execution of the tactical mission assigned to the combat forces.

All personnel in the Military Railway Service will exert every effort to insure the prompt movement of all trains at all times.

The rules and regulations herein set forth govern the railways operated by the Military Railway Service.

Special instructions may be issued by proper authority.

The word "railway" as used in these rules is intended to cover any railroad or railway company being operated as a part of the Military Railway Service, as well as new railway construction built for operation by the Military Railway Service.

Maintenance standards will be such as opportunity permits, and arbitrary safety rules become secondary to military necessity and the mission. Facilities for maintenance of equipment near the front are limited. Shops are established well in the rear to minimize enemy interference. Rapid repair or replacement of parts or units must be the rule to which momentary considerations should be subordinated.

In general, methods and practices of construction and maintenance will follow those outlined in FM 5-10. Special rules and instructions will be issued covering conditions and requirements of railroads being operated in combat areas and under blackout regulations.

GENERAL RULES

A. All personnel whose duties are prescribed by these rules and regulations will provide themselves with a copy.

All personnel whose duties are in any way affected by the timetable will have a copy of the current timetable with them while on duty.

B. All personnel must be conversant with and obey the rules and special instructions. If in doubt as to their meaning, they will apply to proper authority for an explanation.

C. All personnel must pass the required examinations.

D. Personnel employed in any service pertaining to maintenance of way are subject to the rules and special instructions.

E. All personnel will render every assistance in their power in carrying out the rules and special instructions and must report to the proper official any violations thereof.

F. Any condition which may adversely affect the movement of trains or engines will be promptly reported by the quickest available means to the proper official.

G. The use of intoxicants while on duty is prohibited. Personnel reporting for duty under the influence of intoxicants will be subject to disciplinary action.

H. Division superintendents will issue orders relating to smoking by personnel on duty at passenger stations or on passenger trains. Such orders shall conform at all times to restrictions regarding smoking as issued by higher military authorities.

J. Such identification badges as may be prescribed for the Military Railway Service will be worn by personnel in this service.

L. Military railway property and equipment will be protected by personnel of the Military Railway Service and such other troops as may be designated.

M. All personnel will be on the alert at all times to detect defective or unserviceable track or equipment. If facilities for making necessary repairs are not immediately available, necessary protection will be afforded, and prompt report made to the division superintendent or his assistant.

Personnel must inform themselves as to the location of structures or obstructions where clearances are close.

Personnel must expect trains to run at any time, on any track, in either direction.

Personnel must not stand on the track in front of an approaching engine or car for the purpose of boarding same.

N. Should trains be delayed by accident or other causes, all available personnel will unite in rendering prompt assistance as necessary to restore traffic.

DEFINITIONS

Military railway. All railroads, standard gauge or otherwise, which are constructed, maintained, or operated for the use of the Army, whether by military personnel or by civilian personnel under military direction.

Regulating station. A railway yard in the theater of operations through which military railway traffic moves under the control of a regulating officer.

Railhead. A point on, or at the forward end of, a military railway, at which troops and supplies are discharged for distribution by means of other transportation agencies.

Theater of war. Those areas of land, sea, and air which are, or may become, directly involved in the conduct of war.

Theater of operations. An area of the theater of war necessary for military operations and the administration and supply incident to military operations. The War Department designates one or more theaters of operations.

Combat zone. That part of a theater of operations required for the active operations of the combatant forces. It is divided into army, corps, and division areas, each comprising the zone of operations of the unit to which it pertains.

Communications zone. That part of a theater of operations, contiguous to the combat zone, which contains the lines of communication, establishments for supply and evacuation, and other agencies required for the immediate support and maintenance of the field forces in the theater of operations.

Zone of the interior. The area of the national territory exclusive of areas included in the theater of operations.

Engine. A unit propelled by any form of energy and used in train or yard service.

Train. An engine, or more than one engine, coupled, with or without cars, displaying markers.

Regular train. A train authorized by a timetable schedule.

Section. One of two or more trains running on the same schedule displaying signals or for which signals are displayed.

Extra train. A train not authorized by a timetable schedule. It may be designated as—

a. Extra. For any extra train, except passenger extra or work extra.

b. Passenger extra. For passenger train extra.

c. Work extra. For work train extra.

Superior train. A train having precedence over another train.

Train of superior right. A train given precedence by train order.

Train of superior class. A train given precedence by timetable.

Train of superior direction. A train given precedence in the direction specified by timetable as between opposing trains of the same class.

Timetables. The authority for the movement of regular trains subject to the rules. It contains the classified schedules of trains with special instructions relating thereto.

Schedule. That part of a timetable which prescribes class, direction, number, and movement for regular train.

Division. That portion of a railroad assigned to the supervision of a superintendent.

Subdivision. A portion of a division designated by timetable.

Main track. A track extending through yards and between stations, upon which trains are operated by timetable or train order, or both, or the use of which is governed by block signals.

Single track. A main track upon which trains are operated in both directions.

Two or more tracks. Two or more main tracks, upon any of which the current of traffic may be in either specified direction.

Current of traffic. The movement of trains on a main track, in one direction, specified by the rules.

Station. A place designated on the timetable by name.

Siding. A track auxiliary to the main track for meeting or passing trains.

Fixed signal. A signal of fixed location indicating a condition affecting the movement of a train.

NOTE. The definition of a "fixed signal" covers such signals as slow boards, stop boards, yard limits, switch, train order, block, interlocking, semaphore, disk, ball, or other means for displaying indications that govern the movement of a train.

Yard. A system of tracks within defined limits provided for the making up of trains, storing of cars and other purposes, over which movements not authorized by timetable, or by train order, may be made, subject to prescribed signals and rules, or special instructions.

Yard engine. An engine assigned to yard service and working within yard limits.

Pilot. Personnel assigned to a train when the engine-man or conductor, or both, are not fully acquainted with the physical characteristics or rules of the railroad, or portion of the railroad, over which the train is to be moved.

Train register. A book or form which may be used at designated stations for registering signals displayed, the time of arrival and departure of trains, and such other information as may be prescribed.

Reduced speed. Proceed prepared to stop short of train or obstruction.

Yard speed. A speed that will permit stopping within one-half the range of vision.

OPERATING RULES

STANDARD TIME

1. Standard Time obtained from GHQ will be transmitted to all points from designated offices at 12 o'clock noon, daily, or at such other time as may be prescribed by the Manager, Military Railway Service.

2. Watches issued by the Military Railway Service must be used by the following:

- Engineer maintenance of way
- Assistant engineer maintenance of way
- Track supervisor
- Supervisor of bridges and buildings
- Signals and communications engineer
- Assistant track supervisor
- Assistant to the supervisor of bridges and buildings
- Assistant signals and communications supervisor
- Water service foreman
- Bridge inspector
- Bridge and building foreman
- Track maintenance sergeant
- Section foreman
- Track car operators
- Work equipment operators

In addition to the monthly inspection, all officers and personnel designated as required to carry certified watches must submit watches for weekly comparison and sign record thereof on form prescribed therefor.

3. Where standard clocks are available, watches of train dispatchers, conductors, enginemen, hostlers and engine foremen must be compared with a standard clock before commencing each day's work or trip. The time when watches are compared must be registered on a prescribed form.

In the event of failure of communication by telegraph, telephone, or radio with GHQ, it may be necessary to transmit time by courier, and in the event of such failure, effort should be made to secure standard time from any source possible.

Conductors, or engine foremen, and enginemen will also compare time with each other and with trainmen, yardmen, or firemen before commencing each day's work or trip.

TIMETABLES

4. Each timetable, from the moment it takes effect, supersedes the preceding timetable, and its schedules take effect on any division or subdivision, at the leaving time at their initial stations on such division or subdivision. But when a schedule of the preceding timetable corresponds in number, class, day of leaving, direction, and initial and terminal stations with a schedule of the new timetable, a train authorized by the preceding timetable will retain its train orders and assume the schedule of the corresponding number of the new timetable.

Schedules on each division or subdivision date from their initial stations on such division or subdivision.

Not more than one schedule of the same number and day will be in effect on any division or subdivision.

5. Not more than two times are given for a train at any station; where one is given, it is, unless otherwise indicated, the leaving time; where two, they are the arriving and the leaving time.

The time applies at the switch where an opposing train clears; where there is no switch, it applies at the station.

Schedule meeting or passing stations are indicated by figures in full-faced type.

Both the arriving and leaving time of a train are in full-faced type when both are meeting or passing times or when one or more trains are to meet or pass it between those times.

Where there are one or more trains to meet or pass a train at any station, attention is called to it by the numbers of the trains to be met or passed in small figures adjoining.

6. The following letters when placed before the figures of the schedule indicate—

L—leave.

A—arrive.

S—regular stop.

F—flag stop to receive or discharge traffic.

SIGNALS

7. All personnel whose duties may require them to give signals, will provide themselves with the proper appliances, and keep them in good order and ready for immediate use. Those giving signals must locate themselves

so as to be plainly seen and give them so as to be plainly understood.

8. Flags of the prescribed color must be used by day and lights of the prescribed color by night. The use of lights as signals of any kind during blackouts or other special situations will be subject to such special instructions as may be issued at the time by proper authority.

9. Day signals must be displayed from sunrise to sunset, but when day signals cannot be plainly seen, night signals must be used in addition. Night signals must be displayed from sunset to sunrise.

10. Color signals.

Color	Indication
(a) Red.....	Stop.
(b) Yellow.....	Proceed at reduced speed, and for other uses prescribed by the rules
(c) Green.....	Proceed, and for other uses prescribed by the rules.
(d) Green and white...	Flag stop. See Rule 28.
(e) Blue.....	See Rule 26.
(f) Purple.....	Stop. (Indication for dwarf signals.)

11. A fusee burning red or blue on or near the track of an approaching train must be extinguished. The train may then proceed at reduced speed.

12. Hand, flag, and lamp signals.

NOTE. The hand, or a flag, moved the same as the lamp, as illustrated in the following diagrams, gives the same indication, except in the observance of Rule 12 (a) the hand or flag movement may be above the shoulder.

a. Stop.—Swung across the track.



b. Reduce speed.—Held horizontally at arm's length.



c. Proceed.—Raised and lowered vertically.



d. Back.—Swung vertically in a circle at half arm's length across the track.



g. Release.
Held a
above t
standing

e. Train has parted.—
Swing vertically in a circle at arm's length across the track when train is running.



f. Apply air brakes.—
Swung horizontally above the head when standing.



g. Release air brakes.—
Held at arm's length above the head when standing.



h. Any object waved violently by anyone on or near the track is a signal to stop.

14. Engine whistle signals.

NOTE. The signals prescribed are illustrated by "o" for short sounds; "-" for longer sounds. The sound of the whistle should be distinct, with intensity and duration proportionate to the distance signal is to be conveyed. The use of the whistle may be restricted or prohibited by special instructions.

Sound	Indication
(a) o	Apply brakes. Stop.
(b) - -	Release brakes. Proceed.
(c) - o o o	Flagman protect rear of train.
(d) - - - -	Flagman may return from west or south.*
(e) - - - - -	Flagman may return from east or north.*
(g) o o	Answer to 14 (k) or any signal not otherwise provided for.
(h) o o o	When standing, back. Answer to 12 (d) and 16 (c). When running, answer to 16 (d).
(j) o o o o	Call for signals.
(k) - o o	(Single track) To call attention of engine and train crews of trains of the same class, inferior trains and yard engines and of trains at train order meeting points, to signals displayed for a following section. If not answered by a train, the train displaying signals must stop and ascertain the cause.
	(Two or more tracks) To call attention of engine and train crews of trains of the same class and to inferior trains moving in the same direction and to yard engines, to signals displayed for a following section.
(l) - - o -	Approaching highway crossings at grade. To be prolonged or repeated until crossing is reached.
(m) - - - - -	Approaching stations, junctions, railroad crossings at grade and drawbridges, as may be required.

* As prescribed

15. The exp
at reduced sp
dicate the sa

Torpedoes
crossings.

Sound	Indication
(n) - - o	Approaching meeting or waiting points. See Rule S-90.
(o) O -	Inspect train line for leak or for brakes sticking.
(p) Succession of short sounds.	Alarm for persons or livestock on the track.
(q) - o	When running against the current of traffic: (1) Approaching stations, curves, or other points where view may be obscured. (2) Approaching passenger or freight trains and when passing freight trains. (3) Preceding the signals prescribed by (d), (e), (r), (s), (t), (u), (v), and (w).

For additional tracks the following signals may be used:

(r) - - - - o	Flagman may return from east or north on _____ track.*
(s) - - - - o	Flagman may return from west or south on _____ track.*
(t) - - - - o o	Flagman may return from east or north on _____ track.*
(u) - - - - o o	Flagman may return from west or south on _____ track.*
(v) - - - - o o o	Flagman may return from east or north on _____ track.*
(w) - - - - o o o	Flagman may return from west or south on _____ track.*

* As prescribed by Rule 99.

15. The explosion of two torpedoes is a signal to proceed at reduced speed. The explosion of one torpedo will indicate the same as two, but the use of two is required.

Torpedoes must not be placed at stations or on public crossings.

16. Communicating signals.

NOTE. The signals prescribed are illustrated by "o" for short sounds; "-" for longer sounds.

Sound	Indication
(a) o o	When standing — start.
(b) o o	When running — stop at once.
(c) o o o	When standing — back.
(d) o o o	When running — stop at next passenger station.
(e) o o o o	When standing — apply or release air brakes.
(f) o o o o	When running — reduce speed.
(g) o o o o o	When standing — recall flagman.
(h) o o o o o	When running — increase speed.
(j) o o o o o o	When running — increase train heat.
(k) o — o	Shut off train heat.
(l) — — — — —	When running — brakes sticking; look back for hand signals.

17. The headlight will be displayed to the front of every train by night. It will be concealed or extinguished when a train turns out to meet another and has stopped clear of main track.

It will be dimmed—

a. While passing through yards where yard engines are employed.

b. Approaching stations at which stops are to be made or where trains are receiving or discharging passengers.

c. Approaching train order signals, junctions, terminals, meeting points, or while standing on main track.

d. On two or more tracks when approaching train in the opposite direction.

When an engine is running backward a white light must be displayed by night on the rear of the tender.



FIGURE 1.
*Running backward by night, without cars
or at the front of a train pulling cars.*

White light at A.

18. Yard engines will display the headlight to the front and rear by night. When not provided with a headlight at the rear, a white light will be displayed.

19. The following signals will be displayed to the rear of every train, as markers, to indicate the rear of the train:

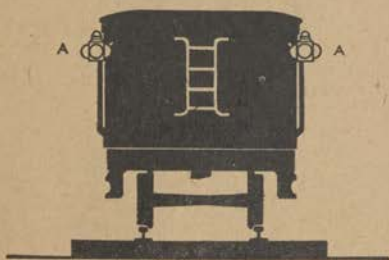


FIGURE 2.
*Running forward by day, without cars or
at the rear of a train pushing cars.*

Marker lamps not lighted, or yellow (or green)
flags at A A as markers.

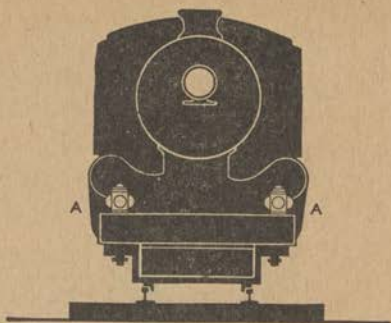


FIGURE 3.

*Running backward by day, without cars
or at the rear of a train pushing cars.*

Marker lamps not lighted, or yellow (or green)
flags at A A as markers.

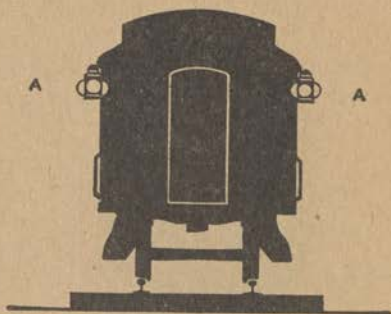


FIGURE 4.

Rear of train by day.

Marker lamps not lighted, or yellow (or green)
flags at A A as markers.

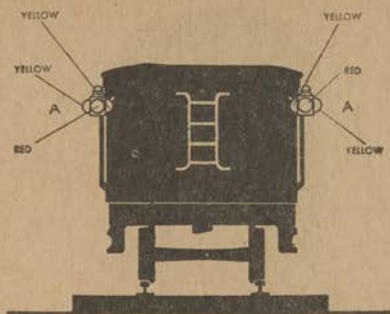


FIGURE 5.

Running forward by night, without cars or at the rear of a train pushing cars on single track, with the current of traffic on two tracks and with the current of traffic on passenger tracks where there are three or more tracks.

Lights at A A as markers, showing yellow (or green) to the front and side and red to the rear.

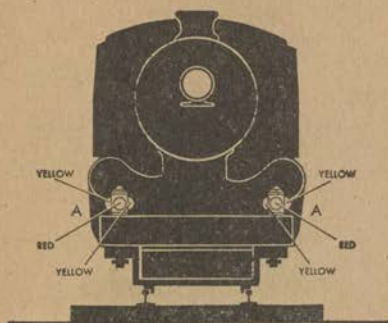


FIGURE 6.

Running backward by night, without cars, or at the rear of a train pushing cars on single track, with the current of traffic on two tracks and with the current of traffic on passenger tracks where there are three or more tracks.

Lights at A A as markers, showing yellow (or green) to side and in direction engine is moving and red in opposite direction.

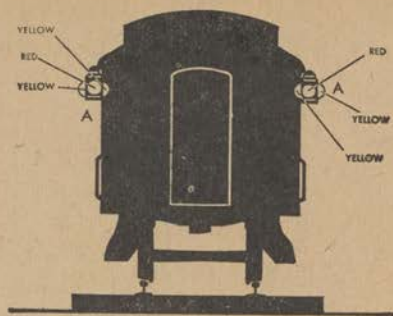


FIGURE 7.

Rear of train by night while running on single track, with the current of traffic on two tracks and with the current of traffic on passenger tracks where there are three or more tracks.

Lights at A A as markers, showing yellow (or green) to the front and side and red to the rear.

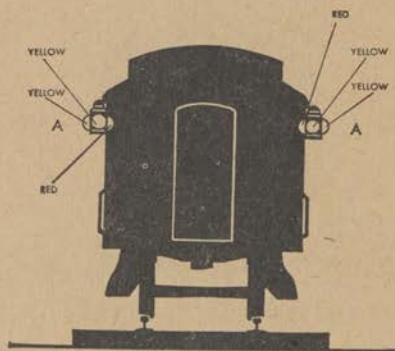


FIGURE 8.

Rear of train by night when clear of main track.

Lights at A A as markers, showing yellow (or green) to the front, side and to rear.

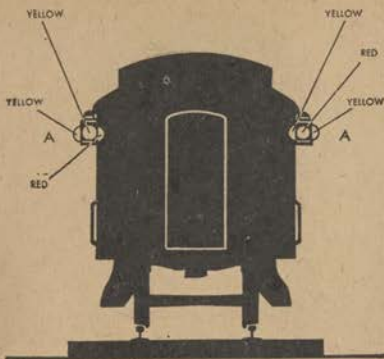


FIGURE 9.

Rear of train by night running with the current of traffic on designated track where there are three or more tracks.

Lights at A A as markers, showing yellow (or green) to rear on the side next to the other track in the direction of current of traffic and red on the opposite side.

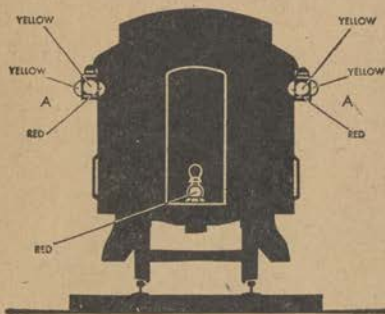


FIGURE 10.

Rear of train by night running on any track against the current of traffic where there are three or more tracks.

Lights at A A as markers, showing yellow (or green) to the rear, with a red light on the platform or the cupola.

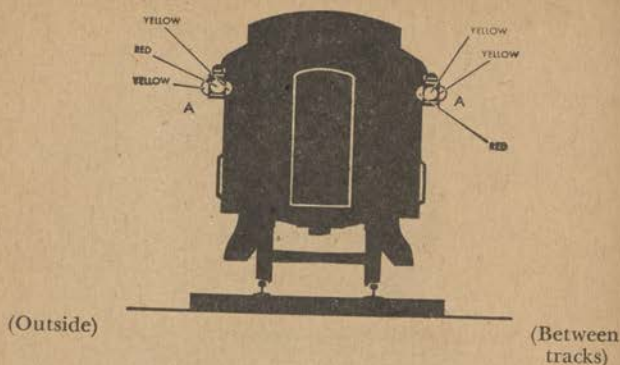


FIGURE 11.

(This illustration is for a road which uses the right-hand track.)

Rear of train by night running against the current of traffic on two tracks.

Lights at A A as markers, showing yellow (or green) to front and side and yellow (or green) to the rear on the side next to the main track on which the current of traffic is in the direction the train is moving and red to the rear on the opposite side.

Note to Rules 17, 19, 20, and 21: The diagrams are intended to illustrate the general location of the train signals, not the exact manner in which they are to be attached.

A train not equipped to display the prescribed signals will display a red flag by day and a red light by night, to indicate the rear of the train.

20. All sections except the last will display two green flags, and, in addition, two green lights by night in the places provided for that purpose on the front of the engine.

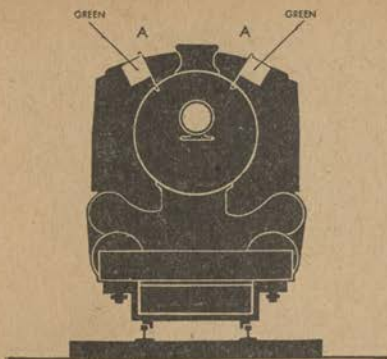


FIGURE 12.

*Running forward by day displaying signals
for a following section.*

Green flags at A A.

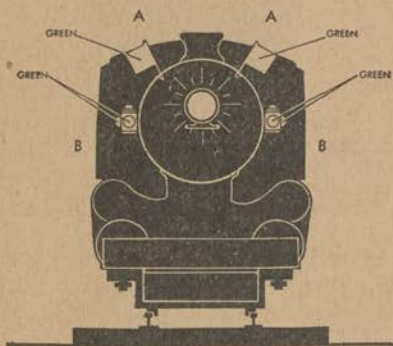


FIGURE 13.

*Running forward by night displaying signals
for a following section.*

Green flags at A A and green lights at B B.

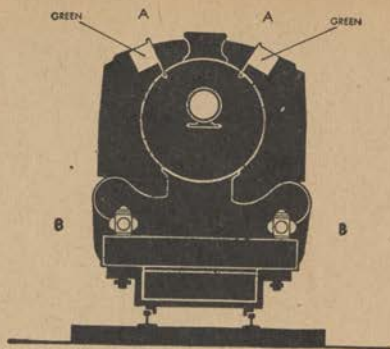


FIGURE 14.

Running backward by day, without cars or at the rear of a train pushing cars, and displaying signals for a following section.

Green flags at A A.

Marker lamps not lighted, or yellow (or green) flags at B B as markers.

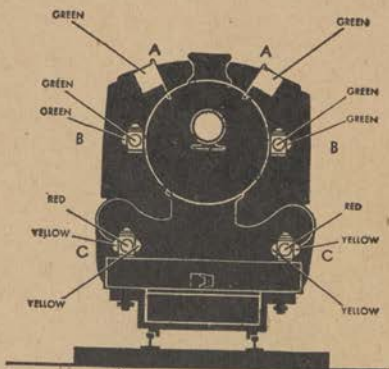


FIGURE 15.

Running backward by night, without cars or at the rear of a train pushing cars, and displaying signals for a following section.

Green flags at A A.

Green lights at B B.

Lights at C C as markers, showing yellow (or green) to side and in direction engine is moving and red in opposite direction.

21. Extra trains will display two white flags and, in addition, two white lights by night, in the places provided for that purpose on the front of the engine.

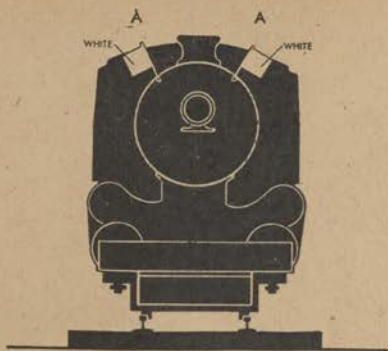


FIGURE 16.

Running forward by day as an extra train.

White flags at A A.

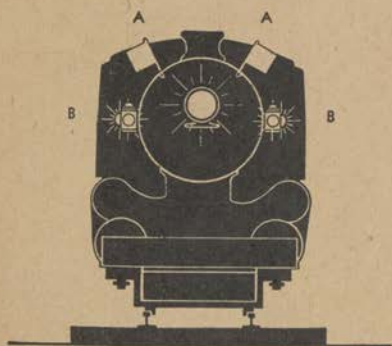


FIGURE 17.

Running forward by night as an extra train.

White flags at A A and white lights at B B.

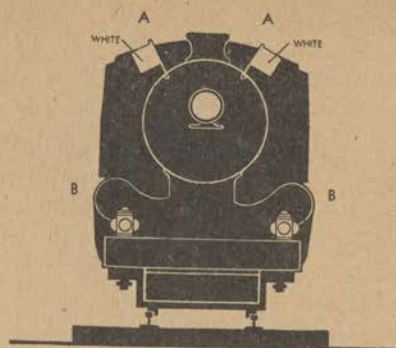


FIGURE 18.

Running backward by day as an extra train, without cars or at the rear of a train pushing cars.

White flags at A A.

Marker lamps not lighted, or yellow (or green) flags at B B as markers.

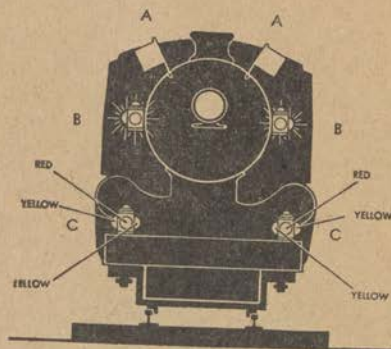


FIGURE 19.

Running backward by night as an extra train, without cars or at the rear of a train pushing cars.

White flags at A A.

White lights at B B.

Lights at C C as markers, showing yellow (or green) to side in direction engine is moving and red in opposite direction.

22. When two or more engines are coupled, signals will be displayed on the leading engine as prescribed by Rules 20 and 21.

23. One flag or light displayed where in Rules 20 and 21 two are prescribed will indicate the same as two; but the proper display of all train signals is required.

25. Each car of a passenger train will be connected with the engine by a communicating signal appliance where such signal appliances are provided. Where not provided, enginemen and trainment will be governed by hand, flag, or lamp signals as prescribed in Rule 12.

26. Except as otherwise prescribed, a blue signal, displayed at one or both ends of an engine, car or train, indicates that workmen are under or about it; when thus protected it will not be coupled to or moved. Each class of workmen will display the blue signals and the same workmen are alone authorized to remove them. Other equipment will not be placed on the same track so as to intercept the view of the blue signals without first notifying the workmen.

When emergency repair work is to be done under or about cars in a train and a blue signal is not available, the engineman and fireman will be notified and protection will be given those engaged in making repairs.

USE OF SIGNALS

7. A signal imperfectly displayed, or the absence of a signal at a place where a signal is usually shown, except during blackouts, will be regarded as the most restrictive indication that can be given by that signal, except that when the day indication is plainly seen, or when sufficient lights in a position or color position light signal are

displayed to determine indication of the signal, it will govern.

Engine and train crews using a switch where the switch light is imperfectly displayed or absent, will, if practicable, correct or replace the light.

A signal imperfectly displayed or the absence of a signal at a place where a signal is usually shown, will be promptly reported to the train dispatcher.

28. A green and white signal will be used to stop a train only at the flag stations indicated on its schedule.

29. When a signal, except a fixed signal, is given to stop a train, it will, unless otherwise provided, be acknowledged as prescribed by Rule 14 (g) or (h).

30. Unless prohibited by special instructions, the engine bell will be rung when an engine is about to move and while approaching and passing highway crossings at grade and while moving through cities, towns, yards, and tunnels.

32. The unnecessary use of either the whistle or the bell is prohibited.

33. Watchmen stationed at highway crossings at grade will use stop signals when necessary to stop trains. They will use prescribed signals to stop highway traffic.

34. All members of engine and train crews will, when practicable, communicate to each other by its name the indication of each signal affecting the movement of their train or engine.

35. The following signals will be used by flagmen:

Day signals: A red flag, torpedoes, and fuses

Night signals: A red light, torpedoes, and fuses

SUPERIORITY OF TRAINS

S-71. A train is superior to another train by right, class, or direction.

Right is conferred by train order; class and direction by timetable.

Right is superior to class or direction.

Direction is superior as between trains of the same class.

D-71. A train is superior to another train by right or class.

Right is conferred by train order; class by timetable.

Right is superior to class.

S-72. Trains of the first class are superior to those of the second; trains of the second class are superior to those of the third; and so on.

Trains in the direction specified by the timetable are superior to trains of the same class in the opposite direction.

D-72. Trains of the first class are superior to those of the second; trains of the second class are superior to those of the third; and so on.

73. Extra trains are inferior to regular trains.

MOVEMENT OF TRAINS

82. Timetable schedules, unless fulfilled, are in effect for 12 hours after their time at each station.

Regular trains more than 12 hours behind either their schedule arriving or leaving time at any station lose both right and schedule, and can thereafter proceed only as authorized by train order.

S-83. A train will not leave its initial station on any division or subdivision, or a junction, or pass from one of two or more tracks to single track, until it has been ascertained whether all trains due, which are superior, have arrived or left.

Stations at which train registers are located will be designated by timetable.

D-83. A train will not leave its initial station on any division, or subdivision, or a junction, until it has been ascertained whether all superior trains due have left.

Stations at which train registers are located will be designated by timetable.

83-α. Unless otherwise provided, a train must not leave its initial station, on any division or subdivision, without a clearance.

84. A train will not start until the proper signal is given.

85. Trains of one schedule may pass trains of another schedule of the same class, and extra trains may pass and run ahead of second and third class trains and extra trains.

A section may pass and run ahead of another section of the same schedule, first exchanging train orders, signals, and numbers with the section to be passed. The change in sections must be reported from the next available point of communication.

86. Unless otherwise provided, an inferior train must be clear at the time a superior train in the same direction is due to leave the next station in the rear where time is shown.

S-87. An inferior train will keep out of the way of opposing superior trains, or failing to clear the main track by the time required by rule will be protected as prescribed by Rule 99.

Extra trains will clear the time of opposing regular trains not less than 5 minutes unless otherwise provided, and will be governed by train orders with respect to opposing extra trains.

S-88. At meeting points between extra trains, the train in the inferior timetable direction will take the siding unless otherwise provided.

Trains will pull into the siding when practicable; if necessary to back in, the train will first be protected as prescribed by Rule 99, unless otherwise provided.

S-89. At meeting points the inferior train will take the siding and clear the time of the superior train not less than 5 minutes, except at schedule meeting points between trains of the same class, where the inferior train will clear the main track before the leaving time of the superior train.

The superior train will stop at schedule meeting points with trains of the same class unless switch is properly lined and track clear. The inferior train will pull into the siding when practicable. If necessary to back in, unless otherwise provided, it will be protected as prescribed by Rule 99.

S-90. The engineman of each train will give signal 14 (n) at least 1 mile before reaching a meeting or waiting point.

91. Unless some form of block system is used, trains in the same direction will keep not less than 5 minutes apart, except in closing up at stations.

A train following a train carrying passengers must keep not less than 10 minutes behind it.

92. A train will not leave a station in advance of its schedule leaving time.

93. Within yard limits the main track may be used without protecting against second and third class, extra trains, and engines. Second and third class, extra trains, and engines will move within yard limits at yard speed unless the main track is known to be clear.

NOTE. Where block signal rules are in effect, "known to be clear" includes when track is known to be clear by signal indication.

94. A train which overtakes another train so disabled that it cannot proceed will pass it, if practicable, and if necessary, will assume the schedule and take the train orders of the disabled train, proceed to the next available point of communication, and there report to the dispatcher. The disabled train will assume the right of schedule and take the train orders of the last train with which it has exchanged, and will, when able, proceed to and report from the next available point of communication.

95. Two or more sections may be run on the same schedule.

Each section has equal timetable authority.

A train will not display signals for a following section, except as prescribed by Rule 85, without orders from the chief dispatcher.

S-96. Unless otherwise provided, signals will not be ordered displayed to, nor taken down at, other than a register station for the train displaying the signals.

97. Unless otherwise provided, extra trains will not be run without train orders.

98. Trains will approach the end of two or more tracks, junctions, railroad crossings at grade, and drawbridges, prepared to stop, unless the switches are properly lined, signals indicate proceed, and track is clear. Where required by regulations, trains will stop.

99. When a train stops under circumstances in which it may be overtaken by another train, the flagman will go back immediately with flagman's signals a sufficient distance to insure full protection, placing two torpedoes, and when necessary, in addition, displaying lighted fuses. When recalled and safety to the train will permit, he may return.

When the conditions require, he will leave the torpedoes and a lighted fusee.

The front of the train will be protected in the same way when necessary by the head brakeman or fireman.

When a train is moving under circumstances in which it may be overtaken by another train, the flagman will take such action as may be necessary to insure full pro-

tection. By night, or by day, when the view is obscured, lighted fusees will be thrown off at proper intervals.

When day signals cannot be plainly seen, owing to weather or other conditions, night signals will also be used. Conductors and enginemen are responsible for the protection of their trains.

100. When the flagman goes back to protect the rear of the train and is left behind, another trainman will take his place on the train.

101. Trains will be fully protected against any known condition, not covered by the rules, which interferes with their safe passage.

102. When a train is disabled or stopped suddenly by an emergency application of the air brakes or other causes, adjacent tracks as well as tracks of other railroads that are liable to be obstructed must at once be protected until it is ascertained they are safe and clear for the movement of trains.

103. When cars are pushed by an engine, and the conditions require, a trainman will take a conspicuous position on the leading car and when shifting over highway crossings at grade not protected by a watchman or by gates, a member of the crew will protect the crossing.

104. Conductors are responsible for the position of switches used by them and their trainmen, except where switch tenders are stationed. Switches will be properly lined after having been used.

A switch will not be left open for a following train or engine unless in charge of a trainman of such train or engine.

When practicable, the engineman will see that the switches near the engine are properly lined.

A train or engine will not foul a track until switches connected with the movement are properly lined, and when waiting to cross from one track to another and during the approach or passage of a train or engine on tracks involved, all switches connected with the movement will be secured in the normal position. Switches will not be restored to normal position until a movement is completed or clear of the main track involved.

Where trains or engines are required to be reported clear of main track such report will not be made until switch has been secured in its normal position.

NOTE. Rule 104 applies only to hand-operated switches.

105. Unless otherwise provided trains using a siding will proceed at reduced speed.

Sidings of an assigned direction will not be used in a reverse direction unless authorized by the dispatcher, or in an emergency under flag protection.

106. Both the conductor and the engineman are responsible for the safety of the train and the observance of the rules, and, under conditions not provided for by the rules, will take every precaution for protection.

107. When a passenger train is receiving or discharging traffic on the side toward a station, a train or engine will not pass between it and the station unless proper safeguards are provided.

108. In case of doubt or uncertainty, as safe a course as is justified by the military situation will be taken.

GENERAL INSTRUCTIONS

109. Personnel must not give information regarding train movements except to authorized persons.

110. Personnel must not remain near the track when a train is passing, as coal, stone, car doors, or other articles may fall from the train. In territory where there are adjacent tracks, personnel must not stand on any track while trains are passing, nor in front or in rear of switch stands, obstructing the view of the switch target to engine crews and trainmen.

111. Personnel must not rely on others to notify them of approaching trains.

112. Personnel must observe trains closely and, if anything dangerous is noted, such as a loose or broken wheel, hot box, defective coupling, brake rod, or brake beam dragging, etc., they must call attention of train and enginemen to the fact by signal. Train and enginemen are required to observe trackmen, bridgemen, and other personnel as they pass and look out for signals from them. When inspecting passing trains, foremen must divide their gangs where practicable and safe so that trains can be closely observed from both sides. If nothing irregular is noted they will give proceed signal to rear of train. If unable to communicate signals dispatcher should be notified of defective conditions.

113. In emergencies, or in case of obstruction by accident or from other causes, suggestions based upon observation of the actual situation are useful and helpful in the

removal of cause. Reports in such instances should be made by personnel in the absence of the person upon whom the responsibility most normally rests.

114. Disregard of stop or caution signals, or failure to answer signals properly must be reported with a full statement of facts.

115. Unsafe track, bridges, culverts, or other obstructions to traffic must be promptly reported by wire after being protected in accordance with flagging rules. Conditions likely to affect safety of trains, such as storms, floods, fire, etc., must be promptly reported by wire and watched. In case of severe storms, track must be patrolled. Completion of repairs must be promptly reported when traffic has been obstructed.

116. All the facts must be fully stated when reporting accidents and unusual occurrences to avoid necessity of additional inquiries to obtain such information. Careful estimates of material necessary to repair damages must be made.

117. The telegraph service is indispensable in the handling of trains and must not be interrupted. Personnel handling derricks and pile drivers or doing work that may interfere with wires are required to use every precaution to prevent damage and interference.

118. Should trains be delayed by accident or from other cause, the conductor is authorized to call on any person for assistance. Personnel will respond promptly when so called and must assist with their entire force, if necessary.

119. When large numbers of inexperienced personnel are working on the track, foreman must take extra precautions to protect them from accident.

120. It is dangerous to assume that signals given to the engineman or fireman have been seen, and if seen will be obeyed, when obedience to such signals on the part of the engineman or fireman is essential to the safety of personnel in the performance of duty. It must be known that the signal has been seen, understood, and will be obeyed before a man is placed in a dangerous position.

121. Personnel must thoroughly understand that they are expected to take the initiative in placing slow orders wherever, in their judgment, track and bridge conditions are such that running at full speed is not safe and must protect such locations as per rules.

122. Personnel must carefully observe signals displayed by all trains, and assure themselves before obstructing the track that all trains and sections due have passed.

123. All electric light or power wires are to be considered to be alive at all times. Personnel must not depend for their safety on the insulating covering of wires. Unqualified personnel will not do any work with or near electric light or power wires.

124. None but insulated track gauges must be used where there are track circuits.

125. Personnel working in or near the end of a tunnel when a train approaches from either direction, must stand clear of all tracks, and if in the tunnel, should occupy the refuge niches. If there is insufficient clearance or no refuge niches, arrangements must be made to work under flag protection.

126. Track cars must be operated in accordance with rules governing their use.

127. Supervisors must see that personnel requiring goggles are provided with them and must see that goggles are used at all times when there is danger of flying particles entering the eye, and must be kept in good repair and clean condition.

128. When in doubt about wearing goggles, the supervisor or foreman must be consulted and his instructions observed.

129. Foreman of bridge and concrete and signal-telegraph crews may make exceptions to the above whenever in their judgment the use of goggles would endanger the safety of their men.

130. Operators of welding equipment will be provided with proper goggles which must be worn when using a welding or cutting torch.

131. Every precaution must be taken to prevent fires. Stoves, stovepipes, and flues must be maintained in safe working order and precaution must be taken against fires from loose matches, oily waste, or other inflammable materials.

132. Avoid the accumulation of refuse in or about buildings, structures, or cars.

133. Smoking is prohibited in or about buildings or cars containing inflammable material.

134. Ashes must not be deposited within 20 feet of any building or structure.

135. Oily or greasy waste or rags should be burned or removed from buildings. Such material and greasy clothing must not be stored in lockers.

136. Woodwork in close proximity to stoves or stove pipes must be protected by noncombustible covering.

137. The ground under wooden bridges must be kept free of grass, brush, or rubbish.

138. Fires on or near the right-of-way must be extinguished or protected against.

139. Fire pumps, hydrants, hose, and appurtenances must be kept in serviceable condition.

FLAGGING

140. Track must never be obstructed without first conspicuously displaying stop signals in each direction a sufficient distance to insure full protection, distance to be determined by grade, curvature, visibility, speeds, weather, etc. Signals must be in the hands of a reliable flagman having proper understanding of the use of signals. The flagman must stop all trains and give the engineman an explanation of the nature of the obstruction and its exact location.

141. If a train approaches flagman from the opposite direction, having passed the obstructions, flagman, when practicable, should remove torpedoes and must replace them immediately after train has passed.

142. Should the track be found unsafe or obstructed by a trackwalker, bridge inspector, or other lone employee, he will remain at the point of danger, if there is an unobstructed view in each direction of at least one-half mile, until a train is seen or heard approaching, when he will go toward train as rapidly as possible, displaying stop signals.

143. If there is not an unobstructed view for at least one-half mile, he will, after leaving red flag at point of obstruction, first go in the direction of the next regular train, unless a train is seen or heard approaching, and place two torpedoes on the right-hand side facing the point to be protected and then go in the opposite direc-

tion. If no train is due for considerable length of time, best judgment should be used as to which direction to go first. Train finding signals thus displayed will proceed, preceded by a flagman, until a cause is found. This method of flagging must never be used except in emergency and when only one man is available.

Personnel whose duties preclude access to a standard clock, must obtain time from train dispatchers, or compare and regulate their watches daily with those of conductors and enginemen who have standard time and have registered as provided.

144. In placing torpedoes, they must be securely fastened to the top of the rail on the engineman's side.

145. Torpedoes shall be replaced after passage of train that explodes them.

146. When the flagman is to be recalled, he will be notified by the foreman that the track or bridge has been made safe for the passage of trains. Flagman must not accept such information from any other source.

147. When work is necessary that will obstruct the track, foreman must give chief dispatcher the location by mile post, the nature and probable duration of the obstruction, and find whether there are any trains that must not be delayed; then choose a time which will interfere as little as possible with traffic.

148. When the track is unsafe, or is to be made unsafe for the passage of trains at the usual rate of speed, and this condition will continue over night, or the greater

part of the day, notice of same must be sent by wire immediately to the superintendent, chief dispatcher and roadmaster. In such notices, the location and character of the obstruction and the speed at which trains can safely pass must be stated.

149. In addition to sending this notice, slow order signals will be placed as follows:

150. A yellow flag by day, and in addition, a yellow light by night, placed on the engineman's side of the track, indicates that the track 2,640 feet distant is in a condition for a speed of not more than 10 miles per hour unless a lower speed is specified by timetable rule or a different speed by train order or general order. A green flag by day, and in addition a green light by night, placed on the engineman's side of the track 150 feet beyond the obstruction, indicates that the slow track has been passed. The entire train must pass over the designated territory at the speed required and a trainman will give proceed signal when the rear of the train has passed the green flag or light. The proceed signal will be acknowledged by a whistle signal 14-b.

151. When two or more gangs are working at the same location, the foremen must have a mutual and definite understanding for providing proper flag protection.

152. Track cars must be flagged the same as trains.

153. In using signals on two or more tracks, each track must be considered as a single track railroad upon which trains may be operated in either direction, at any time.

154. Foremen engaged in bridge and track work must keep themselves supplied with following signals, and in proper condition ready for use:

- 12 torpedoes
- 6 fusees
- 2 red flags
- 2 green flags
- 2 yellow flags
- 2 red lanterns
- 2 green and 2 yellow lanterns
- 1 white lantern

155. Signal supervisors and maintainers must keep themselves and each man under them, who may be called upon to do flagging, supplied with the following signals and in proper condition for use:

- 12 torpedoes
- 6 fusees
- 2 red flags
- 2 red lanterns
- 1 white lantern

156. Messages or orders concerning the condition of track, bridges, or structures that affect the movement of trains must be in writing.

WORK EQUIPMENT

157. Locomotive cranes, power shovels, ditchers, pile drivers, bridge derricks, tractors, and other similar equipment are very important and require the best of attention, both in maintenance and operation. Rules cannot be prescribed for every move to be made, and operators are expected to exercise the best judgment in their operation, making a thorough study of the equipment and the work to be done within the capacity of such machines.

158. Work equipment operator reports to the supervisor of work equipment and works under the direction of the supervising officer under whose jurisdiction the work is performed.

Operators will be governed by maintenance of way and operating rules and will familiarize themselves with current instructions governing the operation of the machine assigned to them.

159. Roadway equipment operators will not permit unauthorized or inexperienced personnel to occupy or operate machines in their charge without proper authority.

160. Operator is responsible for the proper operation and maintenance of equipment. All machinery must be inspected daily for loose bolts, nuts, cotter keys, and defects to operating mechanisms, and proper corrections made

accordingly. Defects should be reported promptly in order to make repairs before breakdown of equipment.

161. On steam-powered equipment the boiler anchor bolts and all pipe clamps must be kept tight to eliminate vibration and subsequent failure to pipes, boiler fittings, and appurtenances.

Proper inspection and test certificate will be displayed in the cab of steam machines.

Only an authorized officer or mechanic will be permitted to set safety pop-valve or alter steam pressure on boilers.

162. Before lifting loads, operator will familiarize himself with the lifting capacities of machine, normally indicated on name plate, and confine load capacities within safe limits. Cables, chains, ropes, slings, tongs, and any other members supporting the load must be examined often as necessary to make sure that they are in good serviceable condition. Proper lubrication of cables should not be overlooked. Proper-sized clamps must also be used for the cables as clamps too large or too small will be unsafe.

163. Operator must have a thorough understanding with other personnel as to signals to be used.

164. Operators must remain calm at all times and be sure of all moves they are to make, as well as keeping any surrounding personnel at a safe distance from swinging loads.

165. Extreme caution must be taken to avoid sideswiping by trains passing on adjoining tracks, and all track ma-

chines must be brought to a stop, the engine stopped, and the swing or rotating mechanism locked while the trains are passing.

166. All track type machines operating on main track must have proper flag protection.

167. Operators are responsible for the proper protection of traffic when working on or near tracks. When work requires boom to be swung over adjacent tracks on which trains are operating, operator must see that flag protection is provided.

WELDING

168. Welders will report to the supervisor of work equipment and will work under the direction of the supervising officer under whose jurisdiction the work is performed.

169. In using portable equipment care must be exercised in the handling of the pressure gauges on regulators, in order not to damage them.

170. The study of maintaining the proper flame is of the highest importance. A neutral flame is used for most work, while at times an oxidizing or carbonizing flame may be required.

171. To make a good weld it is necessary to start at the bottom of the crack or fracture and fuse the metal perfectly all the way through. (To get perfect fusion, metals over $\frac{1}{8}$ inch thick must be chamfered or beveled on each side in order to permit the flame to penetrate to the bottom.) In doing so the flame should be directed at the work at an angle of about 65° . Usually the weld should advance in the direction in which the torch is pointed, thereby preheating the metal as the weld advances.

The flame should never be permitted to play continuously upon one particular spot, but must be kept constantly moving in a circular motion, in this way heating a limited area until the surface heated presents a

uniformly glossy white appearance, free from specks of scale. Apply the filling rod by rubbing over the area previously heated, at the same time describing a half circle about the rod with the torch, occasionally removing the rod and describing a complete circle with the flame, striking the work at right angles, thereby fusing all the edges, and preventing molten metal from collecting opposite the half-circular motion and running over the cold metal in advance of the welded spot being completed. Never direct the torch on the filling rod in an effort to drop the metal on the place to be welded, as it is *impossible* to make successfully a weld in this manner on steel or cast iron.

Use proper filling rod for weld being made.

TRACK CARS

172. Definition.—Unless otherwise indicated, the term “car” where used herein will apply to motorcars, hand cars, velocipedes, trailers, and push cars, and all on-track roadway machines. If operating under train orders, transportation rules shall govern their movements.

173. Track cars must be used only in Military Railway Service. No persons other than officers or enlisted men in the discharge of their duties will be permitted to ride upon or use such cars, except in connection with Military Railway Service.

174. Unauthorized use of a track car will be immediately reported to the officer in charge.

175. Only those designated who have been properly qualified will be allowed to operate track cars.

176. The operator of a track car will be held responsible for proper operation and for all accidents and must protect himself and others against accidents, flagging as per operating rule No. 99 when required. The presence of an officer, or noncommissioned officer of any rank, on the car does not relieve the operator of his responsibility for the safe operation of the car. However, an officer or noncommissioned officer of any rank riding on the car should satisfy himself that the car is being operated safely and properly, as the situation requires.

177. Operators of track cars must carry a copy of the current timetable covering the territory over which they are moving, and familiarize themselves with special rules and instructions. Each track car must carry the following equipment:

- 12 torpedoes
- 6 fuzees
- 2 red flags
- 2 red lanterns
- 1 white lantern

178. The speed of motorcars must not exceed that at which the cars can be stopped within the limit of safety, and must not at any time exceed the speed given in the following table for the kind of car and class of service indicated:

Gang cars without trailers	— 20 miles per hour
Gang cars with trailers	— 15 miles per hour
Light inspection cars	— 20 miles per hour
All cars through turn-outs, over switches, frogs, railroad crossings, and public or private cross- ings, and tunnels	— 5 miles per hour

179. Operators must familiarize themselves with time of regular trains and will be required to exercise sufficient caution to avoid being struck by a train, flagging curves and other obscure places when necessary, and to take every precaution to avoid accidents of any kind, stopping before passing over street or road crossings unless the way is seen to be clear. In case of doubt, crossing must be flagged. Operators must familiarize themselves with the position of fixed and block signals used on their respective territories. In case of doubt or uncertainty the safe course must be taken.

180. Lookout must be maintained in both directions when track cars are in use.
181. Track cars moving in the same direction on one track or following a train must be kept a sufficient distance apart to insure safety. Track cars must not be attached to trains.
182. When track cars are operated at night or through tunnels, they must be equipped with a white light in front and red light to the rear.
183. A track car must not be used on the main track when view is not clear on account of fog or other weather conditions unless properly protected.
184. When necessary to open switches for the use of track cars it is the responsibility of the operator to see that the switch is lined and locked in its normal position.
185. Section men, linemen, bridgemen, water service men or others authorized to operate track cars will secure a "line-up" on the movement of trains but this does not relieve the operator of track car of any responsibility so far as the safe operation of track car is concerned. The same precautionary measures, such as flagging curves, must be taken with a "line-up" as without it, and close lookout must be kept for extra trains not shown, regular trains annulled and run ahead of their schedule, or of trains that may be turned back from any point.
186. When "line-up" is desired, operator of track car will request same of telegrapher, who will secure it from dispatcher.
187. On two or more tracks, motor cars should be run with the current of traffic, except in emergency. Hand cars and velocipedes should be run against the current of traffic.

A sharp lookout must be maintained in both directions, as trains are liable to be run against traffic at any time.

188. Torpedoes exploded or flags or fusees displaced by track cars must be replaced.

189. A motor track car must never be used to push another car. When used to move another car, the motor track car must always be ahead and attached close to the car being towed. No one shall be allowed to sit with legs between such cars.

In attaching motor track cars to trailers or in coupling trailers together, substantial drawbars must be used.

190. Track cars must not be left standing on main track except in charge of a sufficient number of men to properly handle them.

191. Cars must be removed from the track or protected by flag when not in use. When they cannot be removed from the track to clear an approaching train, they must be protected as prescribed in flagging rules.

192. When cars are removed from the track, they must be placed not less than 6 feet from nearest rail, and so located that they cannot foul the track. They must not be left standing where they will obstruct a highway or private road crossing. They must be kept locked when not in sight of the men in charge; and at night and other times when not in use, should be kept under cover.

193. Care must be exercised in placing motor track car on or off the track and in loading or unloading tools to avoid disturbing the adjustment of the engine or car.

194. Cars must be under absolute control when passing through yards and bystations, over switches, or through interlocking plants. At all other points speed is to be restricted as prescribed by rules.

195. Cars must be operated with care in passing trains receiving or discharging passengers and must not be run between such trains and the station. They must be operated at reduced speed while passing section men working on that or adjoining tracks and must be pushed throughout the actual working limits of extra gangs, or other large bodies of men.

196. Track cars passing a train standing on an adjacent track must not exceed 5 miles per hour and be prepared to stop in case someone should step out from between the cars.

197. A track car must be stopped and persons using car must step off track when a moving train is passing on adjacent track.

198. Engine must not be raced or left running when the car is standing.

199. Operators are responsible for the proper maintenance of the car in their charge and a report must be made to the superior officer if the car is in need of repair or is, in their opinion, unsafe to operate.

200. Motor track cars must be thoroughly cleaned and all bolts and nuts tightened at least once a week. A thorough inspection of all parts must be made when car is overhauled or cleaned.

201. All wearing parts and bearings of engine and car must be kept properly lubricated. When lubricated gasoline is used, it must be properly proportioned and mixed before it is placed in the fuel tank.

202. When the motor has a watercooling system, water hoppers and radiators must be kept properly filled, and during freezing temperatures they must be protected against freezing or the water drained when not in use.

203. Operators must thoroughly understand the complete cycle of operation of the engine, study the printed booklet of instructions furnished, and acquaint himself with the gasoline system, electric equipment and circuit, the methods of lubrication, and the proper methods of starting and stopping the engine and car.

204. Motor track cars must be inspected carefully before starting to detect loose or broken parts, and to see that the wheels are not excessively worn and are in proper alignment. A running test will be made to see that brakes are working properly. When running, attention must be given to any unusual noise about the engine or car, and if any unusual noise is heard while running, the car must be stopped and adjusted before proceeding. In making long runs, the car must be stopped frequently and examined for overheated parts or bearings and to insure proper lubrication.

205. Extreme care must be exercised in the handling of gasoline, and gasoline should preferably be stored in tanks removed from the motor track car house. Gasoline must be strained through the wire screen of the funnel furnished for that purpose when filling fuel tank.

Fuel tanks, oil cans, and funnels must be kept clean.

Gasoline must not be handled near a lighted lantern or any other flame or when motor is running. Motor track cars must not be inspected with matches or torches.

206. Monoxide gas is one of the most deadly poisons and it is strictly forbidden to operate a gas engine or motor car inside a tool house, motor car shop, or any other building, unless doors and windows are open.

207. Only insulated cars shall be used where there are track circuits.

208. Windshields obstructing a clear view are forbidden.

209. Before starting, there should be a thorough understanding as to what part each person is to take in handling the car should an emergency arise necessitating prompt action.

210. A motor track car must never be operated under its own power unless person running the car is on the car. Before applying power, whether starting or running, see that spark lever is in the retard position.

211. Men in charge of motor track cars must not permit occupants to ride in insecure or careless positions.

212. Personnel must never get on or off a moving track car. When the car is being started, it is permissible to get on the car from the rear.

213. The use of seats not securely fastened to the car is prohibited.

214. Brakes must be applied gradually and emergency stops made only when absolutely necessary. Do not use brakes suddenly without warning everyone on the car.

215. When rails are slippery due to wet weather or frost, a greater distance is required to stop a track car and the person operating the car should take this into account.

216. Operators must keep a constant lookout for dogs or other animals. Also for objects such as stones and sticks on rails which are liable to be struck and thus derail car.

217. Do not adjust motor track cars while in motion. Adjustment of carburetor is permitted.

218. Track motor and hand cars are to be used only for transporting men and tools. Heavy materials, such as ties, rails, frogs, etc., must be transported by means of push cars or trailers.

219. Tools and material must be properly placed on cars and braced to prevent their falling off. Track jacks must not be carried on the front end of the car.

220. More than the required number of dry cell batteries must not be used. Spark coil vibrator must be kept clean and properly adjusted. Spark plugs must be kept clean and free from carbon. Timers must be kept clean, well oiled, and in proper adjustment. Wiring must be properly insulated and connections kept tight.

221. To secure the lowest maintenance and highest efficiency of the engine, the carburetor must be adjusted by a competent man and must not be tampered with. Gas line must be kept free from stoppage and leaks immediately repaired.

INSPECTIONS

222. Track must be inspected daily by track maintenance sergeant or section foreman. He will observe track closely, noting any irregularities in line or surface, watching for broken or defective rails or angle bars. He will inspect switches and turnouts and observe and report immediately any unusual conditions at bridges or culverts. If any unsafe condition is found he will protect and report as prescribed by rule.

223. Bridges will be inspected periodically by the bridge inspector or B and B foreman. The inspector will make and keep notes of the general condition of structure and make thorough inspection of timber and steel within designated periods. He will observe and report any unusual condition such as settlement, or indication of excessive scour around piers, abutments or bents.

224. In making steel inspection, particular care should be taken to ascertain condition of splices and connections noting any distortion of members, especially end and intermediate posts, top chords, and top flanges of beams and girders; cracked or torn sections; nicks or sharp bends in eyebars and line and camber of trusses and girders.

225. Buildings and other structures will be inspected directed by the supervising officer.

TOOLS AND MATERIAL

226. Foremen and others are responsible for the proper use and care of the tools, material, and supplies in their charge. Lost tools must be promptly reported and tools must not be loaned without proper authority. When not in use tools must be locked up.

227. No tool must be used for any purpose other than that for which it was intended. Defective and wornout tools must be turned in and not used.

228. Care must be used to keep tools clear of passing trains and they must be loaded on track cars so that they do not fall off when car is moving.

229. All tools and material shall be carefully inspected and checked against invoice or shipping notice when received. Report of receipt and any exceptions must be made promptly. Material that varies from specifications must not be used without special authority, and will be held pending disposition.

230. All surplus tools and material must be stored in a neat and orderly manner at designated points. Piles to be not nearer than 6 feet from nearest rail.

Scrap material must be picked up and stored at designated locations.

Timber and piling not intended for immediate use must be piled in line with the approved standard practice, and properly safeguarded from fire.

231. The level board shall be tested often to know that it is true. This shall be done by shimming up the level board until the bubble is in the middle of the tube. Mark the exact position of the board with a pencil. Turn the level board end for end and place it on the same spot. If the bubble remains in the center of the tube, the level board is accurate; if it does not, the level board will be sent in for repairs, or exchanged.

232. The standard tool list will be posted in each section tool house.

233. Cars must not be loaded beyond their load limit. The weight will be equally divided with respect to trucks and side load. When in doubt as to height and distribution of load, cars must be weighed.

234. Cars must be loaded in such a manner as to insure safe passage through bridges and tunnels, and by cars on adjacent tracks. When in doubt, vertical and horizontal clearances must be checked to know they are within authorized limits.

235. be
be
trac
ban
space
the c
clear

236. I
end
ation
stream
waterw

237. A
them to
larly v
superin
or super
high wa
rides in
ridge a

238. It is
bridge
affecting
ported

ROADBED AND DRAINAGE

235. For standard gauge single track the roadbed should be 15 feet wide on embankments or cuts; for double track, not less than 28 feet should be provided on embankments and in cuts. Parallel tracks on tangents are spaced not less than 13 feet center to center; on curves the distance should be increased to maintain equivalent clearances between equipment on adjoining tracks.

236. Deforestation, soil erosion, highways, paving, etc., tend to accelerate run-off, cause channel changes and siltation. The effect is to greatly increase the rapid rise of streams and increase hazard to the roadway and at waterway openings.

237. All personnel, especially those whose duties require them to pass frequently over the tracks, must be particularly watchful at all times and promptly report to the superintendent, maintenance engineer, track supervisor, or supervisor of bridges and buildings, any evidences of high water coming to their notice which might cause slides in cuts or fills, or scour around culverts or at bridge abutments or piers.

238. It is the duty of the track supervisor and supervisor of bridges and buildings to see that all high water marks affecting roadbed and bridges are carefully preserved and reported to the maintenance engineer for record.

239. It is the duty of the supervisors to carefully observe the effect of flood waters on buildings, roadbed, and bridges. As soon as possible after flood waters have receded and before the marks of drift or other flood evidences have been destroyed, they should endeavor to determine the cause of the flood conditions and what remedial action should be taken, and make suitable report to the maintenance engineer.

240. A well-drained roadbed is the cheapest and most effective means of obtaining good riding track. The first requirement for a successfully drained roadbed is to see that all ditches and waterway openings are uniformly constructed and kept open at all times for the free flow of water. Track ditches should have a fall of from 4 to 6 inches in 100 feet.

241. Embankments poorly constructed or improperly widened provide a sure hiding place for water which passing trains will rapidly develop into water pockets which will result in difficult and expensively maintained track.

242. Channels and streams must be examined for a considerable distance away from the track and frequently cleared of brush drift or other movable obstructions which may interfere with the free flow of water. Such obstructions are the frequent cause of overflow or changes in channels which result in serious damage to the roadbed.

243. Ditches, drains, and culverts must be inspected frequently and kept clear of all driftwood or other obstructions that would in any way retard or restrict passage of water through openings or cause water or drift to back and damage railway or other property.

244. After a snowstorm ditches must be cut through the snow wherever a sudden thaw would be likely to flood the track.

245. Surface ditches, when improperly placed, are frequently the cause of slides. When placed at the bottom of embankments, a berm of sufficient width should be provided to insure against filling of the ditch from embankment slides and wash.

246. In the drainage of cuts, ditches should be located so as to avoid damage to roadbed. Where the adjacent land slopes toward cuts and surface ditches are provided for the purpose of intercepting lateral drainage and diverting it from cuts, they shall be so located as not to cause or be undermined by slides. Surface ditches should be of adequate size and where practicable a levee should be built up on the side nearest the cut to prevent overflow into cut.

247. Cross-drains must be put in wherever necessary and protected at the ends against washing. The end of a ditch must be diverted from the roadbed so that the scouring action of the water will not weaken or wash the embankment. Where such scouring becomes injurious, it must be controlled by cribbing with old ties, filling with brush or large stone, or riprapping.

248. Care must be exercised to provide adequate drainage at highways and crossings, and that a passageway is kept open for drainage. When the drainage of the highway is toward the track, special care must be taken to divert the water from the roadbed.

BALLAST

249. Bank widening and ballasting will be done in line with current instructions. Before distributing ballast the roadbed must be properly prepared to receive the ballast. All unsatisfactory material above the bottom of the ties must be removed and used to widen narrow roadbed to standard section. In stripping track, care must be taken to see that all material is removed and evenly spread on the shoulder so that the finished roadbed will be smooth and free from loose dirt.

250. Open track must be protected by necessary slow order. Such track must be carefully watched; loosen bolts if necessary, to avoid buckling and throwing track out of line.

251. When surfacing track out of face, ties shall be spaced, unserviceable ties replaced, gauge corrected, tie plates adjusted to full bearing, spikes driven down, anchors reset and track lined to center.

252. In unloading ballast, care must be taken to secure uniform distribution of material in order to complete the work with the minimum rehandling.

253. In raising track, jacks shall be worked in pairs directly opposite each other and both rails lifted to the same elevation, which must be determined by the use of level board.

RAIL

254. Rails will be placed in position by use of rail tongs, lining bars, or rail forks. Under no circumstance will rail be struck with maul or similar tool.

255. Rail will be laid in line with current instructions. Curves will be staked and track lined before rails are laid.

When relaying or replacing rail with second-hand rails they should be carefully matched.

256. Holes in rails must be drilled. Burning holes in rail is prohibited.

257. On a curve the inner line of rails is shorter than the outer line by about 1 inch for each degree of curve in every 100 feet, necessitating occasional use of short rails. For example, in every 100 feet of a 6° curve the inner rail is 6 inches shorter than the outer rail.

258. Rails for curves, of 6° and over, may, when required, be curved by the use of a standard rail bender before being laid. Curvature shall be uniform throughout.

259. If it is not feasible to replace a broken base rail in main track immediately, a pair of angle bars shall be applied to the rail, using two bolts through the outside holes. Rails in the main track of main line so repaired shall be removed as soon as possible.

Until rail is replaced, a restrictive speed train order shall be placed on the track.

260. A broken rail found in main track must be protected immediately by flagmen and no trains allowed to pass over it until it has been determined that the rail is in such condition as will permit the safe passage of trains. If it is decided trains may pass over the rail safely, all trains must be stopped before reaching the break and then allowed to proceed at slow speed. * If a suitable rail is not available, the broken ends of the rail must be connected by joint bars, the rail drilled and the joint bars full bolted, after which traffic may be resumed at a speed not to exceed 10 miles per hour. The rail must be removed from track as quickly as possible, speed restrictions then removed and report made on proper form to the track supervisor and maintenance engineer.

261. All foremen shall acquaint themselves with the appearance of serious defects in rails, such as piped rails, transverse fissures, crushed heads, split heads, and split webs. It is the duty of supervisors to instruct their foremen in these matters so that such defects can be readily recognized, the rail immediately removed and a correct report made.

262. Internal fissures found in steel rails are of four types namely:

- First—Transverse
- Second—Compound
- Third—Horizontal
- Fourth—Vertical

263. Internal fissures are found only in the heads of rails. The point of origin of the *transverse fissure*

called the *nucleus* and is indicated by a granular appearance as distinct from the smooth face of the rest of the fissure. The transverse fissures occur predominately on the gauge side of the head. When failure occurs before the growth of the fissure has reached the rail surface, its appearance is smooth, bright, and lustrous, and is sometimes described as a "silver spot."

In cases where the fissures reach the rail surface before failure occurs, air and moisture enter, making the fissure dark colored with respect to the other metal. *This type may sometimes be detected before failure through the appearance of a vertical crack on the gauge side of the head.*

The *compound fissure* is a combination of the horizontal fissure and transverse fissure occurring close together.

The origin of a *horizontal fissure* has the appearance of a seam running horizontally through the head of the rail usually from $\frac{1}{4}$ inch to 1 inch beneath the running surface. The fissure grows outwardly from this origin and may result in a visible horizontal crack on the gauge side of the head.

264. Every rail giving evidence of transverse fissure through the appearance of a vertical crack, as described above, will be immediately removed from track and broken to determine whether or not there is a fissure. The supervisor will personally examine such rails after they have been broken and report his findings promptly.

265. Emergency stocks of rail and track material will be carried in yards and on sections as designated by the engineer of maintenance.

TIES

266. Tie inspection must be made as directed by the engineer of maintenance to determine requirements for renewals.

267. In handling creosoted ties, care must be taken to avoid bruising surfaces, splintering, and cutting or breaking through layer of wood penetrated by creosote.

268. During the progress of tie renewals, the section foremen shall use their judgment as to which of the spotted ties shall be first removed. They shall not remove any ties even though spotted, which, in their judgment, would give at least 1 year's additional safe service. They shall give preference to the removal of broken ties, whether spotted for renewals or not, removing such ties from main track when found. When section foremen find ties not spotted for renewals, which in their opinion are no longer serviceable they shall mark such ties and when the check is complete, present their recommendations to the supervisor.

269. Extra gangs shall not be permitted to make tie renewals, except in special cases which must have the specific approval of the engineer of maintenance and the work shall be under the supervision of the supervisor or his assistant. In such cases the examination and marking of ties to be renewed preferably should be made by the section foreman on the section where the work is to be done.

270. Ties shall not be punctured or otherwise damaged with pick, shovel, or other tools in handling. Spacing of ties shall not be done with mauls or other tools that will damage them.

271. The largest and best ties shall be used at the joints. The maximum spacing of ties at the joints shall not exceed 10 inches. Intermediate ties shall be spaced uniformly as measured from the center of the ties.

272. All ties shall be placed at right angles to the track and none shall be placed obliquely to suit irregular joints.

273. All ties shall be lined from the center of the track. Care must be exercised in placing treated ties which are bored and adzed so that spikes will fit the bored holes.

274. When necessary, twisted and crooked ties may be adzed in order to obtain proper bearing for the base of rail or tie plate.

275. Bowed ties shall be placed with the bow up.

276. The excessive rail cutting of serviceable ties in the track is often the result of the adjoining renewed ties not furnishing their proportion of rail support, on account of being improperly tamped, which compels the older, solidly bedded ties to do double work, and results also in rough riding track. When renewing ties, the old tie bed and adjacent ties should be disturbed as little as possible. The new ties will be solidly tamped and the track left in good line and surface.

277. The tamping and ballast trimming for all ties renewed should be completed each day.

278. New, treated ties will in no case be used for temporary tracks, cribbing, or blocking. New ties of any kind shall not be used for other purposes than cross ties without special authority.

279. In renewing ties, the track will not be jacked up to pull out ties as the ballast is disturbed and runs under adjoining ties, spoiling the surface of the track.

280. Tie plugs will be kept on hand and the invariable practice will be to plug every spike hole from which the spike has been withdrawn, using treated plugs. Care will be taken to drive plugs the full depth of hole. When practicable spikes will be driven into the plugged holes to avoid weakening the tie by additional holes.

281. New ties, when not required for immediate use, will not be allowed to remain scattered along the track but will be piled on dry ground less than 15 feet from the center of nearest track, in neat piles of approximately 75 ties in each pile. Untreated ties shall be piled in layers of nine alternately parallel with and at right angles to the track, except the bottom layer which shall be at right angles to the track but contain only two ties.

282. Ties shall not be distributed where they will block ditches, culverts or other waterways, nor where they are likely to be carried away by flood.

SPIKING

283. Cross ties on tangent track shall be spiked to each rail with two spikes. The two inside spikes shall be driven near the *west* edge and the two outside spikes near the *east* edge of the tie but not less than 2 inches from the edge; timetable directions to govern.

284. On curves, three or four spikes may be used for each rail as necessary to, hold track to gauge. When three spikes are used with tie plates the third one shall be driven close against base of rail.

285. Care shall be taken to prevent injury to the rail by a blow from the maul.

286. Neck-worn spikes shall not be used.

287. The gauge shall always be used when spiking and not lifted until spikes are fully driven.

288. Spikes shall not be placed in the slots or near the ends of insulated joints or of joints on bridges.

TIE PLATES

289. Plates shall be so set as to give uniform bearing on the tie and for the rail on the tie plate, and ties shall be adzed where necessary only sufficiently to secure these results. Plates shall be set at right angles to the rail and with the shoulders tight against the rail base.

290. Canted plates (plates that cause the rail to lean in towards the center of the track) shall not be spotted in with flat plates, but may be placed out-of-face under proper conditions and authority.

JOINTS

291. Provisions for expansion at joints will be made in line with current instructions. Rail joints must at all times be fully bolted and kept tight. Broken or cracked joint bars must be replaced and joint ties must be properly spaced and tamped. Center bolts must be tightened first. In tightening bolts standard wrenches must be used.

TURN-OUTS

292. Switches and turn-outs must be installed and maintained according to standard plans or special instructions.

Where it can be avoided, turn-outs should not be located on the outside of curves; and on track where the traffic is in one direction, they should not face the current of traffic.

293. *Stock rail.*—In split switches, the gauge side of the main track point must be in line with the gauge side of the stock rail in advance of the point. The point must fit closely and accurately to the stock rail throughout. The bend in the stock rail will be in accordance with standard plans and will be kinked with a rail bender. Throughout turn-outs, special attention will be paid to the surface, and care taken that the heel of the switch point does not become low.

294. *Guardrails.*—Guardrails will be applied in accordance with standard plans. When approved forms of guardrails, other than shown on standard plans, are used, they will be applied in accordance with special instructions.

295. *Flangeways.*—The flangeways of guardrails will be maintained at the width shown on standard plans; a wide flangeway causes excessive wear on the frog.

296. Switch points must fit accurately against stock rail and be properly adjusted. Switch stands must be kept fully fastened to head-block ties and set plumb. Switch targets must be kept securely fastened and in proper position.

297. Movable point crossings, spring rail frogs and switches must be kept clean, oiled, and free from snow, ice, or other obstacles. All movable parts must work freely.

298. All ties throughout the turn-out or crossing must be kept firmly tamped. Slide and heel plates must be centered on the tie and provide a full, even bearing for the switch points. When renewing a switch point the stock rail must also be renewed where necessary to secure a proper fit.

299. All bolts in switches, frogs, guardrails, and crossings must be kept tight. Foot guards at frogs and switches and fillers at guardrails must be maintained in accordance with the standard plan.

300. A thorough inspection must be made each working day by track supervisor or track foreman of all turn-outs on main line and important switching leads, testing and examining switch and switch stand for lost motion, throw, gauge and line through turn-out, condition of plates, joint bars at heel of points, switch locks, connecting rod bolts, cotter keys, loose bolts, rivets, point and throat wear of frog, movement of wing rail and its connections, spring bolts, spring housing, hold-down devices; examine guardrails for wear, condition of clamps, gauge and bearing on ties.

301. Throw of switch points, when installed, will be $4\frac{3}{4}$ inches and will not be permitted to become less

than 4 inches in main track or less than $3\frac{1}{2}$ inches in other track switches.

302. The proper elevation of stock rail and wing rail of frog must be maintained.

303. Switch must be unlocked once each week and points thrown to determine that switch operates freely, points fit closely when thrown, and rods do not engage ties.

304. At the end of each day's work of surfacing, the entire piece of track worked over that day must be lined. It must be lined before filling in, as the ties can then be moved without side friction in the ballast. If track is allowed to remain out of line or surface for any length of time, bad gauge is likely to result therefrom; gauge must always be checked and necessary corrections made.

305. When track is being raised and surfaced, run-offs must be such as to provide safe and comfortable passage of trains at maximum permissible train speeds, and in no case at a rate in excess of that shown in table.

LINING AND SURFACING

306. Track must be maintained to true line and surface.

307. In hot weather, lack of expansion or creeping rail may cause track to buckle and kink out of line. This condition must be relieved by loosening the joints and equalizing the expansion. When lining or surfacing in hot weather, the track must be carefully watched to detect any tendency to buckle or kink, especially at the foot of heavy grades or in sags, loosening the bolts, if necessary, at points where there is expansion. Do not open up a section of track in hot weather and permit trains to pass over it except at restricted speed. It is preferable not to disturb the track during the heat of the day. When the temperature is above 80°, trouble may be expected at the foot of grades or in sags. When surfacing track, wherever possible, the work should be done against the direction in which the rail tends to run.

308. Sections of track opened up must be filled in completely before the end of the day's work and loosely filled track protected by orders when necessary.

309. Track will go out of line where it is out of level. Center bound track also goes out of line quickly. Before lining track it must be leveled up and put to proper gauge.

310. A level board must be used at all times in surfacing track, both on tangents and curves, and whether surfac-

ing out of face or surfacing up low spots, spotting joints, centers, quarters, etc.

311. When surfacing track, jack must be set in the crib ahead of the joint to avoid bending angle bars. Jack must also be set plumb to avoid throwing track out of line.

312. Track jacks must not be used between the rails unless protected by flag.

313. The inner rail of a curve is the grade rail and must be maintained at true grade and surface. The outer rail must be brought to the established superelevation by use of the level board after lower rail is surfaced.

RAILROAD CROSSINGS

314. Railroad crossings will be inspected each working day by track supervisor or track foreman, and must be maintained in true line, gauge, and surface. Bolts must be kept tight and broken bolts replaced. The drainage of the roadbed at all crossings is of utmost importance and must be given special attention.

315. At railroad crossings where the weight of rail in the crossing is different from rail in the balance of the track, there must be a full length of rail adjoining all the crossing frogs of the same section at the crossing. When railroad crossings are replaced with new ones, new rails should be placed in the track against the crossing frog to prevent battered wing rails.

BRIDGES AND CULVERTS

316. Bridges and culverts must be inspected at regular intervals as directed by the engineer of maintenance, by the bridge inspector or bridge and building foreman.

317. In addition, section foremen are responsible for the safe condition of bridges and culverts on their sections.

318. Culverts must be kept clean and ground around bridges must be cleaned to avoid fire. Any unsafe condition around bridges must be reported as prescribed by rules.

319. When a steel span forming a part of any bridge has been damaged, no train will be allowed to cross until authorized by the superintendent.

An immediate inspection will be made to determine nature and extent of damage and report wired to the superintendent, division engineer, and supervisor.

Report of damage should state extent to which any steel member is out of line, broken, or disconnected, and its location with reference to one end of bridge, the center of track, and the base of rail; also whether it is a vertical, horizontal, inclined, or transverse member.

SIGNALS, TELEPHONE AND TELEGRAPH

320. Inspections of apparatus must be made at sufficiently frequent intervals to insure that it is in proper condition and functioning as intended.

Rails must be kept free from any type of ballast.

Joints must be tight and properly bonded.

Insulated joints must be carefully installed to prevent damage to insulation.

No joint must be opened without the presence of the section foreman.

Switches must be insulated and fit stock rail snugly.

Switch boxes must be adjusted to shunt track or line circuit when point is open $\frac{1}{4}$ inch or more.

Fouling circuits or turn-outs must be tested for continuity.

Electrical measurement must be made to detect excessive current on relays and excessive leakage on road crossings.

Foreign wires or fixtures must not be attached to a MRS line without authority from signal supervisor.

Avoid opening or shorting lines, or taking any other action which will interrupt train service or communication.

Care must be taken to avoid a cross between signal line, communication lines, or power supply lines.

Power lines must be handled with rubber gloves, as well as insulated tools, as no dependence can be placed upon the insulation of the tool or of the wire, nor should

any dependence be placed upon the information that the power is off.

Wires must be pulled tight and tied to clean insulators. Defective insulators must be replaced.

Wire joints must be properly made, soldered and taped.

Line drops must have drip loops.

Line drops must pass through lightning arresters before entering any building, signal, or instrument case.

Frequent tests, especially after electrical storms, must be made to see that line circuits are not grounded.

321. Poles must be sound and set upright.

Poles must not be climbed unless it is evident that they will support the weight of a man.

No dependence must be placed upon a cross arm supporting the weight of a man.

Safety belts must be used to allow the freedom of both hands.

Pike poles and raising fork must be used in setting poles.

When necessary for two men to be on the same pole at the same time, one man must ascend or descend before the other starts to do so.

Wires should be carried up a pole in such a manner that they can be quickly dropped if necessary. Under no consideration should they be attached to the safety belt.

When pulling or releasing wires on curves, linemen must be on the outside of curve.

Guy wires will be used as per the requirements of the line.

Extreme care must be used in running wires through trees.

Climbers must be removed when walking on the ground.

Climbers will not be used after the gaffs are worn down to $1\frac{1}{4}$ inches, measured on the underside.

Each man is responsible for the condition of his own belt.

322. Kinks in wire must be avoided. If they do occur they must be carefully removed by hand and not thrown or pulled out.

Insulated wire must be kept free from oil and grease.

"Pay-out" and "take-up" reels must be used for line wire.

When sleeves are not used, wire joints must be soldered and properly insulated with tape.

When skinning insulated wire, care must be exercised in order not to nick the wire. Galvanized wire must not be scraped farther back than necessary to make the joint.

323. Signals of all types must be maintained erect, in proper focus and securely locked.

All wire and cable entrances must be stopped to keep out moisture and rodents.

Blades and lenses must be kept clean.

Semaphore signals must be oiled with a high grade nonfreezing oil.

Unauthorized persons must not be permitted to loiter in or around an interlocking tower.

Maintainers must know that the levermen or operators have full knowledge of the operation of their plant.

All switches and signals must be in proper adjustment and well oiled.

Mechanical connections must be securely cottered.

Spare material can be housed in or near the tower for ready distribution in emergency.

When necessary to disconnect any switch or derail, they must be spiked, and an understanding must be reached with the leverman or operator to insure the safety of trains.

Hand signals for a train to proceed must not be given by maintainer.

When not in use, tools that are standard equipment for an interlocking plant must be kept in a place provided for them.

Oil and grease must be kept out of tower.

Fire protection apparatus must be kept in a conspicuous and accessible place.

324. Electrical equipment owing to its delicate nature must be handled with extreme care to avoid mechanical injury or throwing it out of adjustment.

Wherever any electrical equipment is connected to track or line it must be protected by lightning arresters.

Voltage or current readings must be taken on all coils to guard against saturation or burn-outs.

Core pins must be checked to see that armatures have sufficient air gap.

Contacts must be clean, have proper tension, and seat properly.

Relays must not be turned over to close contacts.

No attempt must be made to repair delicate parts in the field.

Transformers must not be overloaded beyond their capacity. If no capacity tag is in evidence, overloading can be detected by heating and excessive humming.

Rectifiers must be checked to ascertain that they are furnishing the proper voltage for the battery they feed.

Power transfer relays must be inspected for floating contacts when the primary voltage is low.

Lamp bulbs must be burned approximately 10 percent under voltage.

Commutators on motors must be kept clean and the mica between segments cut down.

Motor brushes must have the proper tension.

325. Where practicable, dry cells must be kept in a cool place and in an upright position.

Both in storage and in service, cells must be separated by wood or cardboard to prevent the zinc sides and binding posts of adjacent cells from touching.

Cells must be used as soon as practicable to prevent deterioration from lack of use.

Binding posts must be kept clean and tight.

Caustic soda cells must be set up as follows:

a. Immerse element in clean water for complete saturation while other preparations are being made.

b. Fill jar two-thirds full of clean water.

c. Dissolve soda in water slowly, stirring with clean stick or paddle to prevent caking.

d. Place element in jar and add sufficient water to cover element.

e. Allow solution to cool until jar can be touched with back of hand.

f. If soda does not contain oil, add the oil that comes in separate bottle.

g. Clean negative wire and cell is ready for service.

The life of the cell can be determined by the proportion of the zinc plate that has been eaten off.

In renewing cells, care must be taken not to pour the exhausted solution into running water or where anyone can step into it. If possible, a hole should be dug and the solution poured into it, and empty soda cans put into it and the hole well covered to prevent stepping through.

Caustic soda is injurious to vegetation, clothing, and skin. *Use vinegar for a neutralizer.*

Lead acid type storage batteries should be housed in ventilated places, as they give off acid fumes, while being charged.

Exposed metal parts, other than lead, should be coated with vaseline or acidproof paint.

Jars should be set in clean sand and separator for ready inspection.

Connections must be tight. Loose connections cause heating and loss of voltage.

The electrolyte must be kept at $\frac{3}{4}$ inch above the plate. Water added must be distilled or known to be free of minerals. This water must be added at the beginning of the charge.

Sulfuric acid must not be added to the electrolyte to raise the specific gravity unless the cell cannot be fully charged.

The electrolyte must be handled carefully as it is injurious to person and clothing.

Caution: If electrolyte is spilled upon the clothing soak the spot in *strong ammonia*. To prevent burning of holes, a solution of baking soda and water is useful for washing hands after working with the electrolyte. Should any electrolyte splash into the eye, wash the eye at once with clean water and then put in two drops of olive oil. If olive oil is not available, any kind of engine oil is better than entirely doing without.

Storage batteries are charged by the "floating" and "nonfloating" methods.

The floating charge provides a constant voltage of 2.1 volts per cell by means of a rectifier.

The nonfloating charge is at a tapering rate which is reduced as the cell approaches full voltage. This is accomplished by means of motor generators and mercury arc, electrolytic mechanical vibrating, and dry plate rectifier.

The voltage of the charging source must be sufficiently greater than the battery to cause the proper current flow.

If a cell (or battery of cells) has been completely discharged it must be charged immediately to avoid deterioration.

When adding acid to a cell, pour slowly and stir with glass rod or rubber paddle. *Never pour water on acid.*

326. No tool must be used for any purpose other than that for which it was intended.

Edged tools must be kept sharp and the edge protected when not in use.

All tools must be kept in the place provided for them.

Extreme care must be exercised when loading tools on motorcar or push cars so that they do not fall off enroute.

GENERAL RULES FOR SUPERVISORY OFFICERS AND FOREMEN

327. They will familiarize themselves with the operating and maintenance rules, and will know that personnel under their charge are familiar with the operating rules in regard to train signals and flagging and that they fully understand and comply with them.

328. They will see that personnel under their jurisdiction, where required, provide themselves with standard watches, current timetables, and such manuals as may be necessary for their guidance in the performance of their duties.

329. They must know that all employees under their charge are capable of performing their duties properly, see that the work is properly done, and that they make the required reports.

330. They will know that the men under them are supplied with proper tools and material necessary for the efficient performance of their duties and see that these are properly used and cared for.

DUTIES OF PERSONNEL

331. Engineer, maintenance of way (captain and company commander) is directly responsible to the division superintendent. He has charge of all engineering pertaining to maintenance of way and supervises maintenance of track, roadbed, bridges, buildings, fences, and other structures, water supply, and signals and communications; makes frequent inspections to see that his organization is securing proper standard of maintenance; approves and checks before forwarding all requisitions for material; and is responsible that sufficient stock is maintained on the division. He is also responsible for military administration of his company and for rendition of military and railway reports. His territorial limits are the same as those of the division superintendent.

332. Assistant engineer, maintenance of way (second lieutenant) normally handles administration and supply matters under direction of the company commander. He may be delegated such other duties as the situation requires.

333. Platoon commander, supervisor of bridges and buildings (first lieutenant) reports directly to and receives instructions from the engineer, maintenance of way (company commander), to whom he is responsible for the safe and proper maintenance of bridges, culverts, buildings, fuel and water stations, turntables, pipe lines, heating plants, and other roadway structures. He must

familiarize himself with operating rules and special instructions.

He directs the work of the bridge and building sections and sees that they are supplied with proper and adequate material, tools, and equipment, and is responsible for the proper messing and care of his men. He must make periodical inspections over his assigned territory to see that his organization is functioning and securing a proper standard of maintenance.

He is responsible for maintaining an adequate emergency bridge material stock and will, when necessary, cooperate with track and other forces in opening and maintaining the line.

He will see that regular and thorough inspections of structures are made by the bridge inspector, and will check reports submitted by the inspector and arrange for necessary repairs.

334. Track supervisor (first lieutenant and platoon commander) reports directly to and receives instructions from the engineer, maintenance of way, to whom he is responsible for the safe and proper maintenance of track and roadway. He must familiarize himself with operating rules and special instructions.

He directs and supervises the work of the track sections and sees that they are supplied with proper and adequate materials, tools, and equipment and is responsible for the proper messing and care of his men. He will make periodical inspections over his assigned territory to see that his organization is functioning and securing a proper standard of maintenance. He is responsible for maintaining an adequate stock of emergency material and will, when necessary, cooperate with other forces in opening or maintaining the line.

35. Signal and communication engineer (first lieutenant) will report to the engineer of maintenance and is

responsible for the safe condition and proper maintenance of signals, interlocking plants, and telephone and telegraph lines. He must know that signalmen and linemen perform their work properly and make necessary inspections.

He must frequently inspect all signals, interlocking and communication lines and have necessary repairs made as promptly as conditions require. He must see that all failures of signals and communications are promptly investigated and reports made on prescribed forms.

He must, in case of damage to signals or interlockings, promptly assemble forces, tools, and materials to make necessary repairs.

336. Assistant to the supervisor of bridges and buildings (technical sergeant) second in command, and handles such matters as may be delegated to him by the platoon commander. He keeps all bridge records, prepares requisitions for bridge materials, prepares bridge reports, and keeps informed of the location of bridge materials, their kind and quantity. He keeps technical records of other structures assigned to the bridge and building maintenance platoon. He supervises activities of the staff sergeants, bridge and building foreman.

337. Water service foreman (staff sergeant) reports to and receives instructions from the supervisor of bridges and building (platoon commander).

He directs the work of the water service mechanics and is responsible for all matters pertaining to water service and for the proper maintenance of pipe lines, heating plants, and water stations, and will handle such other general mechanical work as is delegated by the platoon commander.

338. Bridge inspector (technician fourth grade) reports to the platoon commander, makes daily inspections of bridge and structures, and performs such other duties as may be assigned by the platoon commander.

He will inspect and report to the platoon commander the condition of timber, steel, culverts, etc.

He will closely observe all bridges, trestles, culverts, etc., noting and reporting any unusual conditions such as settlement or an excessive scour around piers, abutments, or bents. He will report any conditions requiring riprap or other bank protection.

In case of damage or defects requiring immediate repairs he will, after protecting traffic, make report by wire or telephone to the platoon commander and B and B foreman.

339. Bridge and building foreman (staff sergeant) will report to and receive instructions from the supervisor of bridge and building (platoon commander). He must familiarize himself with the operating rules and special instructions and is responsible for the safe and proper performance of the work assigned to him. He must inspect all structures upon which he is working and report any defects found. He will do no work on a structure which might interfere with the safety of traffic without proper flag protection and will so plan his work that train delay will be reduced to a minimum.

He will employ his men as directed by the supervisor and see that they perform their duties properly. He is responsible for the proper discipline of his men. He is responsible for the proper care and use of tools and materials.

He must, upon completion of any work, clear the premises of any debris and make proper disposition of material and scrap and exercise precaution for prevention of fire.

340. Assistant track supervisor (staff sergeant) handles administration, supply, and such other matters as may be delegated to him by the track supervisor. He will keep records and reports and handle requisitions. He will keep informed of the location, kind, and quantity of tools and materials available.

341. Track maintenance sergeant reports to and receives instructions from the track supervisor. He must familiarize himself with the operating rules and special instructions, and is responsible for the safe and proper maintenance of his track. He supervises the work of his section and sees that his men properly perform their duties. He is responsible for the proper care and use of tools and materials and for the care and discipline of his men. He will do no work which might interfere with the safe passage of trains without proper flag protection and will so plan his work that train delays will be reduced to a minimum.

342. Track section foreman (corporal) is responsible for the maintenance of tracks, roadbed, and right-of-way of the territory allocated to him. He is responsible for discipline and training his men, and for tools and materials assigned to him by the track maintenance sergeant. He goes over rail lines of his area or sends a reliable track walker with suitable tools at least once a day to make thorough inspection and see that track, highway crossings, bridges, culverts, fences, signals, telegraph lines, etc., are in safe condition.

If signal, telephone, or telegraph lines are found crossed or down, they must make temporary repairs, if possible, and report facts to dispatcher.

343. Assistant signal and communication supervisor (staff sergeant) reports to and receives instructions from signal supervisor.

He will be responsible for the proper installation, maintenance, and safe condition of signals and interlockings under his charge and will do no work thereon that will interfere with the safe passage of trains, except under proper protection.

He will make such inspections of signals and interlockings as the signal supervisor may direct, and report all defects found on prescribed forms.

For each job when complete, or for each job not completed at the end of the month, report of material used must be made on prescribed form and promptly sent to the signal supervisor.

He will, in case of damage to signal or interlocking apparatus, promptly proceed to the place with men, tools, and materials at their command, and make necessary repairs.

When necessary to do any work requiring cooperation of track forces, he will notify the track foreman a sufficient time in advance so the work will not be delayed. He will instruct the track foreman as to proper method of doing the work so far as operation of signal devices is concerned and will when necessary, leave a competent man in charge to see that the work is properly done.

SIGNAL TELEPHONE AND TELEGRAPH MAINTAINERS

344. Signal and telephone maintainers receive instructions from report to signal supervisor.

They are responsible for the proper installation and maintenance of all signal, telephone, and telegraph equipment, and all track and line circuits pertaining thereto, in their territory.

They will have charge of, and be responsible for, the work of all personnel in their charge.

They will inspect apparatus at sufficiently frequent intervals to insure that it is in proper condition and functioning as intended.

They will make necessary repairs to apparatus and restore it to service as quickly as possible.

They will, in case of failure to apparatus which cannot be repaired promptly, insure the safety of trains until apparatus is restored to service.

They will, except in emergency, take no apparatus out of service without first notifying or receiving permission from the chief dispatcher.

They will report on forms provided therefor, failure of all apparatus.

They will have charge of and be responsible for the proper use of all tools and materials in their charge.

They will comply with the "Regulations for Operating and Maintaining Motor Cars."

They will cooperate with the personnel of other sections to the best advantage of the Military Railway Service.

WATER SERVICE MECHANICS

345. Water service mechanics will work under the direct supervision of the foreman.

They will install and maintain all pipe work and appurtenances including water, steam, gas, oil, and air lines (above and below ground) at engine houses, passenger stations, fuel and water stations, and all other roadway buildings.

They will install and maintain pumps, motor, and engines used in connection with water service and will do such other general mechanical work as may be assigned by the foreman.

They will be responsible for the operation and maintenance of pumping plants under their jurisdiction and will keep a record of plant performance.

Mechanics will keep houses, repair shops, and all buildings in their charge in a neat and clean condition and will store and dispose of waste in such a manner as to guard against fire. They are responsible for proper care and use of tools and supplies issued to them.

BLOCK SIGNALS AND INTER-LOCKING DEFINITIONS

Manual block system. A series of consecutive blocks, governed by block signals operated manually, upon information by telegraph, telephone, or other means of communication.

Automatic block system. A series of consecutive blocks governed by block signals, cab signals, or both, actuated by a train, or engine, or by certain conditions affecting the use of a block.

Interlocking. An arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically.

Block signal. A fixed signal at the entrance of a block to govern trains entering and using that block.

Home signal. A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block.

Approach signal. A fixed signal used in connection with one or more signals to govern the approach thereto.

Dwarf signal. A low home signal.

Limited speed. A speed not exceeding 15 miles per hour.

Medium speed. A speed not exceeding 10 miles per hour.

Slow speed. A speed not exceeding 5 miles per hour.

Restricted speed. Proceed prepared to stop short of

train, obstruction, or switch not properly lined and to look out for broken rail.

NOTE. A signal imperfectly displayed, or the absence of a signal at a place where a signal is usually shown, must be regarded as the most restrictive indication that can be given by that signal, except that when the day indication is plainly seen, or when sufficient lights in a position or color position light signal are displayed to determine indication of the signal it will govern.

A signal imperfectly displayed or the absence of a signal at a place where a signal is usually shown, must be promptly reported to the dispatcher.

TABLES, DIAGRAMS, AND MISCELLANEOUS INFORMATION

<i>Description</i>	<i>Page</i>
Ballast—Table cubic yard per mile various gauges	99
Bridges:	
Cooper's rating timber bridges.....	99
Nomenclature of steel bridges.....	100
Method of rating steel bridges.....	102
Repairs to pile trestles.....	104
Standard plan pile trestles.....	105
Timber crib pier.....	127
Conversion tables.....	129
Crossover data.....	130
Curves:	
Degree and gauge.....	131
Elevation of outer rail.....	132
Middle ordinates for curving rail.....	133
Drainage—Dun's tables.....	134
Rail:	
Method of cutting rail.....	135
Expansion at joints.....	136
Failures.....	137
Surplus rail piles.....	138
Standard sections.....	139
Roadbed section:	
Standard.....	140
Various gauges.....	141
Slow flags—method of placing.....	142
Spiral table.....	147

<i>Description</i>	<i>Page</i>
Surfacing—run-offs.....	144
Switches—method of installation.....	145
Switch and turn-out data.....	148
Switch stand berm—track car set-off.....	166
Temporary run-around tracks.....	168
Ties:	
Turn-outs and cross-overs.....	169
Method of piling	171
Spacing	172
Turn-out data—various gauges.....	172
Turn-out—diagram standard #8	173
Welding:	
Care of equipment.....	174
Recommended practices	175

CUBIC YARDS BALLAST PER MILE OF TRACK

Inches of Ballast under tie	Track Gauge				
	2'6" and 3'0"	3'3" and 3'3 3/8"	3'5 3/8" and 3'6"	4'8 1/2" and 5'0"	5'3" and 5'6"
4	1,391	1,391	1,468	1,529	1,605
5	1,619	1,619	1,708	1,779	1,868
6	1,849	1,849	1,951	2,032	2,134
7	2,088	2,088	2,203	2,295	2,410
8	2,345	2,345	2,473	2,577	2,706
9	2,605	2,605	2,748	2,863	3,006
10	2,855	2,855	3,011	3,137	3,294

20-inch tie spacing. Ballast dressed even with top of tie and slope 1:4.

COOPER'S RATING FOR TIMBER BRIDGES

Span lengths for varying size stringers

No. and size of Stringers	E-30	E-35	E-40	E-45	E-50	E-55	E-60
6-8x16	17'6"	16'3"	15'2"	14'3"	13'6"	12'9"	12'3"
6-7x16	16'6"	15'2"	14'2"	13'4"	12'8"	12'1"	11'8"
6-12x12	16'0"	14'9"	13'9"	13'0"	12'4"	11'11"	11'5"
6-7x14	14'2"	13'1"	12'4"	11'9"	11'3"	10'10"	10'6"
4-8x16	14'2"	13'1"	12'3"	11'9"	11'3"	10'10"	10'7"
4-7x16	13'2"	13'3"	11'7"	11'1"	10'8"	10'3"	9'9"
4-12x12	13'0"	12'2"	11'6"	10'11"	10'6"	10'4"	9'8"
4-7x14	11'8"	11'0"	10'6"	10'0"	9'7"	9'4"	9'0"

NOMENCLATURE FOR STEEL BRIDGES

TRUSSES ARE EITHER RIVETED OR PIN CONNECTED.

T.P.C.T. THRU PIN CONNECTED TRUSS
 D.P.C.T. DECK PIN CONNECTED TRUSS
 T.P.G. THRU PLATE GIRDER
 T.R.T. THRU RIVETED TRUSS
 D.R.T. DECK RIVETED TRUSS
 D.P.G. DECK PLATE GIRDER

GIVE ALL DIMENSIONS FROM CENTER LINE OF TRUSSES OR GIRDERS, CENTER LINES OF STRINGERS, FLOOR BEAMS, CENTERS OF PINS, BACK TO BACK OF ANGLES.

DESIGNATE PANEL POINTS AS SHOWN ON SKETCH. SHOW WHICH END IS FIXED AND WHICH IS EXPANSION. FOR EXAMPLE, TO REPORT BROKEN HANGER IN 2-T.P.C.T. SPAN BRIDGE, SAY 1 INSIDE (OR OUTSIDE OR BOTH) EYE BARS BROKEN, LEFT (OR RIGHT) TRUSS MEMBER U11, SPAN No. 2, BREAK 3 FT. 2 INS. FROM PIN U1.

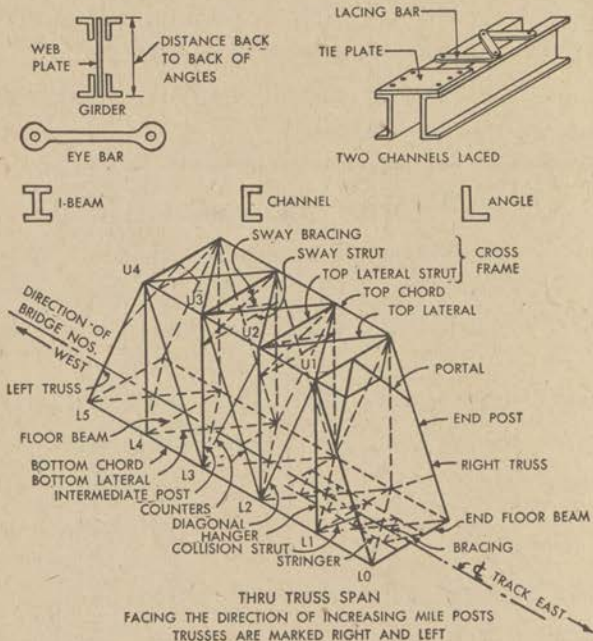


FIGURE 20.

NOMENCLATURE FOR STEEL BRIDGES

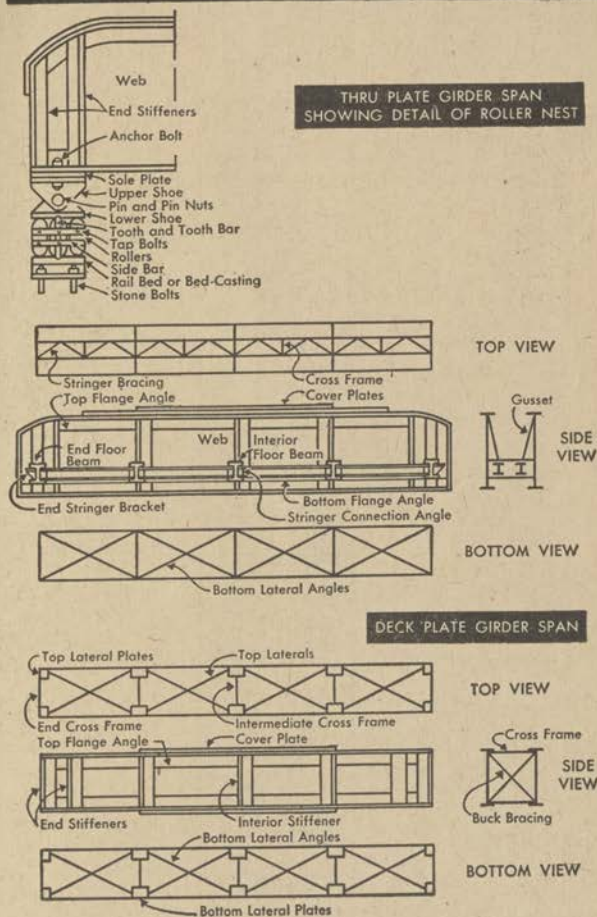


FIGURE 21.

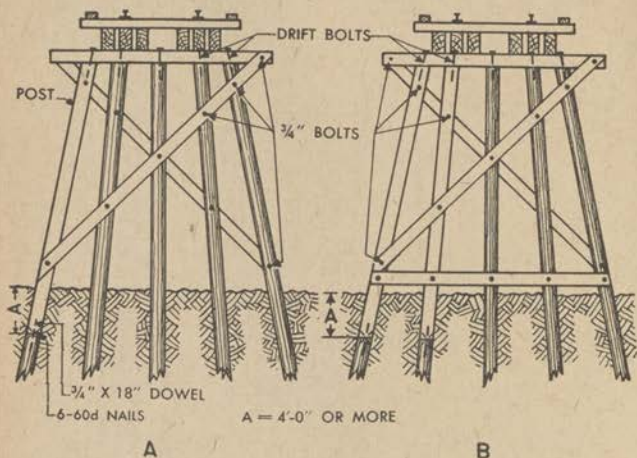
BRIDGE CAPACITIES EXPRESSED IN COOPER'S E RATING, AS REFLECTED IN THE DIMENSIONS
OF THE STRINGERS OF STEEL TRUSS OR OPEN DECK GIRDER BRIDGES OF VARIOUS PANEL
LENGTHS

Panel length in feet		10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30	35
Dimensions of stringers in inches																		
Lower flange	Thick- ness	Beam depth		Size of angles														
		Width																
$\frac{3}{8}$	$8\frac{3}{8}$	18	4 by 3 by $\frac{3}{8}$	E-42	E-41													
$\frac{3}{8}$	$10\frac{3}{8}$	24	5 by $3\frac{1}{2}$ by $\frac{3}{8}$	---	E-40													
$\frac{1}{2}$	$10\frac{3}{8}$	30	5 by $3\frac{1}{2}$ by $\frac{1}{2}$	---	E-61													
$\frac{1}{2}$	$12\frac{1}{2}$	30	6 by 4 by $\frac{1}{2}$	---	---													
$\frac{1}{2}$	14	36	6 by 4 by $\frac{1}{2}$	---	---													
1	$12\frac{3}{8}$	42	6 by 4 by $\frac{1}{2}$	---	---													
$1\frac{1}{8}$	14	42	6 by 4 by $\frac{1}{2}$	---	---													
				E-42	E-41	E-41	E-35	E-31	E-27	E-41	E-37	E-33	E-30	E-27	---	---	---	
				---	E-48	E-40	E-59	E-51	E-46	E-50	E-45	E-41	E-37	E-31	E-26	---	---	
				---	---	E-61	---	E-62	E-56	E-60	E-58	E-55	E-54	E-51	E-48	E-43	E-39	E-34
				---	---	---	---	---	---	---	---	E-60	E-54	E-45	E-39	E-34	E-30	E-26
				---	---	---	---	---	---	---	---	---	E-63	E-60	E-57	E-54	E-51	E-45

[illegible]

For reinforced concrete slab ballast deck plate girder spans, reduce the rating given as follows: For spans 10 feet to 19 feet, reduce by 3; for spans 20 feet to 45 feet, reduce by 10; 50 feet to 75 feet, reduce by 12; 75 feet to 120 feet, reduce by 14. For girder bridge without stringers, use the dimensions of the girder itself.

METHODS OF REPAIRING PILE BENTS



NOTE
WHEN NECESSARY
TO REPLACE 1 OR
2 BAD PILES FIG.
A & B SHOW METHOD
OF REPAIR. WHEN
THERE ARE MORE
THAN TWO BAD
PILES BENT MUST
BE FRAMED AS
IN FIG. C.

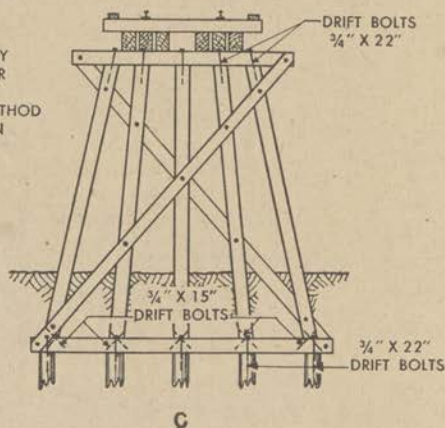
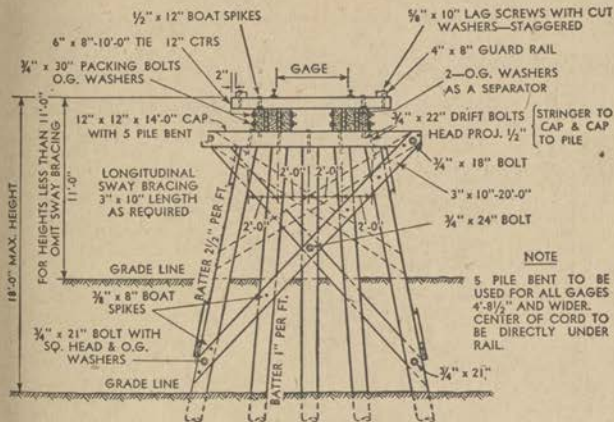
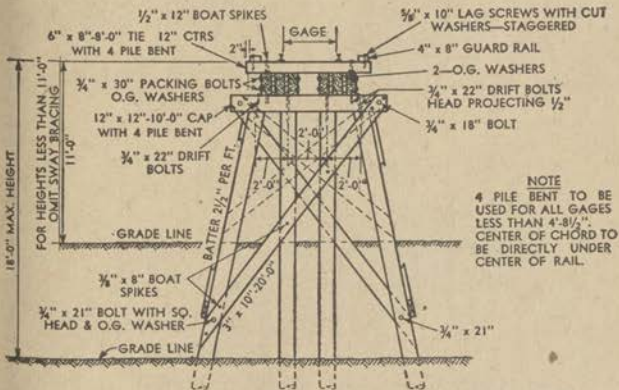


FIGURE 22.

4 & 5 PILE BENT OPEN DECK TRESTLES — ALL GAGES



5 PILE BENT

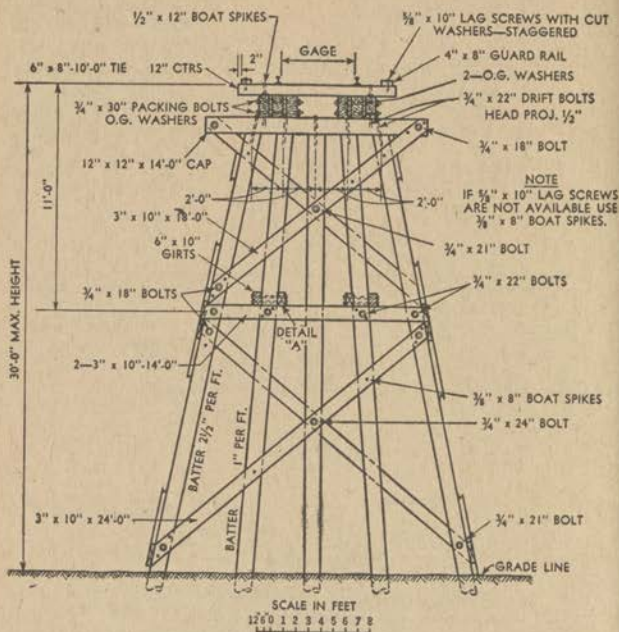


4 PILE BENT

SCALE IN FEET
12' 0 1 2 3 4 5 6

FIGURE 23a.

4 & 5 PILE BENT OPEN DECK TRESTLES—ALL GAGES



5 PILE BENT 19 FT. TO 30 FT.

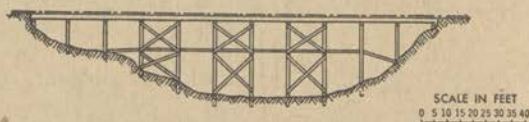
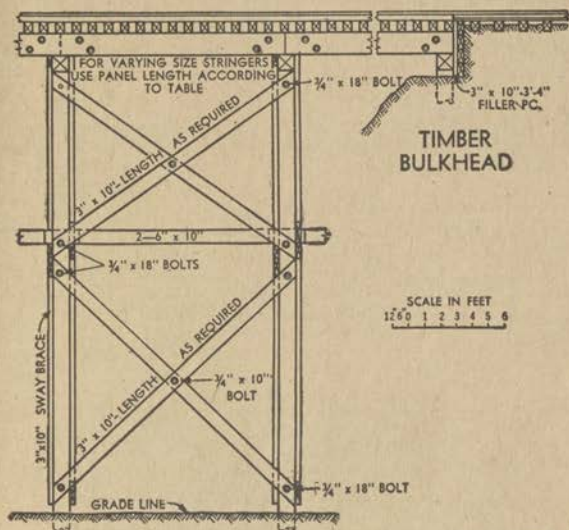


DIAGRAM SHOWING LONGITUDINAL BRACING
FOR TRETTLES 100' IN LENGTH OR LONGER OR 15' IN HEIGHT OR HIGHER

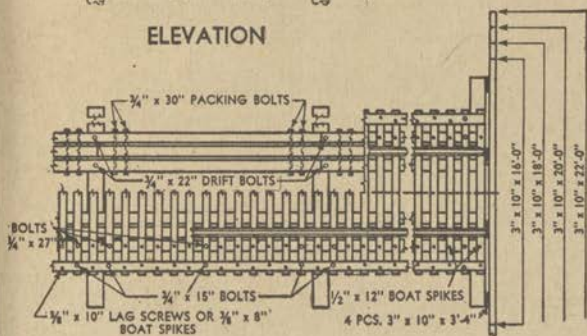
FIGURE 23b.

4 & 5 PILE BENT OPEN DECK TRESTLES — ALL GAGES

6" x 8" x 8'-0" (4 PILE BENT) & 6" x 8" x 10'-0" (5 PILE BENT) TIES 12" CTRS



ELEVATION



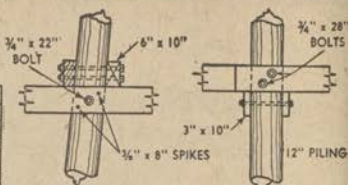
DECK PLAN

FIGURE 23C.

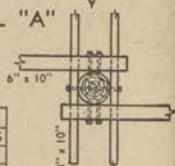
4 & 5 PILE BENT OPEN DECK TRESTLES—ALL GAGES

MAXIMUM PANEL LENGTHS FOR VARYING SIZE STRINGERS

STGRS.		COOPERS RATING			
No.	SIZE	E-30	E-40	E-45	E-50
6	8"x16"	17'-6"	15'-2"	14'-3"	13'-6"
6	7"x16"	16'-6"	14'-2"	13'-4"	12'-8"
6	12"x12"	16'-0"	13'-9"	13'-0"	12'-4"
6	7"x14"	14'-2"	12'-4"	11'-9"	11'-3"
4	8"x16"	14'-2"	12'-3"	11'-9"	11'-3"
4	7"x16"	13'-2"	11'-7"	11'-1"	10'-8"
4	12"x12"	13'-0"	11'-6"	10'-11"	10'-6"
4	7"x14"	11'-8"	10'-6"	10'-0"	9'-7"



DETAIL "A"



MATERIAL FOR 4 PILE BENTS

B/R TO GRD.	3"x10" BRACE	CAP C.D.	No. REQ.	HARDWARE			
				BOLTS	O.G. WAL.	SPIKES	DRIFTS
10'			1	2	3/4"x18"		
12'	2		1	2	"x21"		
14'		2	1	8	3/4"x3"		
16'			1	12		3/8"x8"	
18'			2	1	4		3/4"x22"

MATERIAL FOR ONE DECK PANEL

No. REQ.	STRINGER	6"x8" TIES	4"x8" GUARD RAIL	No. REQ.	HARDWARE			
					BOLTS	O.G. WAL.	LG. SC.	SPIKES
6	PER TABLE			6	3/4"x15"			
14		8' OR 10'		6	"x27"			
2			PAN LGTH	8	"x30"			
				4 D.B.	"x22"			
				22		3/4"x3"		
				22			5/8"x10"	
				22				1/2"x12"

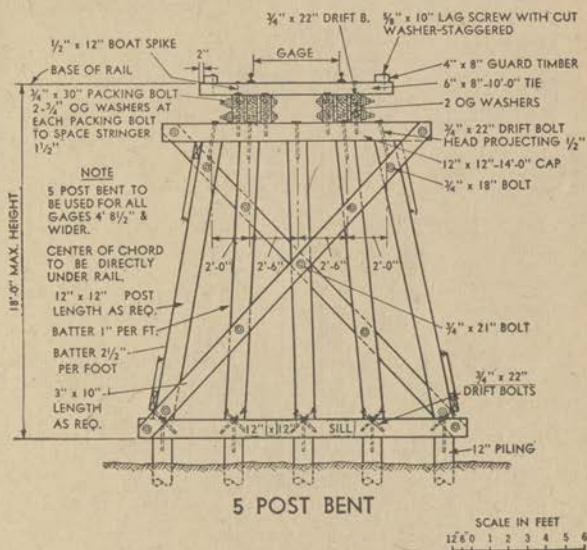
MATERIAL FOR 5 PILE BENTS

B/R TO GRD.	3"x10" SASH & SWAY BRACE					CAP C.D.	No. REQ.	HARDWARE			
	x14"	x16"	x18"	x20"	x22"			BOLTS	O.G. WAL.	SPIKES	DRIFTS
10'							1	2	3/4"x18"		
12'	2						1	2	"x21"		
14'		2					1	1	"x24"		
16'			2				1	10		3/4"x3"	
18'				2			1	14			3/8"x8"
20'	2	2	2				1	5			3/4"x22"
22'	2	2	2				1	6	3/4"x18"		
24'	2		4				1	1	"x21"		
26'	2		2	2			1	5	"x22"		
28'	2		2		2		1	1	"x24"		
30'	2		2				2	1	30	3/4"x3"	
LONGITUDINAL BRACING											
18' & UNDER 4-3"x10" LGTH AS REQ.							10-3/4"	5			3/4"x22"
18' & OVER							8"				

HWD. FOR 5 PILE BENT 20 TO 30'

FIGURE 23d.

4 & 5. POST BENT FRAMED TRESTLE—ALL GAGES



5 POST BENT

FIGURE 24a.

4 & 5 POST BENT FRAMED TRESTLE—ALL GAGES

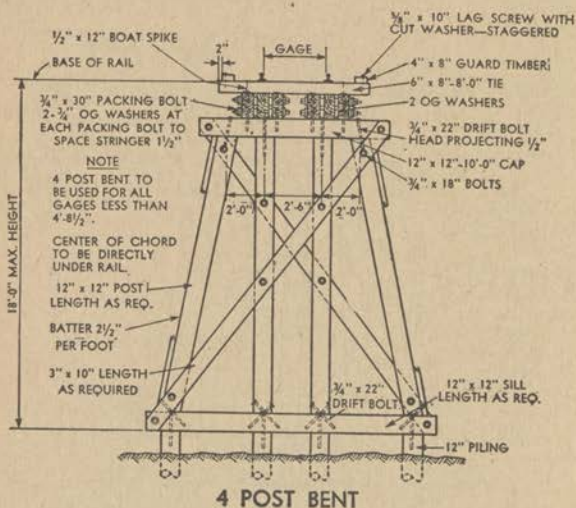


FIGURE 24b.

4 & 5 POST BENT FRAMED TRESTLE—ALL GAGES

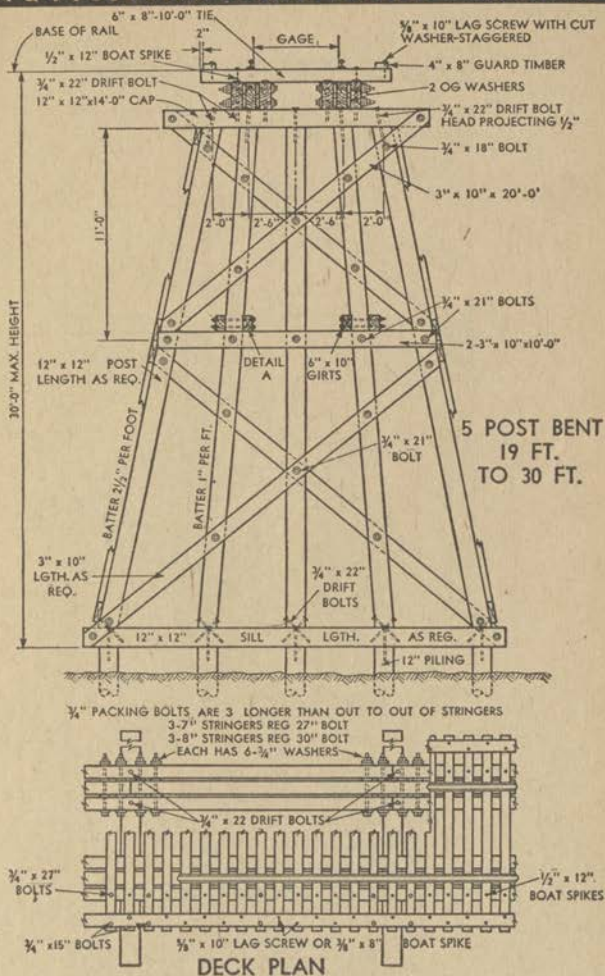
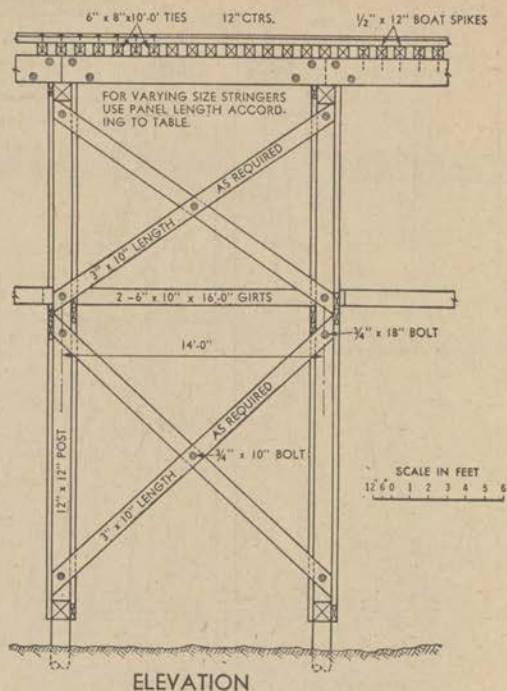


FIGURE 24c.

4 & 5 POST BENT FRAMED TRESTLE—ALL GAGES



MAXIMUM PANEL LENGTHS
FOR VARYING SIZE STRINGERS

No.	SIZE	COOPERS RATING			
		E-30	E-40	E-45	E-50
6	8" x 16"	17'-6"	15'-2"	14'-3"	13'-6"
6	7" x 16"	16'-6"	14'-2"	13'-4"	12'-8"
6	12" x 12"	16'-0"	13'-9"	13'-0"	12'-4"
6	7" x 14"	14'-2"	12'-4"	11'-9"	11'-3"
4	8" x 16"	14'-2"	12'-3"	11'-9"	11'-3"
4	7" x 16"	13'-2"	11'-7"	11'-1"	10'-8"
4	12" x 12"	13'-0"	11'-6"	10'-11"	10'-6"
4	7" x 14"	11'-8"	10'-6"	10'-0"	9'-7"

FIGURE 24d.

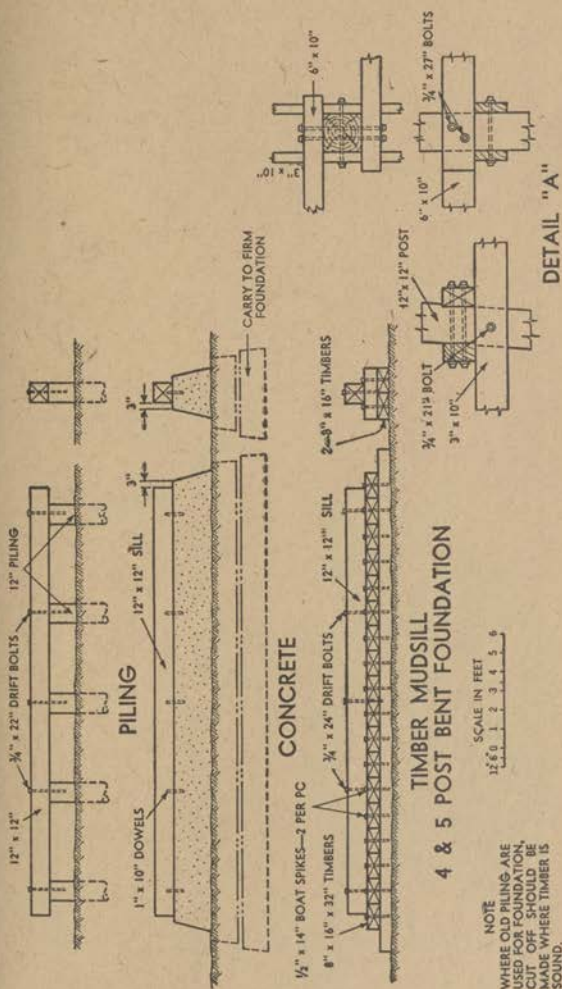


FIGURE 25a.

4 & 5 POST BENT FRAMED TRESTLE—ALL GAGES

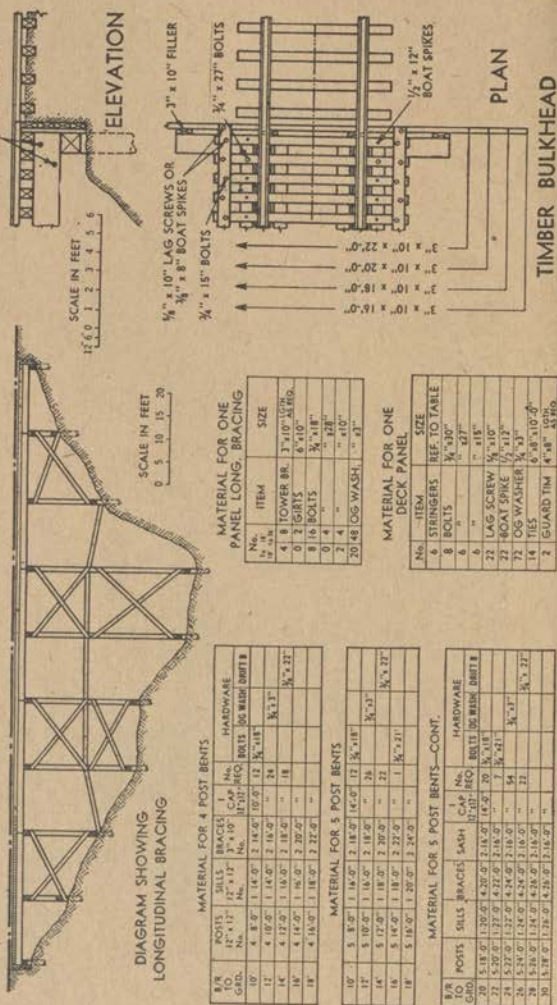
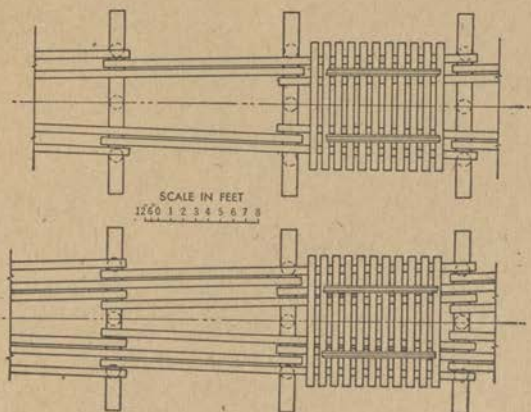
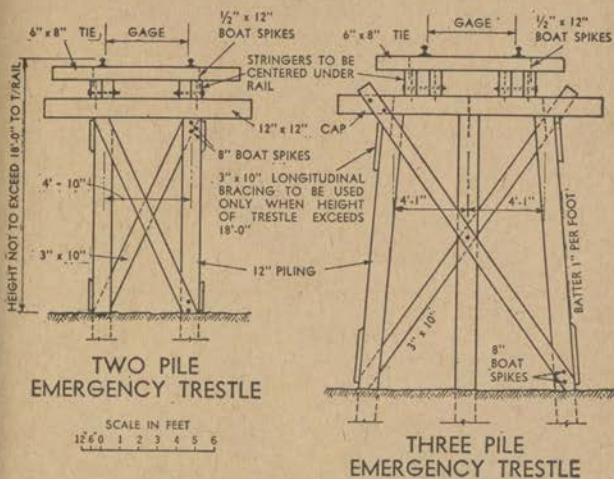


FIGURE 25b.

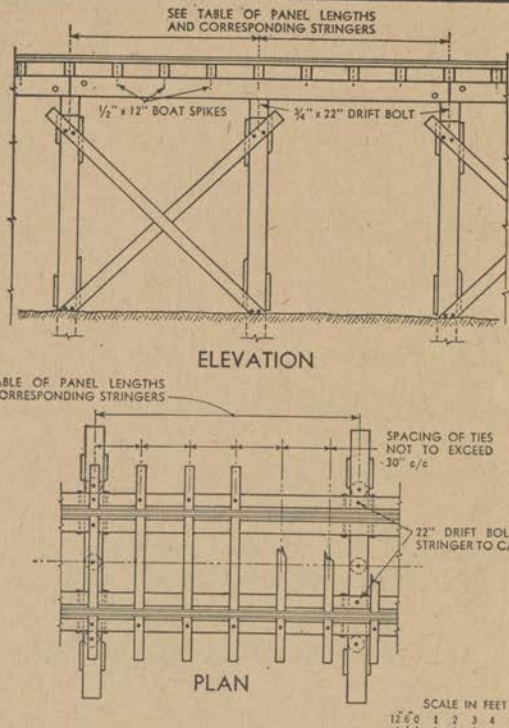
2 & 3 PILE BENT EMERGENCY TIMBER TRESTLES - ALL GAGES



DECK PLAN FOR LAPPED STRINGERS

FIGURE 26a.

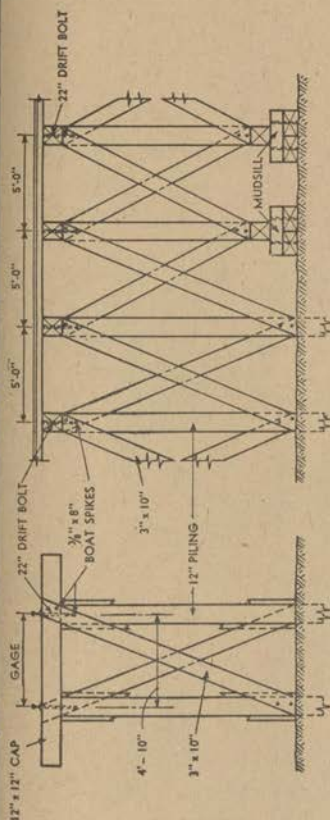
2 & 3 PILE BENT EMERGENCY TIMBER TRESTLES - ALL GAGES



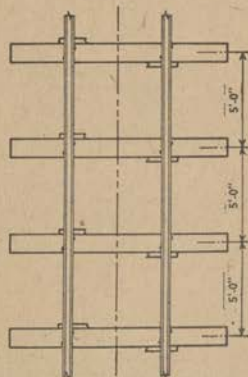
STGRS		COOPERS RATING			
No.	SIZE	E-30	E-40	E-45	E-50
6	8"x16"	17'-6"	15'-2"	14'-3"	13'-6"
6	7"x16"	16'-6"	14'-2"	13'-4"	12'-8"
6	12"x12"	16'-0"	13'-9"	13'-0"	12'-4"
6	7"x14"	14'-2"	12'-4"	11'-9"	11'-3"
4	8"x16"	14'-2"	12'-3"	11'-9"	11'-3"
4	7"x16"	13'-2"	11'-7"	11'-1"	10'-8"
4	12"x12"	13'-0"	11'-6"	10'-11"	10'-6"
4	7"x14"	11'-8"	10'-6"	10'-0"	9'-8"

FIGURE 26b.

EMERGENCY TRETTLES USING RAIL STRINGERS



EMERGENCY TRETTLE ONE RAIL—STRINGERS



NOTE A

80 LB RAIL WILL PASS
E-40 LOADS AT 5 MPH
100 LB RAIL WILL PASS
E-55 LOADS AT 5 MPH

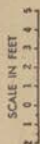


FIGURE 27a.

EMERGENCY TRESTLES USING RAIL STRINGERS

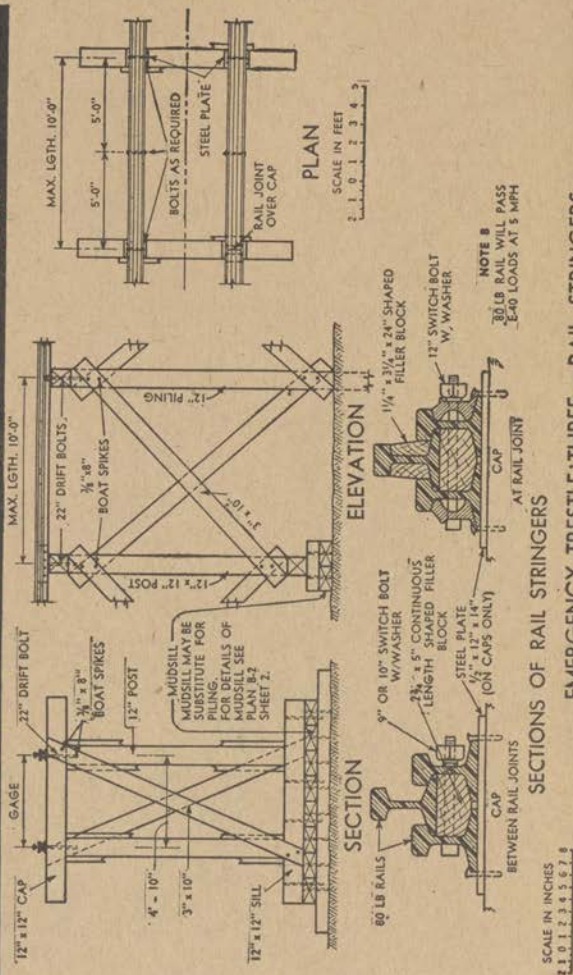


FIGURE 27b.

3 & 4 PILE TRESTLE FOR LIGHT TRAFFIC LINES

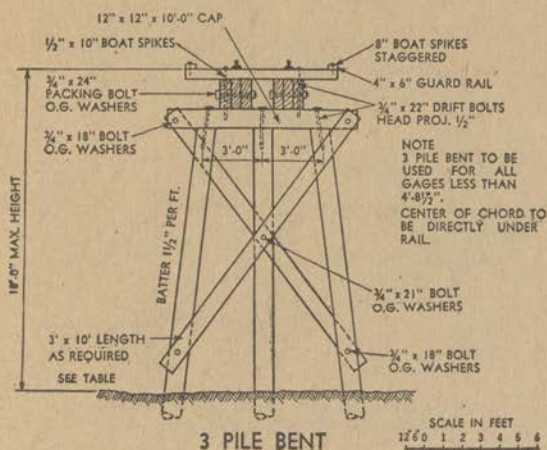
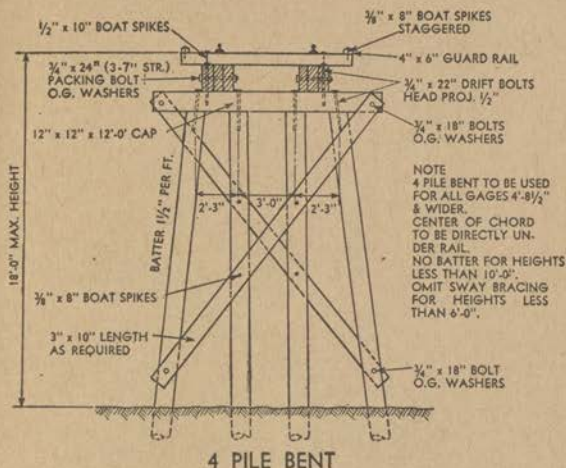
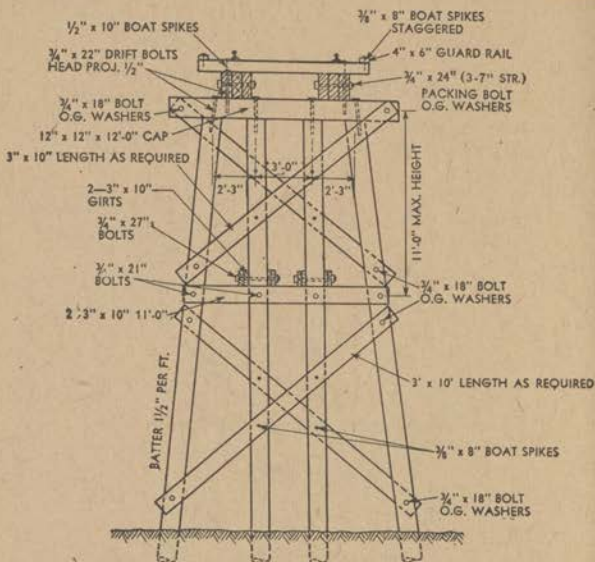


FIGURE 28a.

3 & 4 PILE TRESTLE FOR LIGHT TRAFFIC LINES



4 PILE BENT OVER 18 FT.

SCALE IN FEET
1 0 1 2 3 4 5 6

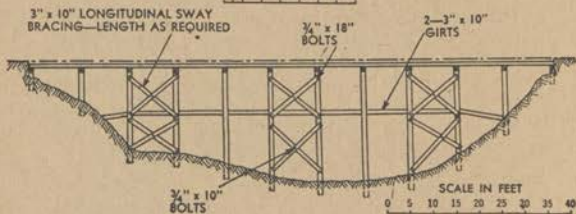
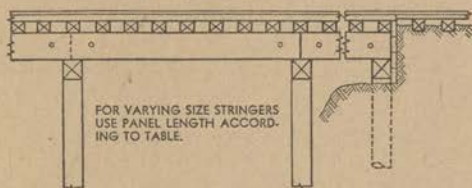


DIAGRAM SHOWING LONGITUDINAL BRACING
WHERE REQUIRED FOR TRETTLES OVER 18 FT.

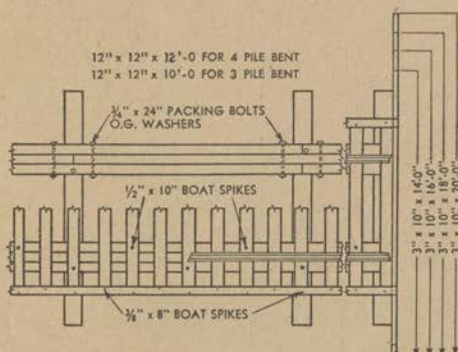
FIGURE 28b.

3 & 4 PILE TRESTLE FOR LIGHT TRAFFIC LINES

TIES APPROX. 18" O.C.

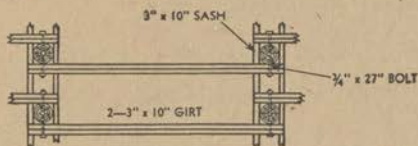


UPPER ELEVATION



DECK PLAN

SCALE IN FEET
1 2 3 4 5 6



DETAIL OF GIRT BRACING

FIGURE 28c.

3 & 4 PILE TRESTLE FOR LIGHT TRAFFIC LINES

MAXIMUM PANEL LENGTH
FOR VARYING SIZE STRINGERS

STRINGERS		COOPERS RATING			
No.	SIZE	E-30	E-40	E-45	E-50
6	8"x16"	17'-6"	15'-2"	14'-3"	13'-6"
6	7"x16"	16'-6"	14'-2"	13'-4"	12'-8"
6	12"x12"	16'-0"	13'-9"	13'-0"	12'-4"
6	7"x14"	14'-2"	12'-4"	11'-9"	11'-3"
4	8"x16"	14'-2"	12'-3"	11'-9"	11'-3"
4	7"x16"	13'-2"	11'-7"	11'-1"	10'-8"
4	12"x12"	13'-0"	11'-6"	10'-11"	10'-6"
4	7"x14"	11'-8"	10'-6"	10'-0"	9'-7"

MATERIAL FOR ONE 4 PILE BENT

MATERIAL FOR ONE 4 PILE BENT																
B/R TO GROUND	3"x10" SASH AND SWAY BRACE								C	HARDWARE						
	11'	12'	13'	14'	15'	17'	19'	BOLTS				O.G. WASH	3/4"x8" BOAT SPIKES	3/4"x22" DRIFT BOLTS		
								No.		SIZE	No.				SIZE	
6'	2								1	4	3/4"x18"			8	4	6
8'		2							1	"	"			"	"	"
10'			2						1	"	"			"	"	"
12'				2					1	"	"			"	"	"
14'					2				1	"	"			"	"	"
16'						2			1	"	"			"	"	"
18'							2		1	"	"			"	"	"

MATERIAL FOR ONE 3 PILE BENT

	10'	11'	12'	13'	14'	16'	18'									
6'	2							1	4	3/4"x18"	1	3/4"x21"	10			5
8'		2						1	"	"	1	"	"	"	"	"
10'			2					1	"	"	1	"	"	"	"	"
12'				2				1	"	"	1	"	"	"	"	"
14'					2			1	"	"	1	"	"	"	"	"
16'						2		1	"	"	1	"	"	"	"	"
18'							2	1	"	"	1	"	"	"	"	"

MATERIAL FOR ONE 14'-0" DECK PANEL

STRINGER No. SIZE	6"x8" TIES	4"x6" GUARD RAIL	HARDWARE						
			BOLTS				O.G. WASH	3/8"x8" BOAT SPIKES	1/2"x10" BOAT SPIKES
			No.	SIZE	No.	SIZE			
PER TABLE	9	* 28'-0"	4	3/4"x24"	8	18	10		

STRINGER PACKING BOLTS ARE 3" LONGER THAN OUT AND OUT THICKNESS OF STRINGER CHORD

NOTE:

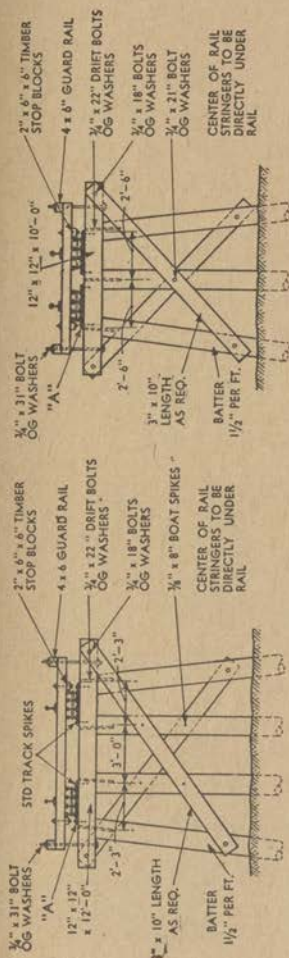
USE 3" x 10"s FOR GIRTS AND LONGITUDINAL BRACING, WHEN REQUIRED.

WHEN O.G. WASHERS ARE NOT OBTAINABLE, ANY SUITABLE WASHER MAY BE USED

* 28'-6" FOR END PANELS.

FIGURE 28d.

T-RAIL TRETTLES FOR LIGHT TRAFFIC LINES

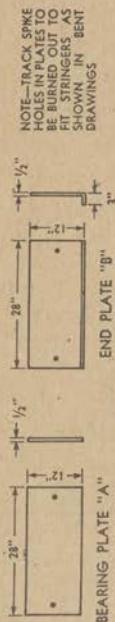


4 PILE BENT

NOTE—3 PILE BENT MAY ALSO BE USED FOR WIDE GAUGE

SCALE IN FEET
1 2 3 4 5 6

3 PILE BENT



SCALE IN INCHES
0 4 8 12 16 20 24 28

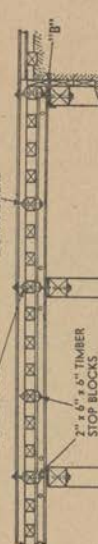
FIGURE 29a.

T-RAIL TRESTLES FOR LIGHT TRAFFIC LINES

NOTE—NUTS TO BE ON TOP SIDE

$\frac{3}{8}$ " x 10" BOLTS
OG WASHERS

TIES APPROX. 18" O.C.



2" x 6" x 6" TIMBER
STOP BLOCKS

NOT TO EXCEED 10'-0"

SCALE IN FEET

12 6 0 1 2 3 4 5 6

ELEVATION

2" x 21" BOLT
2" D x 4" PIPE SPACERS

2" x 6" x 6" TIMBER
STOP BLOCK



2" x 21" BOLT
2" D x 4" PIPE SPACERS

2" x 6" x 6" TIMBER
STOP BLOCK

DECK PLAN

$\frac{3}{8}$ " x 8" BOAT SPIKES

$\frac{1}{4}$ " x 31" BOLTS

COOPERS RATING FOR
VARIOUS WEIGHTS OF RAIL

WEIGHT OF RAILS	NUMBER OF RAILS REQ'D IN TWO CHORDS
E-30	E-40
70*	12
80*	6
90*	8

MATERIAL FOR ONE 4 PILE BENT

B/N TO GROUND	3/4" B BRACE	BOLTS		HARDWARE		OG ROAT DRIFT BOLTS
		SIZE	N ₆	SIZE	N ₆	
11	12	1 1/2"	2	1 1/2"	2	12
12	13	1 1/2"	2	1 1/2"	2	12
13	14	1 1/2"	2	1 1/2"	2	12
14	15	1 1/2"	2	1 1/2"	2	12
15	16	1 1/2"	2	1 1/2"	2	12
16	17	1 1/2"	2	1 1/2"	2	12
17	18	1 1/2"	2	1 1/2"	2	12
18	19	1 1/2"	2	1 1/2"	2	12
19	20	1 1/2"	2	1 1/2"	2	12
20	21	1 1/2"	2	1 1/2"	2	12

MATERIAL FOR ONE 3 PILE BENT

B/N TO GROUND	3/4" B BRACE	BOLTS		HARDWARE		OG ROAT DRIFT BOLTS
		SIZE	N ₆	SIZE	N ₆	
11	12	1 1/2"	2	1 1/2"	2	12
12	13	1 1/2"	2	1 1/2"	2	12
13	14	1 1/2"	2	1 1/2"	2	12
14	15	1 1/2"	2	1 1/2"	2	12
15	16	1 1/2"	2	1 1/2"	2	12
16	17	1 1/2"	2	1 1/2"	2	12
17	18	1 1/2"	2	1 1/2"	2	12
18	19	1 1/2"	2	1 1/2"	2	12
19	20	1 1/2"	2	1 1/2"	2	12
20	21	1 1/2"	2	1 1/2"	2	12

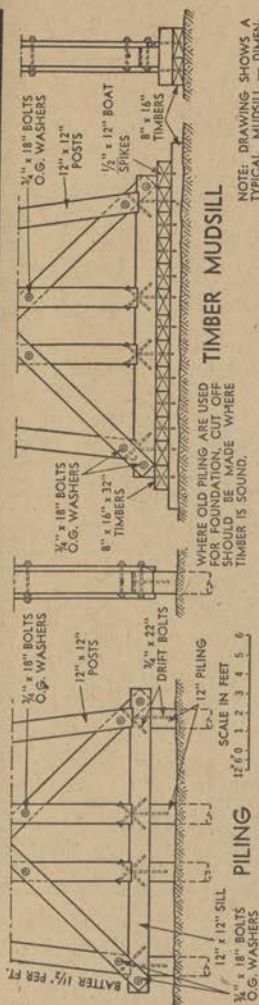
MATERIAL FOR ONE 10' 0" PANEL

RAILS PER PANEL	TIES	GUARD RAIL	BOLTS		HARDWARE		OG ROAT DRIFT BOLTS
			SIZE	N ₆	SIZE	N ₆	
7	7	7	1 1/2"	2	1 1/2"	2	12
8	8	8	1 1/2"	2	1 1/2"	2	12
9	9	9	1 1/2"	2	1 1/2"	2	12
10	10	10	1 1/2"	2	1 1/2"	2	12
11	11	11	1 1/2"	2	1 1/2"	2	12
12	12	12	1 1/2"	2	1 1/2"	2	12

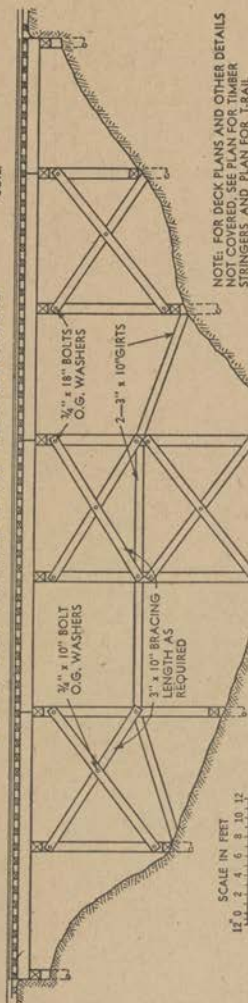
2-BEARING PLATES PER BENT AS SHOWN IN DRAWING.
*END PANELS REQUIRE 20'-6" GUARD RAIL WHEN OG WASHERS
ARE NOT OBTAINABLE. ANY SUITABLE WASHER MAY BE USED

FIGURE 29b.

3 & 4 POST FRAMED BENT



3 & 4 POST FRAMED BENT FOUNDATIONS



LONGITUDINAL BRACING FOR FRAME TRESTLES OVER 18 FT. IN HEIGHT

FIGURE 30a.

3 & 4 POST FRAMED BENT

MATERIAL FOR ONE 3 POST BENT

B/R TO GRD.	POSTS No.	SILLS No.	BRACES No.	C SIZE	HARDWARE				O.G. WASH	
					BOLTS					
					No.	SIZE	No.	SIZE		
6'	3	4'-0"	1	9'-0"	2	10'-0"	1	3/4" x 12"	12	14
8'	3	6'-0"	1	10'-0"	2	12'-0"	1	3/4" x 12"	6	3/4" x 18"
10'	3	8'-0"	1	10'-0"	2	14'-0"	1	"	6	"
12'	3	10'-0"	1	12'-0"	2	14'-0"	1	"	6	"
14'	3	12'-0"	1	12'-0"	2	16'-0"	1	"	6	"
16'	3	14'-0"	1	12'-0"	2	18'-0"	1	"	6	"
18'	3	16'-0"	1	12'-0"	2	20'-0"	1	"	6	"

MATERIAL FOR ONE 3 POST T-RAIL BENT

6'	3	4'-0"	1	9'-0"	2	10'-0"	1	1	$\frac{3}{4}$ " x 1"	2	$\frac{3}{4}$ " x 1"	6	$\frac{3}{4}$ " x 1"	10	18
8'	3	6'-0"	1	10'-0"	2	12'-0"	1	1	"	2	"	6	"	"	"
10'	3	8'-0"	1	10'-0"	2	14'-0"	1	1	"	2	"	6	"	"	"
12'	3	10'-0"	1	12'-0"	2	14'-0"	1	1	"	2	"	6	"	"	"

MATERIAL FOR ONE 4 POST BENT

B/R TO GRD.	POSTS No.	SILLS No.	BRACES No.	C SIZE	HARDWARE			O.G. WASH
				BOLTS				
No.	No.	No.	No.	No.	SIZE	No.	SIZE	No.
6'	4	4'-0"	1	12'-0"	2	12'-0"	1	1
8'	4	6'-0"	1	12'-0"	2	12'-0"	1	1
10'	4	8'-0"	1	14'-0"	2	14'-0"	1	1
12'	4	10'-0"	1	14'-0"	2	16'-0"	1	1
14'	4	12'-0"	1	14'-0"	2	16'-0"	1	1
16'	4	14'-0"	1	14'-0"	2	18'-0"	1	1
18'	4	16'-0"	1	14'-0"	2	20'-0"	1	1

MATERIAL FOR ONE 4 POST T-RAIL BENT

B/R TO GRD.	POSTS No.	SILLS No.	BRACES No.	C SIZE	HARDWARE				O.G. WASH
					BOLTS				
No.	No.	No.	No.	No.	SIZE	No.	SIZE	No.	SIZE
6'	4	4'-0"	1	12'-0"	2	12'-0"	1	1	1
8'	4	6'-0"	1	12'-0"	2	14'-0"	1	1	1
10'	4	8'-0"	1	12'-0"	2	14'-0"	1	1	1
12'	4	10'-0"	1	14'-0"	2	16'-0"	1	1	1

MATERIAL FOR ONE 4 POST BENT OVER 18 FT.

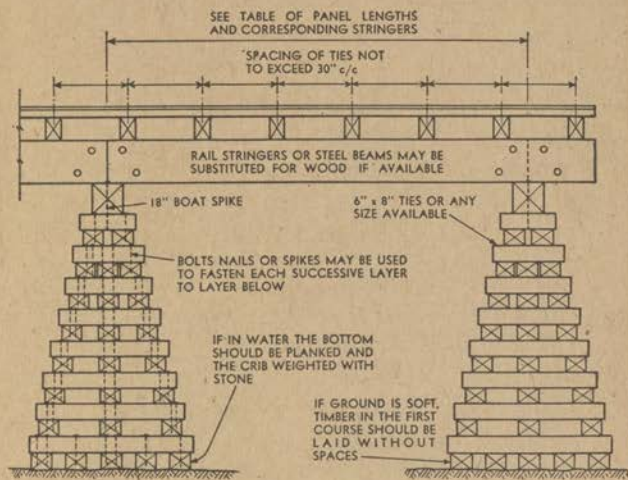
	POSTS	SILLS	BRACES	SASH				
20'	4 1/8" 0"	1 1/2 0"	LGTH	11" 0"	1	4 3/4" x 1"	18 3/4" x 18"	2 1/2 x 27"
22'	4 2/0" 0"	1 1/2 0"		11" 0"	1	"	18 "	2 "
24'	4 2/2" 0"	1 1/2 0"		11" 0"	1	"	18 "	2 "
26'	4 2/4" 0"	1 1/2 0"		11" 0"	1	"	18 "	2 "
28'	4 2/6" 0"	1 1/2 0"		11" 0"	1	"	18 "	2 "
30'	4 2/8" 0"	1 1/2 0"		11" 0"	1	"	18 "	2 "

MATERIAL FOR ONE PANEL LONGITUDINAL BRACING

HEIGHT	TO OVER	TOWER BR. No.	3"X10" LGTH. AS REQ.	No.	SIZE	No.	SIZE	No.	SIZE	WASH O.G.
18'	18'	4	0	8	3/4"x18"	2	3/4"x10"	20		
OVER 18'	OVER 18'	8	2	8	3/4"x18"	4	3/4"x27"	40		

Figure 30b.

TIMBER CRIB PIER



ELEVATION

NOTE—ADAPTED FROM BRITISH ROYAL ENGINEERS PRACTICE

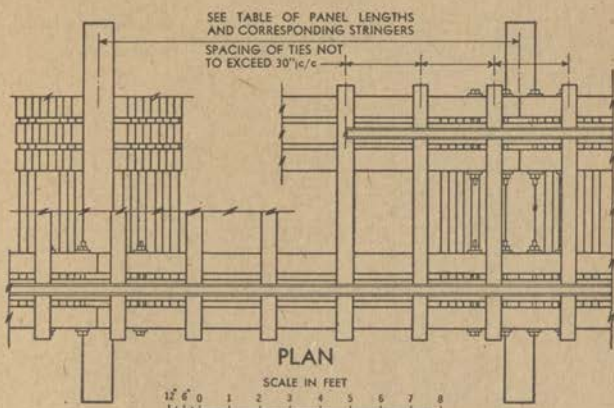
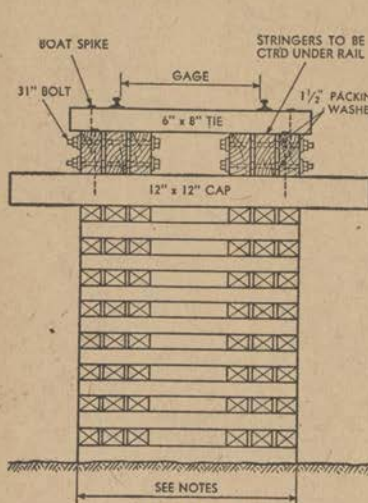


FIGURE 31a.

TIMBER CRIB PIER



SECTION

TIMBER CRIB

UP TO ABOUT 10 FEET HIGH TIMBER CRIBS ARE MORE QUICKLY CONSTRUCTED THAN TRESTLES, ABOVE THIS HEIGHT THEY ARE WASTEFUL OF TIMBER WITHOUT ANY PROPORTIONATE SAVING OF TIME WHEN ONLY SMALL SIZED TIMBER IS AVAILABLE. CRIBS MAY BE THE ONLY POSSIBLE TYPE OF PIER.

MAXIMUM PANEL LENGTHS
FOR VARYING SIZE STRINGERS

STGRS		COOPERS RATING			
No.	SIZE	E-30	E-40	E-45	E-50
6	8"x16"	17'-6"	15'-2"	14'-3"	13'-6"
6	7"x16"	16'-6"	14'-2"	13'-4"	12'-8"
6	12"x12"	16'-0"	13'-9"	13'-0"	12'-4"
6	7"x14"	14'-2"	12'-4"	11'-9"	11'-3"
4	8"x16"	14'-2"	12'-3"	11'-9"	11'-3"
4	7"x16"	13'-2"	11'-7"	11'-1"	10'-8"
4	12"x12"	13'-0"	11'-6"	10'-11"	10'-6"
4	7"x14"	11'-8"	10'-6"	10'-0"	9'-8"

PRINCIPLES OF DESIGN

1. THE AREA OF THE BASE DEPENDS UPON THE LOAD THE GROUND CAN SUPPORT ALTHOUGH THE WIDTH OF THE BASE SHOULD NEVER BE LESS THAN ONE-THIRD THE HEIGHT.
2. THE SIDES AT RIGHT ANGLES TO THE BRIDGE SHOULD BE GIVEN A BATTER FOR STABILITY.
3. THE POINTS OF SUPPORT WHERE SUCCESSIVE LAYERS CROSS SHOULD COME IMMEDIATELY UNDER THE LOAD AND SHOULD BE CARRIED IN A DIRECT LINE FROM THE TOP TO THE BOTTOM OF THE CRIB.
4. EACH SUCCESSIVE LAYER MUST BE SECURELY FASTENED TO THE LAYER BELOW. POINTS OF INTERSECTION SHOULD BE ADDED IF NECESSARY TO GET A GOOD BEARING. BOLTS, NAILS OR SPIKES MAY BE USED AS FASTENERS. FOR VERY TEMPORARY WORK FASTENERS MAY BE LEFT OFF, RELIANCE BEING PLACED ON FRICTION.
5. EACH SUCCESSIVE LAYER MUST BE LEVEL. THE BASE SHOULD BE BUILT TO CONFORM TO THE GROUND AND BUILT TO A LEVEL SURFACE, OR THE GROUND UNDER THE BASE SHOULD BE LEVELED AND PACKED BEFORE THE REMAINDER OF THE CRIB IS CONSTRUCTED.

FIGURE 31b.

CONVERSION TABLE

Multiply	by	to obtain
Inches	2.54001	Centimeters
Centimeters	.3937	Inches
Feet	.304801	Meters
Meters	3.28083	Feet
Yards	.914402	Meters
Meters	1.09361	Yards
Pounds (avoirdupois)	.453592	Kilograms
Kilograms	2.20462	Pounds
Kilometers	.62137	Miles (statute)
Miles (statute)	1.60935	Kilometers
Acres	.404687	Hectares
Hectares	2.47104	Acres

TABLE OF LEADS AND COORDINATES FOR CROSS-OVERS-STANDARD GAUGE



Frog No.	Leads	Frog Angles	Distance between track centers									
			12 feet		13 feet		14 feet		15 feet		18 feet	
			A	B	A	B	A	B	A	B	A	B
5	42'-6"	11°25'	11'10 3/4"	13'1 1/4"	16'10 1/4"	18'1 3/4"	21'9 3/4"	23'2 1/2"	26'9"	28'3"	41'7 1/4"	43'5"
6	47'-6"	9°32'	14'6"	15'6"	20'5 1/2"	21'6 1/2"	26'5"	27'7"	32'4 1/2"	33'7 1/2"	50'3"	51'9"
7	62'-1"	8°10'	17'1"	17'11"	24'0 1/2"	24'11 3/4"	31'0"	32'0"	37'11 3/4"	39'0 1/2"	58'10 1/4"	60'2"
8	68'-0"	7°09'	19'7 1/2"	20'4 1/2"	27'7"	28'5"	35'6 3/4"	36'5 1/4"	43'6 3/4"	44'5 3/4"	67'5 3/4"	68'6 3/4"
9	72'-3"	6°22'	22'2"	22'10"	31'1 3/4"	31'10 1/2"	40'1 1/2"	40'10 3/4"	49'1"	49'11"	76'0"	77'0"
10	78'-9"	5°43'	24'8 1/4"	25'3 3/4"	34'8"	35'4"	44'8"	45'4 1/4"	54'7 1/2"	55'4 1/2"	84'6 1/4"	85'5 1/2"
12	96'-8"	4°46'	29'9"	30'3"	41'8 3/4"	42'3 1/2"	53'9 1/2"	54'3 1/2"	65'8 1/2"	66'3 3/4"	101'7 1/2"	102'4 1/2"
14	107'-1"	4°05'	34'9 1/2"	35'2 1/2"	48'9 1/2"	49'2 3/4"	62'9 1/2"	63'3 1/2"	76'9"	77'3 1/4"	118'8 1/4"	119'4"
15	126'-4"	3°49'	37'3 1/4"	37'8 1/2"	52'3 1/2"	52'8 1/2"	67'3 1/4"	67'8 3/4"	82'3"	82'9"	127'2 1/2"	127'9 3/4"
16	131'-4"	3°35'	39'9 1/2"	40'2 1/4"	55'9 3/4"	56'2 3/4"	71'9 1/2"	72'2 3/4"	88'3"	88'3 1/2"	135'8 3/4"	136'3 1/2"
18	140'-11"	3°11'	44'10"	45'2"	62'10"	63'2 1/4"	80'9 3/4"	81'2 1/2"	98'9 1/2"	99'2 1/2"	152'9"	153'3"
20	151'-11"	2°52'	49'10"	50'1 3/4"	69'10"	70'2"	89'10"	90'2"	109'9 3/4"	110'2 1/4"	169'9 1/2"	170'2 3/4"

FIGURE 32.

TABLE OF GAUGE ON CURVES

1 to 10	11-12	13-14	15-16	17-18	19-20	21 or over
$4'8\frac{1}{2}"$	$4'8\frac{5}{8}"$	$4'8\frac{3}{4}"$	$4'8\frac{7}{8}"$	$4'9"$	$4'9\frac{1}{8}"$	$4'9\frac{1}{4}"$ GAUGE

NOTE. No gauge greater than $4'9\frac{1}{4}"$ to be used.

HOW TO DETERMINE DEGREE OF CURVE

To determine the degree of curve, stretch a line 62 feet long with a small knot at the middle on the gauge side of the outer rail, selecting a well lined portion of the curve.

Measure the distance from the knot to the gauge side of the rail and every inch of the distance indicates 1° curvature. Thus if the distance is 2 inches it is a 2° curve; if 4 inches it is a 4° curve, and so on.

ELEVATION OF OUTER RAIL ON CURVE

Degree of curve	Velocity in miles per hour									
	10	15	20	25	30	35	40	45	50	60
1	0	$\frac{1}{8}$ "	$\frac{1}{4}$ "	$\frac{1}{2}$ "	$\frac{3}{4}$ "	1"	$1\frac{1}{4}$ "	$1\frac{1}{2}$ "	$1\frac{3}{4}$ "	$2\frac{1}{2}$ "
2	$\frac{1}{8}$ "	$\frac{3}{8}$ "	$\frac{1}{2}$ "	1"	$1\frac{1}{4}$ "	$1\frac{3}{4}$ "	$2\frac{1}{4}$ "	$2\frac{3}{4}$ "	$3\frac{1}{4}$ "	$4\frac{3}{4}$ "
3	$\frac{1}{4}$ "	$\frac{1}{2}$ "	$\frac{3}{4}$ "	$1\frac{1}{4}$ "	$1\frac{3}{4}$ "	$2\frac{1}{2}$ "	$3\frac{1}{4}$ "	4"	5"	---
4	$\frac{1}{4}$ "	$\frac{5}{8}$ "	1"	$1\frac{3}{4}$ "	$2\frac{1}{2}$ "	$3\frac{1}{4}$ "	$4\frac{1}{4}$ "	$5\frac{1}{2}$ "	$6\frac{3}{4}$ "	---
5	$\frac{3}{8}$ "	$\frac{3}{4}$ "	$1\frac{1}{4}$ "	2"	3"	4"	$5\frac{1}{4}$ "	$6\frac{3}{4}$ "	---	---
6	$\frac{3}{8}$ "	1"	$1\frac{3}{4}$ "	$2\frac{1}{2}$ "	$3\frac{1}{2}$ "	5"	$6\frac{1}{4}$ "	8"	---	---
7	$\frac{1}{2}$ "	$1\frac{1}{8}$ "	2"	3"	$4\frac{1}{4}$ "	$5\frac{3}{4}$ "	$7\frac{3}{8}$ "	---	---	---
8	$\frac{1}{2}$ "	$1\frac{1}{4}$ "	$2\frac{1}{4}$ "	$3\frac{1}{4}$ "	$4\frac{3}{4}$ "	$6\frac{1}{2}$ "	---	---	---	---
9	$\frac{5}{8}$ "	$1\frac{3}{8}$ "	$2\frac{1}{2}$ "	$3\frac{3}{4}$ "	$5\frac{1}{2}$ "	$7\frac{1}{4}$ "	---	---	---	---
10	$\frac{3}{4}$ "	$1\frac{1}{2}$ "	$2\frac{3}{4}$ "	$4\frac{1}{4}$ "	6"	---	---	---	---	---
11	$\frac{3}{4}$ "	$1\frac{3}{4}$ "	3"	$4\frac{1}{2}$ "	$6\frac{1}{2}$ "	---	---	---	---	---
12	$\frac{7}{8}$ "	$1\frac{7}{8}$ "	3"	5"	$7\frac{1}{4}$ "	---	---	---	---	---

TABLE OF MIDDLE ORDINATES FOR CURVING RAILS

Rails will be curved in accordance with the following table, which gives the middle ordinate of a curved rail. Stretch a line from end of rail on inside of curvature. The distance from the edge of rail to the line at the exact center of rail is the middle ordinate. Ordinates at the quarters are three-fourths of the middle ordinate.

Degree of curve	Length of rails in feet		
	30	33	39
	(Inches)	(Inches)	(Inches)
6°	$1\frac{3}{8}$	$1\frac{3}{4}$	$2\frac{3}{8}$
7°	$1\frac{5}{8}$	2	$2\frac{3}{4}$
8°	$1\frac{7}{8}$	$2\frac{1}{4}$	$3\frac{1}{8}$
9°	$2\frac{1}{8}$	$2\frac{1}{2}$	$3\frac{5}{8}$
10°	$2\frac{3}{8}$	$2\frac{7}{8}$	4
11°	$2\frac{5}{8}$	$3\frac{1}{8}$	$4\frac{3}{8}$
12°	$2\frac{7}{8}$	$3\frac{3}{8}$	$4\frac{3}{4}$
13°	3	$3\frac{3}{4}$	$5\frac{1}{8}$
14°	$3\frac{1}{4}$	4	$5\frac{1}{2}$
15°	$3\frac{1}{2}$	$4\frac{1}{4}$	6

DUN'S DRAINAGE TABLES

Square miles area drained	Acres	Water- way required	Square miles area drained	Acres	Water- way required	Square miles area drained	Water- way required
0.01	6.4	2	0.55	352	70	15	835
.02	12.8	4	.60	384	74	20	970
.03	19.2	6	.65	416	78	30	1180
.04	25.6	7.5	.70	448	81	40	1350
.05	32.0	9	.75	480	85	50	1510
.06	38.4	10.5	.80	512	88		
.07	44.8	12	.85	544	91		
.08	51.2	13.5	.90	576	94		
.09	57.6	15	.95	608	97		
.10	64.0	16	1.	640	100		
.15	96.0	25	2.		200		
.20	128.	32	3.		300		
.25	160.	38	4.		388		
.30	192.	44	5.		455		
.35	224	51	6.		509		
.40	256	56	7.		556		
.45	288	62	8.		601		
.50	320	66	9.		641		
			10.0		679		

METHOD OF CUTTING RAIL

To cut rails, determine point of cut. Disconnect one end of rail to be cut, and pull spikes on both sides from the loose end of rail to the marked point. With bars, spring the loose end outward, holding the position. Cut base of rail on gauge side to the usual depth in making any cut, persons using chisel and maul taking position so as to be clear of rail should it break while this cutting is in progress. If rail does not break with this first operation, place chisel on edge of base immediately opposite the first cut, and strike a sharp blow with the maul, as the men with bars exert stress against the loose end. This will break it.

Lay rail on side with support of angle bars or short piece of rail directly under place where rail is to be cut. Chisel mark rail about $\frac{1}{4}$ inch deep in web, being very careful not to disturb "fishing" surfaces. After marking in web, nick base directly in line with mark on web, turn rail bottom side up, and cut across the base until rail breaks. Care must be taken to keep all cuts square. A tie plate with shoulder is a convenient square for lining up the cuts.

TABLE OF EXPANSION TO BE LEFT AT JOINTS

Temperature Fahrenheit	Allowance	
	33-foot rails	39-foot rails
-20° to 0°	(Inch) $\frac{5}{16}$	(Inch) $\frac{3}{8}$
0° to 25°	$\frac{1}{4}$	$\frac{5}{16}$
25° to 50°	$\frac{3}{16}$	$\frac{1}{4}$
50° to 75°	$\frac{1}{8}$	$\frac{1}{8}$
75° to 100°	$\frac{1}{16}$	$\frac{1}{16}$

DESCRIPTION OF TRACK FAILURES



Fig. A
Transverse Fissure



Fig. B
Compound Fissure



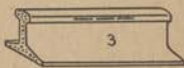
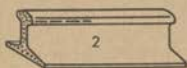
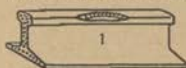
Fig. C
Horizontal Split Head



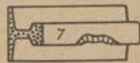
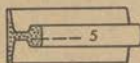
Fig. D
Vertical Split Head

Transverse Fissure—A crosswise break starting from a center or nucleus inside the head of the rail from which it spreads outward. The broken rail will show either a bright or dark, round or oval smooth area around the nucleus. See Fig. A.

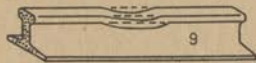
Compound Fissure—A horizontal split head which, in spreading turns up or down in the head of the rail. See Fig. B.



Horizontal Split Head—A horizontal break beginning inside the head of the rail and spreading outward; usually indicated on the side of the head by a lengthwise seam or crack, or by the flow of metal. See Fig. C and diag. 1, 2 and 3.

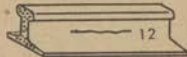
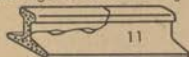


Vertical Split Head—A vertical split through or near the middle of the head, and extending into or through it. A crack or rust streak may show under the head close to the web or pieces may be split off the side of the head. See Fig. D and diagrams 4, 5, 6 and 7.

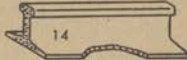


Crushed Head—A flattening or crushing down of the head. See diagrams 8 and 9.

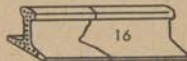
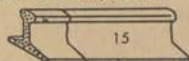
Piped Rail—One with vertical split, usually in web, due to failure of the shrinkage cavity in the ingot to unite in rolling. See diagram 10.



Split Web—A lengthwise crack along the side of the web and extending into or through it. See diagrams 11 and 12.



Broken Base—Any break in the base of a rail. See diagrams 13 and 14.

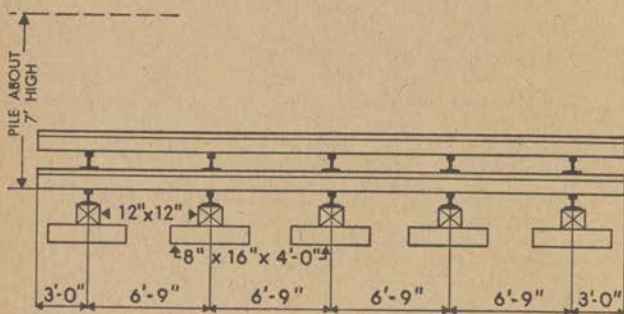


Square or Angular Break—Any partial or complete break in which there is no sign of a fissure, and in which none of the defects listed above can be seen. See diagrams 15 and 16.

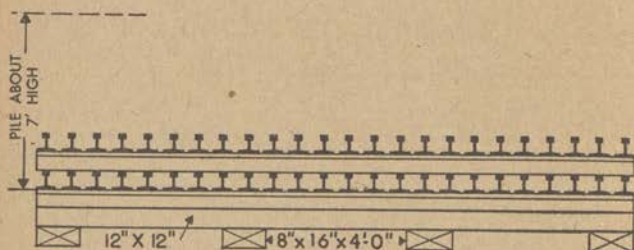
Damaged Rail—Any rail broken or injured by wrecks, broken, flat, or unbalanced wheels, slipping or similar causes.

FIGURE 33.

METHOD OF PILING SURPLUS RAIL



SIDE VIEW



END VIEW

FIGURE 34.

DIMENSIONS OF STANDARD RAIL SECTIONS

Weight	Section	Height	Width of base	Width of head	DRILLING			
					Height above base	Diameter holes	End to first hole	First to second hole
90	A.R.A.-A	(Inches) $5\frac{1}{8}$	(Inches) $5\frac{5}{8}$	(Inches) $2\frac{1}{2}$	(Inches) $2\frac{3}{4}$	(Inches) $1\frac{1}{8}$	(Inches) 3	(Inches) 6
85	A.S.C.E.	$5\frac{3}{16}$	$5\frac{3}{16}$	$2\frac{9}{16}$	$2\frac{1}{4}$	$1\frac{1}{8}$	3	6
80	A.S.C.E.	5	5	$2\frac{1}{2}$	$2\frac{3}{16}$	1	3	6
75	A.S.C.E.	$4\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{4}$	1		
70	A.S.C.E.	$4\frac{5}{8}$	$4\frac{5}{8}$	$2\frac{7}{16}$	$2\frac{3}{4}$	1	$2\frac{3}{8}$	5
67	IS Co. 6701	$4\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{5}{16}$	$1\frac{25}{32}$	1	$1\frac{7}{8}$	5
66	IS Co. 6602	$4\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{5}{16}$	$1\frac{1}{2}$	1	$2\frac{1}{2}$	6
65	A.S.C.E.	$4\frac{7}{16}$	$4\frac{7}{16}$	$2\frac{1}{2}$	$1\frac{1}{2}$	1	$2\frac{1}{2}$	5
60	A.S.C.E.	$4\frac{1}{4}$	$4\frac{1}{4}$	$2\frac{3}{8}$	$1\frac{1}{2}$	1	$4\frac{1}{2}$	9
56	IS Co. 5601	4	$3\frac{7}{8}$	$2\frac{5}{8}$	$1\frac{1}{2}$	1	$2\frac{3}{8}$	5
52	E.T. Co. 145	$3\frac{3}{4}$	$3\frac{3}{4}$	$2\frac{5}{8}$	$1\frac{3}{4}$	1	$3\frac{1}{2}$	5

STANDARD GAGE ROADBED SECTION

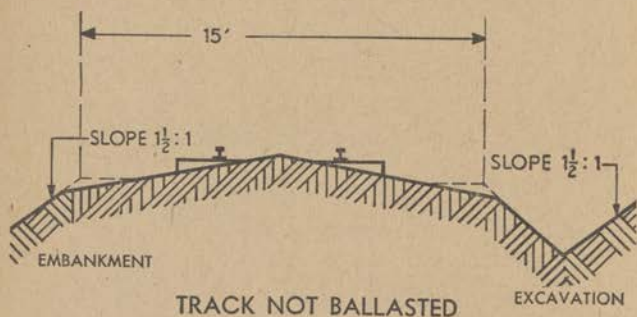
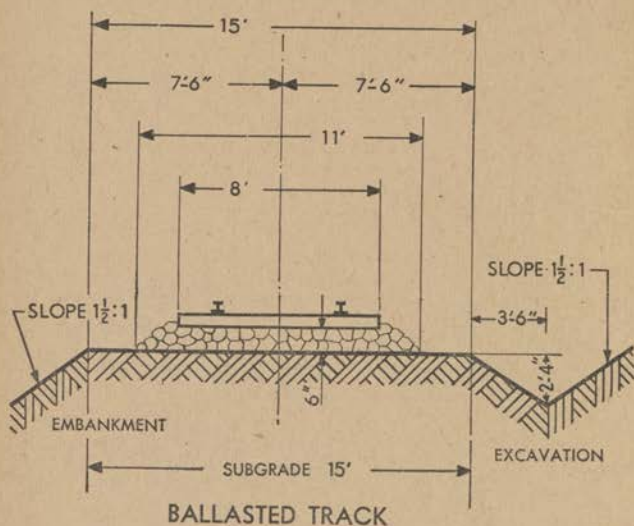


FIGURE 35.

ROADBED SECTIONS VARIOUS GAGES

GAGE	A	B	C
2'6" } 3'0" }	7'0"	10'0"	12'0"
3'3" } 3'3 ³ / ₈ " }	7'0"	10'0"	12'0"
3'5 ³ / ₈ " } 3'6" }	7'6"	10'6"	12'6"
4'8 ¹ / ₂ " } 5'0" }	8'0"	11'0"	15'0"
5'3" } 5'6" }	8'6"	11'6"	15'6"

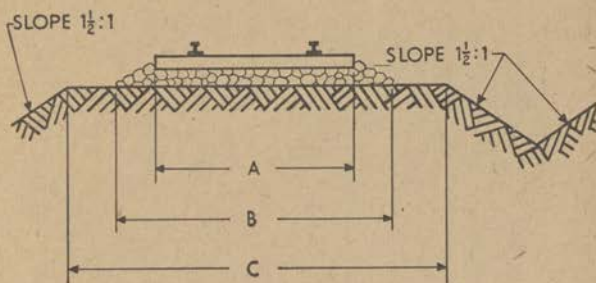
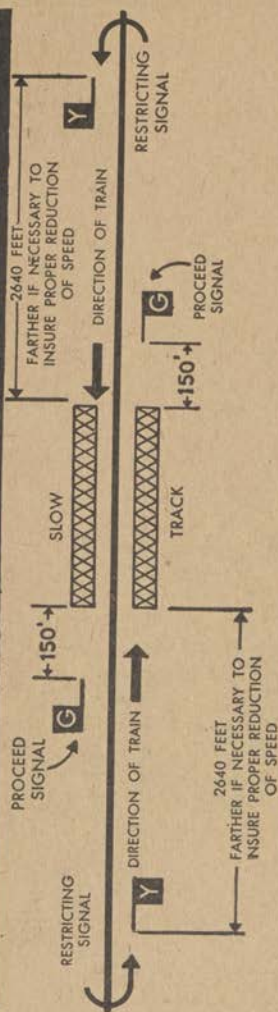


FIGURE 36.

FLAGGING CHART FOR PROTECTING TEMPORARY SLOW TRACK



RESTRICTING SIGNAL: Yellow signal by day and yellow light in addition, by night, placed on the engineer's side of track, not less than 2640 feet, and farther, if necessary, from the point where the slow track begins.

PROCEED SIGNAL: Green signal by day and a green light in addition by night placed at a point 150 feet from where the slow track ends, and on the side of the engineer, as seen from a train approaching track to be protected.

In territory where two or more main tracks are in service, each track must be protected in both directions the same as if it were single track.

FIGURE 37.

TABLE OF SPIRAL LENGTHS FOR VARIOUS ELEVATIONS AND TRAIN SPEEDS

Elevation in inches	Train speeds in miles per hour												Elevation in inches	
	10	15	20	25	30	35	40	45	50	55	60	65		70
(Inches) 1		(Feet) 18	(Feet) 23	(Feet) 29	(Feet) 35	(Feet) 41	(Feet) 47	(Feet) 53	(Feet) 59	(Feet) 64	(Feet) 70	(Feet) 76	(Feet) 82	(Inches) 1
1½		26	35	44	53	62	70	79	88	97	106	114	123	1½
2			47	59	70	82	94	106	117	129	141	152	164	2
2½			59	73	88	103	117	132	147	161	176	191	205	2½
3			70	88	106	123	141	158	176	193	211	229	246	3
3½				103	123	144	164	185	205	226	246	267	288	3½
4				117	141	164	188	211	235	258	282	305		4
4½				132	158	185	211	238	264	290	317	343		4½
5					176	205	235			322		381		5
5½					194	225						419		5½

SURFACING TRACK—TABLE OF RUN-OFFS

Maximum permissible train speed	Rate of run-off
90 miles per hour	One inch in 105 feet.
80 miles per hour	One inch in 95 feet.
70 miles per hour	One inch in 80 feet.
60 miles per hour	One inch in 70 feet.
50 miles per hour	One inch in 60 feet.
40 miles per hour	One inch in 45 feet.
30 miles per hour	One inch in 35 feet.
20 miles per hour	One inch in 25 feet.
10 miles per hour	One inch in 10 feet.

METHOD OF INSTALLING SWITCH

a. Curvature.—When a switch is on the inside of a curve, the degree of curvature of the switch is approximately its normal degree plus the degree of curvature of the main line; if outside, the degree of curvature of the switch is the difference of these two. Thus, if a No. 8 frog calling for a curve of $11^{\circ}47'$ is installed on the inside of a $6^{\circ}0'$ curve, the curvature through the turn-out will be $11^{\circ}47' + 6^{\circ} = 17^{\circ}47'$. Safety against derailment and economy in maintenance require that switches be located so that the curvature of the turn-out will not be in excess of 16° . Switches should always be located on tangents, if possible, to simplify switch lay-outs.

b. Location of switch point.—After the location and number of the frog have been determined, a stake in the center of the tract or mark on the rail should be placed to locate the point of frog. The lead distance is measured from this point to determine the location of the switch point.

c. Rail cutting.—Measurements should be taken to determine the number and length of the rails to be cut. Joints must not fall in the continuous rails between the point and heel of the switch points or between the ends of the guard rails. Rail cuts should be made before commencing to install the switch.

d. Subsequent procedure.—(1) Pull all spikes from every other cross tie throughout the length to be occupied by switch ties and remove the ballast from around these unspiked cross ties.

(2) Set track jacks under the rail and loosen the track by jacking it up very slightly.

(3) Withdraw the loose ties and substitute switch ties of the proper lengths.

(4) Remove the remainder of the cross ties and substitute switch ties in a similar manner.

(5) Set the frog. This can be done in 15 minutes by a party of 12 experienced men and consists merely of taking out the rail where the frog is to be located, setting the frog into place, spiking it up to gauge and making the connection with the proper length of cut rail, and installing a guard rail opposite the frog.

(6) Assemble the inside lead rail, joint it to the frog and the switch point, and spike it up so as to allow $6\frac{1}{4}$ inches clearance between the heads of the rail at the heel of the switch, leaving the rail to be shifted back and forth between the heel of the switch and the frog.

(7) Line the lead rail by eye and spike it.

(8) Unspike and line out the main line rail on the turn-out side.

(9) Fit the slide plates beneath it and place the switch point against it. When the main line rail (stock rail) is lined to the proper point, the gauge will just fit from the opposite main line rail to the gauge line of the switch point. Both the switch point and the stock rail should be spiked at this time and a rail bender should be applied so as to produce a slight kink in the stock rail $8\frac{1}{4}$ inches ahead of the switch point so that the switch point may fit against the stock rail without creating a line kink.

(10) Lay the outside lead rail to connect with the stock rail at the proper gauge distance from the inside lead rail.

(11) Install the guard rail opposite the frog on the outside lead rail. It is important that the gauge fit exactly from the point of frog to the outside lead rail and that the guard rail provide a flangeway of $1\frac{3}{4}$ inches.

e. Installation of switch points and switch stands.—

The main line side switch point may now be installed, the head and back rods applied, switch stand set up on the turn-out side of the main line, and the connecting rod installed. It will always be necessary to adjust the head and back rods in such a manner that each switch point will fit snugly when thrown against the stock rails.

*f. Time of installation.—*An experienced foreman and 12 men can install a turn-out in an existing track in 2 working days of 8 hours each, provided material is assembled and ready for installation. Where a new switch is installed, incident to the construction of the main line itself, a turn-out can be completely installed and ballasted in 8 hours.

TURN-OUT DATA (see Fig. 38.)

Frog No.	Frog angle	Length of frog		Length of switch points	Degree of turn-out curve	Length of lead	Total length of connecting rail	Gauge line offsets					
		Point to toe	Point to heel					A	B	C	D	E	F
5	11°25'	3'6 $\frac{1}{2}$ "	5'5 $\frac{1}{2}$ "	11'0"	32°40'	42'6"	56'4"	18'0"	25'0"	32'0"	12"	20 $\frac{1}{2}$ "	2'9"
6	9°32'	3'9"	6'3"	11'0"	22°18'	47'6"	65'9"	19'2 $\frac{1}{4}$ "	27'4 $\frac{1}{2}$ "	35'6 $\frac{3}{4}$ "	12 $\frac{1}{2}$ "	21 $\frac{1}{2}$ "	2'10"
7	8°10'	4'8 $\frac{1}{2}$ "	7'3 $\frac{1}{2}$ "	16'6"	15°43'	62'1"	82'0"	26'2 $\frac{1}{4}$ "	35'10 $\frac{1}{2}$ "	45'6 $\frac{3}{4}$ "	11 $\frac{1}{2}$ "	19 $\frac{1}{2}$ "	2'7"
8	7°09'	5'1"	7'11"	11'0"	11°05'	60'11"	90'0"	27'7 $\frac{1}{4}$ "	38'8 $\frac{1}{2}$ "	49'9 $\frac{3}{4}$ "	12"	20 $\frac{1}{2}$ "	2'8 $\frac{1}{2}$ "
9	6°22'	6'4 $\frac{1}{2}$ "	9'7 $\frac{1}{2}$ "	16'6"	11°47'	68'0"	93'0"	28'10 $\frac{1}{4}$ "	41'21 $\frac{1}{2}$ "	53'6 $\frac{3}{4}$ "	12"	21 $\frac{1}{2}$ "	2'9 $\frac{1}{2}$ "
10	5°43'	6'5"	10'1"	16'6"	9°20'	72'3"	99'0"	29'11 $\frac{3}{4}$ "	43'5 $\frac{1}{2}$ "	56'11 $\frac{1}{4}$ "	12 $\frac{1}{2}$ "	21"	2'8 $\frac{1}{2}$ "
11	5°12'	7'0"	11'8 $\frac{1}{2}$ "	22'0"	6°11'	91'10"	125'10"	37'8 $\frac{1}{2}$ "	53'5"	69'11 $\frac{1}{2}$ "	12 $\frac{1}{2}$ "	21 $\frac{1}{2}$ "	2'10"
12	4°46'	7'9 $\frac{1}{2}$ "	12'6 $\frac{1}{2}$ "	22'0"	5°11'	96'8"	133'10"	38'8 $\frac{1}{2}$ "	55'5"	72'11 $\frac{1}{2}$ "	12 $\frac{1}{2}$ "	21 $\frac{1}{2}$ "	2'10"
14	4°05'	8'7 $\frac{1}{2}$ "	14'11 $\frac{1}{2}$ "	22'0"	3°37'	107'1"	153'0"	41'1 $\frac{1}{4}$ "	60'21 $\frac{1}{2}$ "	79'3 $\frac{3}{4}$ "	13"	22 $\frac{1}{2}$ "	2'10 $\frac{1}{2}$ "
15	3°49'	9'5"	14'11 $\frac{1}{2}$ "	30'0"	3°20'	126'4"	174'0"	51'9"	73'6"	95'3"	12"	22"	2'10"
16	3°35'	9'5"	16'7"	30'0"	2°51'	131'4"	183'11"	53'0"	76'0"	99'0"	12 $\frac{1}{2}$ "	22"	2'10"
18	3°11'	11'0 $\frac{1}{2}$ "	18'2 $\frac{1}{2}$ "	30'0"	2°13'	140'11"	199'11"	55'0"	80'0"	105'0"	13"	22"	2'10 $\frac{1}{2}$ "
20	2°52'	11'0 $\frac{1}{2}$ "	19'10"	30'0"	1°44'	151'11"	221'11"	57'9"	85'6"	113'3"	13"	22 $\frac{1}{2}$ "	2'11"

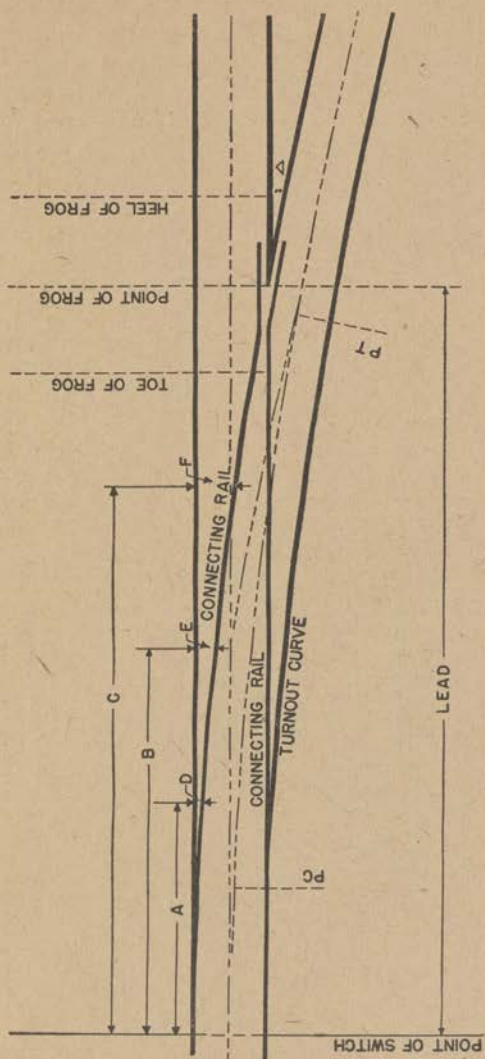


FIGURE 38.

THREE WAY STUB TURNOUTS Details—5, 8, 8—6, 8, 8—8, 8, 8

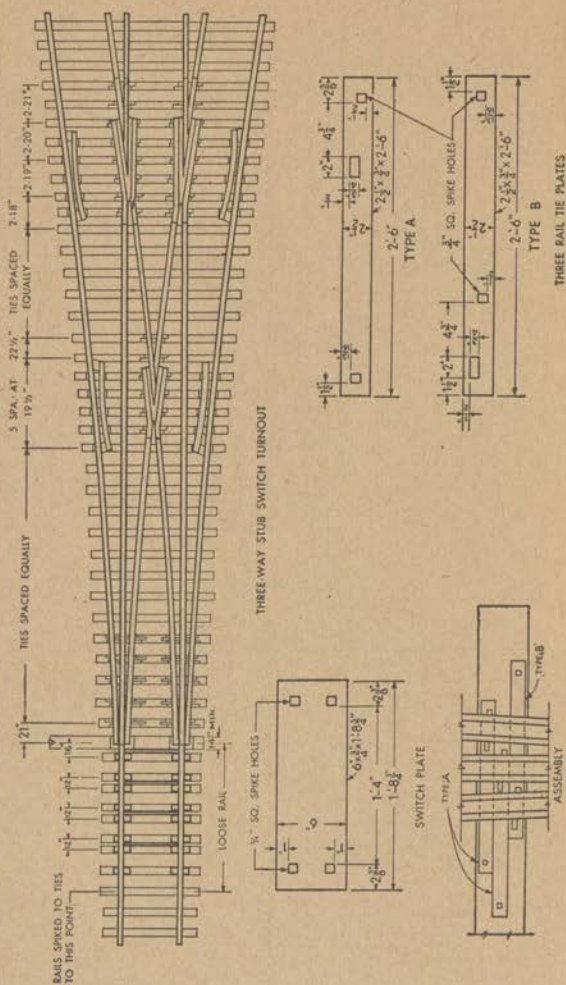
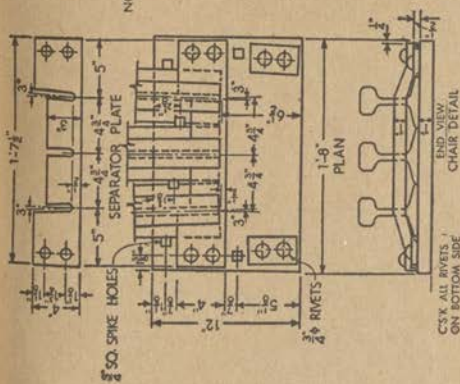
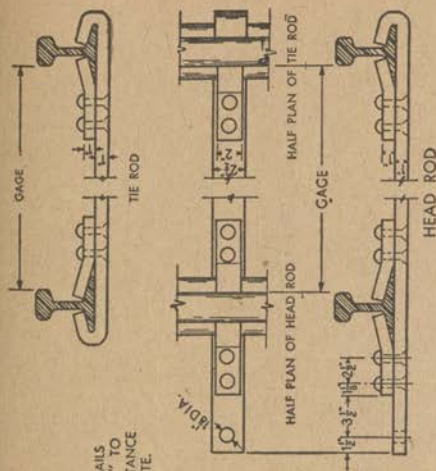


FIGURE 39a.



NOTE: TRIM BASE OF RAILS
IF WIDER THAN 4 3/4" TO
MAINTAIN THIS DISTANCE
ON SEPARATOR PLATE.



NOTE: SEPARATOR PLATE RAIL STOPS, AND
TIE ROD AND HEAD ROD CLIPS MAY BE
WELDED OR RIVETED TO CHAIR, TIE RODS,
AND HEAD ROD AS CIRCUMSTANCES PERMIT.

SCALE
0" 2" 4" 6" 8" 10" 12"

FIGURE 39b.

THREE WAY STUB TURNOUTS Dimensions—5, 8, 8-6, 8, 8-8, 8, 8-8, 8

#5 CROTCH FROG — #8 TURNOUT FROGS

Gauge	RAILS	CROTCH HEAD	TURNOUT HEAD	WHEELS AT CROTCH	WHEELS AT TURNOUT	CROTCH TO CROTCH	TURNOUT TO CROTCH
3'-0"	122.25	11.48	13.53	5.65	—	7.26	7.99
3'-1 1/2"	142.57	12.27	14.04	5.21	—	7.95	8.79
3'-3"	166.58	13.29	14.64	4.69	—	8.60	9.81
3'-3 3/8"	172.12	13.53	14.78	4.57	—	8.74	10.03
3'-5 1/2"	201.69	14.88	15.52	3.93	—	9.46	11.40
3'-6"	210.92	15.51	15.75	3.74	—	9.69	11.84
4'-8 1/2"	407.54	26.12	21.07	—	0.40	13.46	22.64
5'-0"	426.92	28.41	22.30	—	0.91	13.94	24.95
5'-3"	442.10	30.38	23.37	—	1.34	14.34	26.93
5'-6"	487.29	32.38	24.42	—	1.77	14.72	28.93

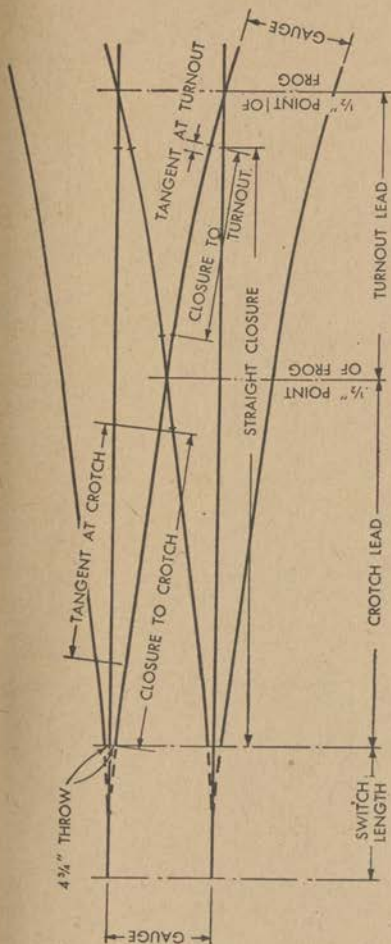
#6 CROTCH FROG — #8 TURNOUT FROGS

Gauge	RAILS	CROTCH HEAD	TURNOUT HEAD	WHEELS AT CROTCH	WHEELS AT TURNOUT	TURNOUT HEAD TO CROTCH	TURNOUT HEAD TO TURNOUT
3'-3"	114.08	14.99	16.00	11.32	—	7.11	11.30
3'-3 3/8"	117.69	15.18	16.15	11.26	—	7.22	11.49
3'-5 1/2"	136.94	16.22	16.95	11.56	—	7.79	12.53
3'-6"	142.96	16.57	17.20	11.63	—	7.96	12.87
4'-8 1/2"	282.37	25.30	22.99	13.10	—	11.21	21.63
5'-0"	316.25	27.58	24.39	13.45	—	11.86	23.92
5'-3"	345.13	29.59	25.58	13.73	—	12.39	25.92
5'-6"	374.01	31.60	26.78	14.06	—	12.90	27.94

#8 CROTCH FROG — #8 TURNOUT FROGS

Gauge	RAILS	CROTCH HEAD	TURNOUT HEAD	WHEELS AT CROTCH	WHEELS AT TURNOUT	TURNOUT HEAD TO CROTCH	TURNOUT HEAD TO TURNOUT
3'-5 1/2"	105.89	21.58	19.53	19.58	—	9.50	16.54
3'-6"	110.36	22.00	19.80	19.86	—	9.50	16.96
4'-8 1/2"	213.90	31.66	26.24	26.31	—	9.75	26.64
5'-0"	238.89	34.03	27.79	27.87	—	10.30	29.03
5'-3"	260.31	36.11	29.12	29.20	—	10.75	31.09
5'-6"	281.74	38.20	30.45	30.54	—	11.19	33.19

Figure 40a.



FROG NUMBER	ANGLE	TOE	HEEL
5	11°-25'-16"	3.54	5.46
6	9°-31'-38"	3.75	6.25
8	7°-09'-10"	5.08	7.92

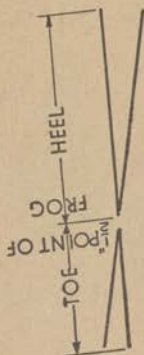


Figure 40b.

No. 8 TURNOUT

LENGTH OF TRACK TIE TO BE USED VARIOUS GAGES					
GAGE	2'-6"	3'-0"	3'-3"	3'-7"	3'-9"
LENGTH	5'-6"	6'-0"	6'-6"	6'-6"	6'-6"

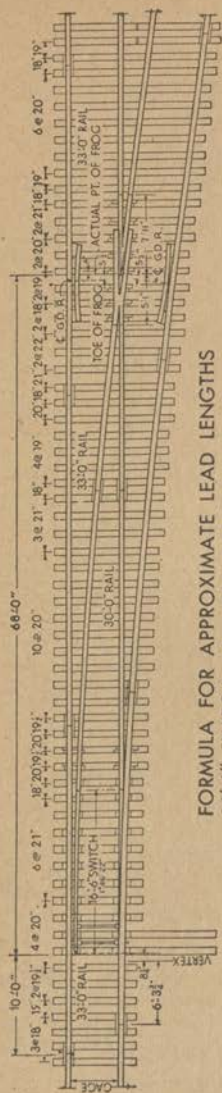
BILL OF SWITCH TIES — VARIOUS GAGES									
LENGTH	GAGE					3'-3"	3'-5"	3'-7"	3'-9"
	2'-6"	3'-0"	3'-3"	3'-5"	3'-7"				
5'-0"									
5'-6"									
6'-0"	7								
6'-6"	4								
7'-0"	3								
7'-6"	3	2							
8'-0"	2	2							
8'-6"	2	2							
9'-0"	2	2							
9'-6"	2	2							
10'-0"	2	2							
10'-6"	2	2							
11'-0"	2	2							
11'-6"	2	2							
12'-0"	2	2							
12'-6"	2	2							
13'-0"	2	2							
13'-6"	2	2							
14'-0"	2	2							
14'-6"	2	2							
15'-0"	2	2							
15'-6"	2	2							
16'-0"	2	2							
16'-6"	2	2							
17'-0"	2	2							
17'-6"	2	2							
18'-0"	2	2							
TOTAL PCS	33	33	38	34	60				
LIN. FT.	267	379	353½	599½	747				

NOTE: * INDICATES HEADBLOCK
 (P-11 INDICATES 1ST TIE OF THAT LENGTH TO BE
 LOCATED UNDER FROG POINT)

LEADS TO BE USED FOR VARIOUS GAGES				
A.R.E.A. STD. NO. 8. PROG. ANGLE 7'09"				
HEEL SPREAD AT SWITCH 6 1/4"				
SWITCH ANGLE 11' = 2'39" 16'-6" = 1'-46"				
FEET	WHEEL	SW. POINT	LEAD	
GAGE				
2'-6"	0.76	11'-0"	32'-0"	
3'-0"	0.91	11'-0"	38'-0"	
3'-3"	0.95	11'-0"	38'-0"	
3'-6"	0.99	11'-0"	42'-0"	
3'-9"	1.00	11'-0"	42'-0"	
4'-0"	1.03	11'-0"	42'-0"	
4'-3"	1.07	11'-0"	42'-0"	
4'-6"	1.10	11'-0"	48'-0"	
4'-9"	1.15	11'-0"	48'-0"	
5'-0"	1.20	16'-6"	54'-0"	
5'-3"	1.25	16'-6"	54'-0"	
5'-6"	1.28	16'-6"	54'-0"	

RADIUS—STRAIGHT CLOSURE & CURVED— CLOSURE FOR VARIOUS GAGES			
GAGE	RADIUS OF OUTER RAIL	STRAIGHT CLOSURE	CURVED CLOSURE
2'-6"	198.37	15.917	16.020
3'-0"	280.02	21.917	22.561
3'-3"	343.03	21.917	22.052
3'-6"	302.96	25.917	26.050
3'-9"	313.10	25.917	26.053
4'-0"	377.43	25.917	26.058
4'-3"	377.43	25.917	26.058
4'-6"	419.60	25.917	26.072
4'-9"	437.41	25.917	26.072
5'-0"	553.43	53.417	53.033
5'-3"	553.43	53.417	53.033
5'-6"	553.43	53.417	53.033

FIGURE 41a.



FORMULA FOR APPROXIMATE LEAD LENGTHS

16'-6" SWITCH L = 7 + 12.8 G.

11'-0" SWITCH L = 7 + 11.6 G

WHEN L = APPROXIMATE PRACTICAL LEAD IN FEET

G = GAGE IN FEET

FIGURE 41b.

16'-6" STRAIGHT SPLIT SWITCH WITH GRADUATED RISERS

BILL OF MATERIAL			
16'-6" NON-INSULATED STRAIGHT SPLIT SWITCH WITH RIGID RAIL BRACES			
DESCRIPTION		A.R.E.A.	SPEC. 112-G DETAIL NO.
2 DOUBLE REINFORCED SWITCH POINTS COMPLETE WITH DETAILS FOR SIDE JAW CLIPS		3/4"	2112
2 NON-INSULATED SWITCH RODS 1-NO. 1		2 1/2" x 1"	2010
1-NO. 2		2 1/2" x 1"	2011
16 RAIL BRACES 1/2" THICK		6" WIDE	2022
16 SOLID BASE SLIDE PLATES 14-NO. 1 1/4" RISER		6" WIDE	1120R
2-NO. 2 1/8" RISER		6" WIDE	1121R
2 SHOULDER SLIDE PLATES NO. 3-NO RISER		6" WIDE	1130
4 SHOULDER HEEL PLATES 1 PR. NO. 4 R.H. AND L.H.		7" WIDE	2140
1 PR. NO. 5 R.H. AND L.H.		7" WIDE	2149
28 TWIN TIE PLATES 14 TYPE NO. 1		3 1/2" x 3/4"	
14 TYPE NO. 2		3 1/2" x 3/4"	
2 HEEL BLOCKS, COMPLETE WITH BOLTS, JOINT BARS AND THIMBLES			1125 (ALT.)
2 STOPS TO BE ASSEMBLED WITH SWITCH POINTS			1024

FIGURE 42a.

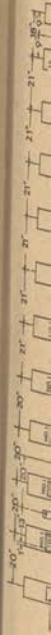
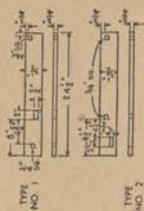


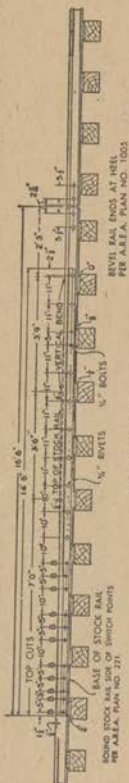
Diagram illustrating a switch layout with rigid rail braces. The layout shows two main rails with cross-ties. Dimensions are provided for the spacing of the ties and the length of the rails. Labels include "BEND", "GAGE", "VERTICAL", "RIGID RAIL BRACE", "SWITCH LAYOUT WITH RIGID RAIL BRACES", and "RAIL BRACE FOR 1:8 SLOPE". The diagram is oriented vertically on the page.

SWITCH LAYOUT WITH RIGID RAIL BRACES

SCALE



DETAIL OF TWIN TIE PLATES



ELEVATION OF SWITCH POINT

NOTE B—ALL OTHER DETAILS TO BE STRICTLY IN ACCORDANCE WITH A.R.A. TRACK WORK PLANS NO. 221-40, NO. 112-41 AND NO. 222-41.

NOTE B—ALL OTHER DETAILS TO BE STRICTLY IN ACCORDANCE WITH A.R.E.A. TRACK WORK PLANS NO. 221-40, NO. 112-41 AND NO. 222-41.

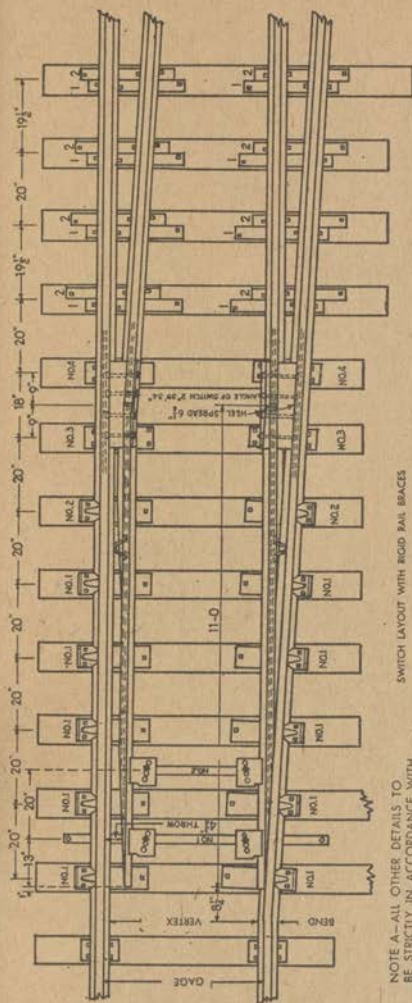
157

11'-0" STRAIGHT SPLIT SWITCH WITH GRADUATED RISERS

BILL OF MATERIAL			
11'-0" NON-INSULATED STRAIGHT SPLIT SWITCH WITH RIGID RAIL BRACES		A.R.E.A. SPEC. 114-G	
DESCRIPTION		DETAIL NO.	
2 DOUBLE REINFORCED SWITCH POINTS, COMPLETE, WITH DETAILS FOR SIDE JAW CLIPS		3/4"	2112
2 NON-INSULATED SWITCH RODS 1 NO. 1		2 1/2" x 1"	2010
1 NO. 2		2 1/2" x 1"	2011
12 RAIL BRACES 1/2" THICK		6" WIDE	2022
12 SOLID BASE SLIDE PLATES 10 NO. 1 1/4" RISER		6" WIDE	1120R
2 NO. 2 1/8" RISER		6" WIDE	1121R
2 STOPS TO BE ASSEMBLED WITH SWITCH POINT			1024
4 SHOULDER HEEL PLATES 1 PR. NO. 3 R.H. & L.H.		7" WIDE	2140
1 PR. NO. 4 R.H. & L.H.		7" WIDE	2149
16 TWIN TIE PLATES			
8 TYPE NO. 1		3 1/2" WIDE	
8 TYPE NO. 2		3 1/2" WIDE	
2 HEEL BLOCKS, COMPLETE, WITH BOLTS, JOINT BARS, AND THIMBLES			1125 (ALT.)

FIGURE 43a.

Figure 43a.



NOTE A—ALL OTHER DETAILS TO BE STRICTLY IN ACCORDANCE WITH A.R.E.A. TRACK WORK PLANS NO. 114-41, NO. 221-40, AND NO. 222-41.

SWITCH LAYOUT WITH RIGID RAIL BRACES

NOTE B—FOR SWITCH PLATE DETAILS SEE A.R.E.A. PLAN NO. 223-40. SUBSTITUTING NO. 1 SWITCH PLATES FOR NO. 1A AND NO. 1G.

SCALE
12" 6" 0" 1' 2'

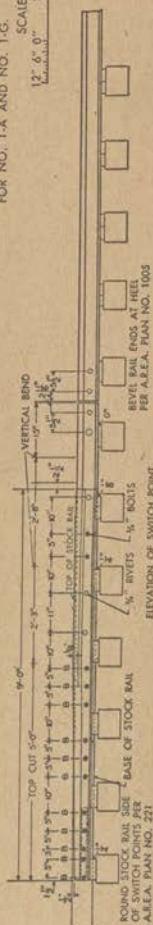


Figure 43b.

No. 8 RIGID FROG

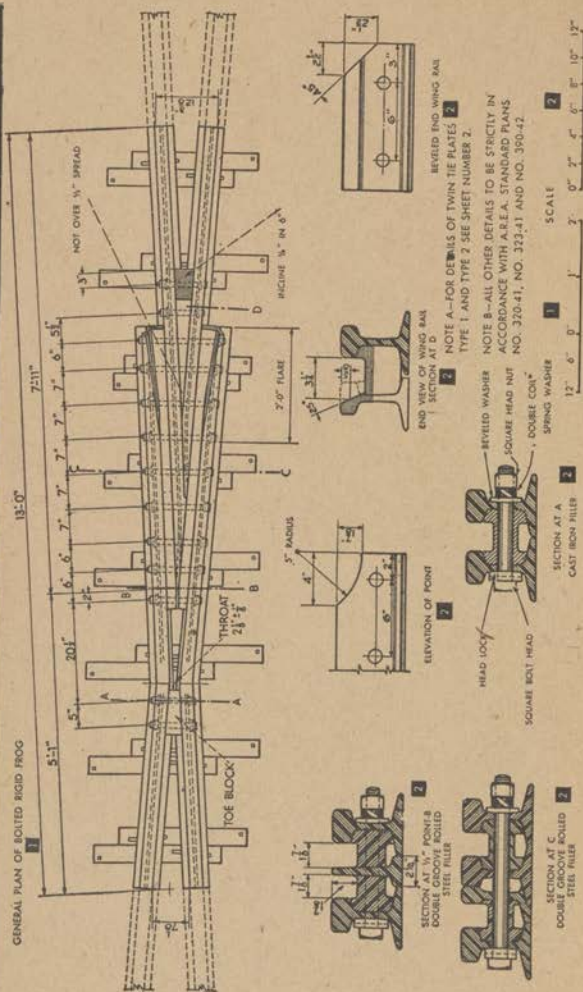
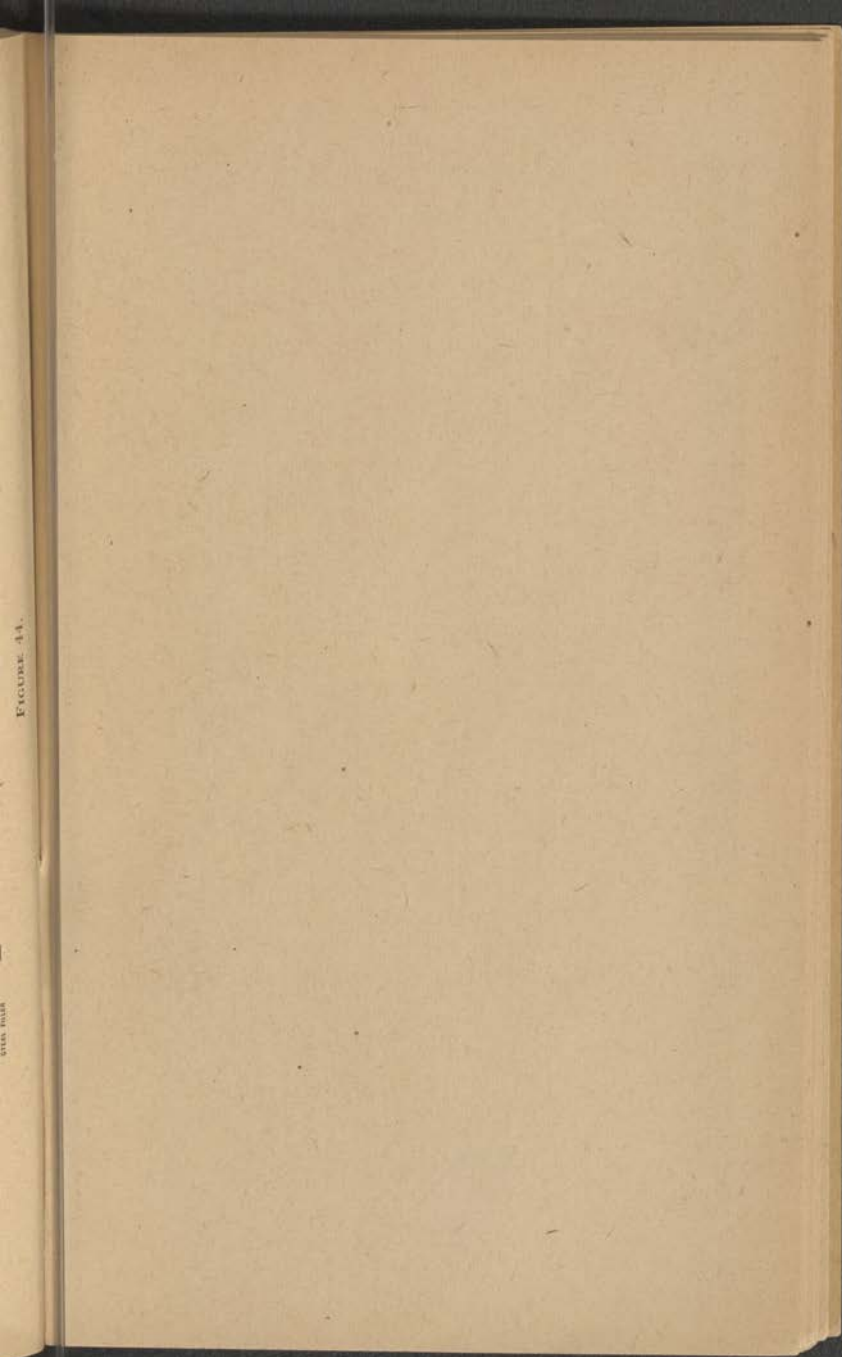
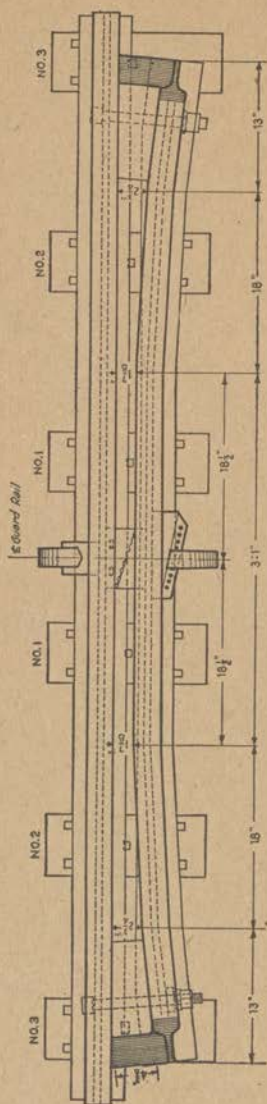


FIGURE 44.



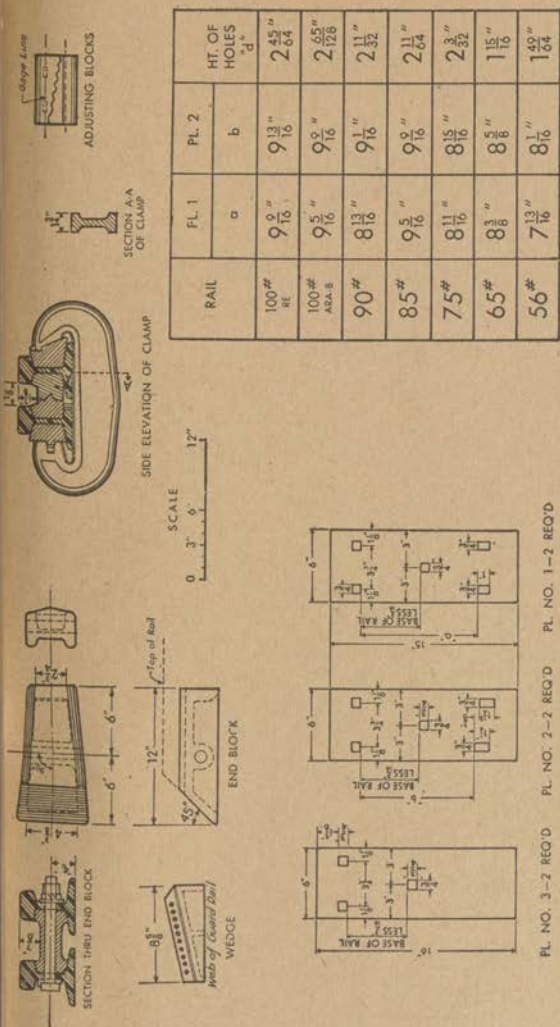
GUARD RAIL



PLAN OF GUARD RAIL

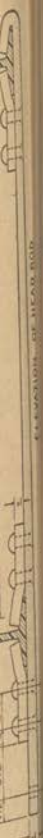


FIGURE 45a.

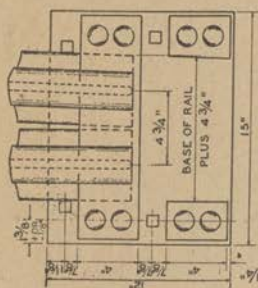
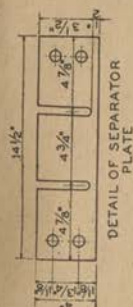


ALL PLATES TO BE OF ROLLED STEEL $\frac{3}{16}$ " THICK AND STAMPED WITH RESPECTIVE NUMBER AND WEIGHT OF RAIL

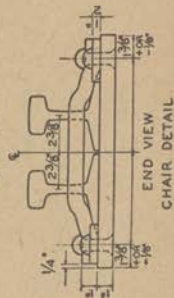
FIGURE 45b.



RAILROADS OF HEAD END



PLAN
SPIKE HOLES $3\frac{1}{2}$ " SQUARE
 $\frac{3}{4}$ " RIVETS



SCALE
0' 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 12'

TABLE OF LEADS

GAGE LEAD	LOOSE RAIL	GAGE LEAD	LOOSE RAIL
2'-0"	30'-0"	3'-3"	15'-0"
3'-0"	44'-0"	3'-6"	15'-6"
3'-1 1/2"	44'-0"	3'-9"	16'-0"
3'-3"	48'-0"	3'-12"	16'-6"
3'-3 3/4"	48'-0"	4'-0"	17'-0"
		4'-3"	17'-6"
		4'-6"	18'-0"
		4'-9"	18'-6"
		5'-0"	19'-0"
		5'-3"	19'-6"
		5'-6"	20'-0"
		5'-9"	20'-6"
		6'-0"	21'-0"

FIGURE 46b.

TRACK CAR SET-OFF AND SWITCH STAND BERM

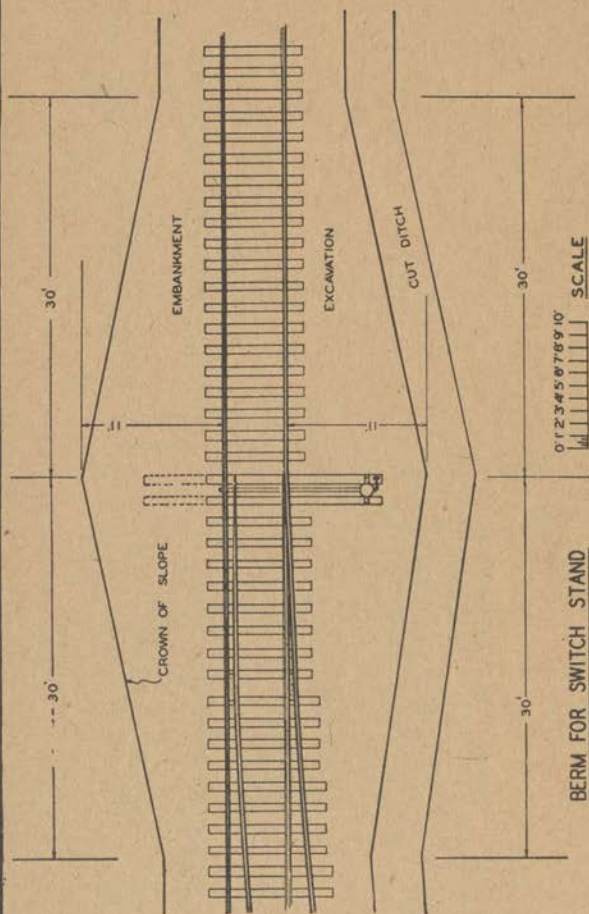


FIGURE 47a.

FIGURE 47a.

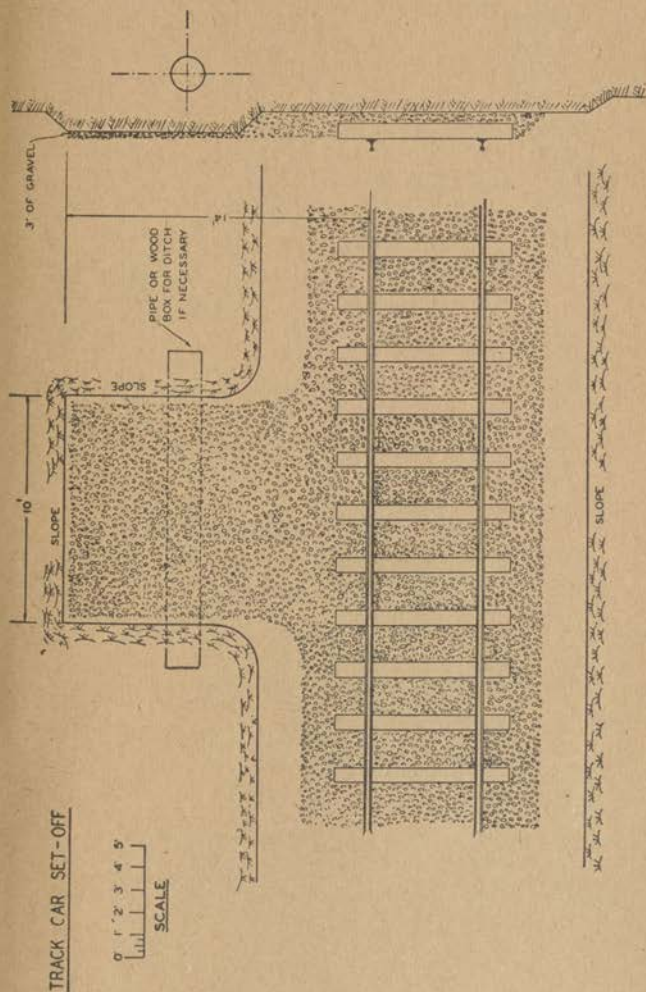
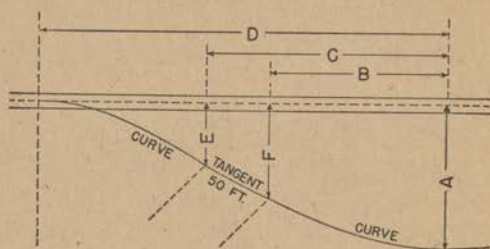


FIGURE 47b.

DIAGRAM AND TABLES
FOR LAYING TEMPORARY
TRACKS AROUND WRECKS AND WASHOUTS
(Dimensions in feet)



10° CURVES

A	B	C	D	E	F
10	53.6	103.3	156.9	2.5	7.5
20	84.0	133.5	217.5	6.3	13.7
30	107.3	156.5	263.8	10.3	19.7
40	127.3	176.0	303.3	14.4	25.6
50	144.8	193.1	337.9	18.7	31.3
60	160.3	208.3	368.6	23.0	37.0
70	174.5	222.1	396.6	27.4	42.6
80	187.8	235.0	422.8	31.8	48.2
90	200.2	247.0	447.2	36.2	53.8
100	211.9	258.3	470.2	40.7	59.3

FIGURE 48.

15° CURVES

A	B	C	D	E	F
10	42.2	92.0	134.2	2.3	7.7
20	66.2	115.4	181.6	5.7	14.3
30	85.0	133.7	218.7	9.5	20.5
40	100.8	149.2	250.0	13.5	26.5
50	114.7	162.6	277.3	17.5	32.5
60	127.2	174.4	301.6	21.5	38.3
70	138.7	185.6	324.3	26.0	44.0
80	149.4	195.6	345.0	30.3	49.7
90	159.2	204.8	364.0	34.6	55.4
100	168.5	213.5	382.0	39.0	61.0

FIGURE 48—Continued.

BILL OF TIMBER FOR TURN-OUTS

Frog No.	Lengths and quantities of ties															Quantity of ties	Board measure	
	8'0"	8'6"	9'0"	9'6"	10'0"	10'6"	11'0"	11'6"	12'0"	12'6"	13'0"	13'6"	14'0"	14'6"	15'0"			15'6"
5	0	0	6	4	3	1	2	2	2	2	1	2	1	1	4	2	33	2027
6	0	0	6	4	4	2	2	2	2	2	2	2	2	2	4	2	38	2352
7	0	0	9	7	4	3	3	3	3	2	2	2	2	2	4	2	48	2880
8	6	9	0	4	4	4	3	3	2	3	3	2	2	3	3	4	55	2875
9	0	0	9	8	5	4	3	3	4	3	2	4	3	3	4	2	57	3457
10	0	0	9	8	5	4	4	4	3	3	4	4	3	3	5	3	62	3809
11	0	0	13	12	6	5	4	4	3	4	3	4	3	3	5	3	72	4302
12	0	0	13	12	6	5	5	3	5	3	4	4	3	4	6	3	76	4583
14	0	0	13	12	6	5	6	5	6	5	4	5	4	4	6	4	85	5182
15	0	0	17	14	8	8	6	5	5	6	5	5	4	4	7	4	98	5891
16	0	0	17	15	9	7	7	6	5	5	5	5	5	5	7	5	103	6221
18	0	0	17	16	11	8	8	6	5	4	4	6	7	5	7	6	110	6654
20	0	0	17	16	11	8	8	8	6	6	7	7	7	6	8	6	121	7400

BILL OF TIMBER FOR CROSS-OVERS

Frog No.	Lengths and quantities of ties Maximum length 15'0"															Quantity of ties	Board measure		
	7'6"	7'9"	8'0"	8'6"	9'0"	9'6"	10'0"	10'6"	11'0"	11'6"	12'0"	12'6"	13'0"	13'6"	13'9"			14'0"	15'0"
5	0	2	2	4	12	10	8	4	6	6	6	2	4	2	2	0	4	74	4143
6	2	0	4	4	12	10	13	4	4	9	6	4	4	4	0	2	4	86	4827
7	2	0	4	6	18	14	15	6	6	13	6	4	6	4	0	2	4	110	6109
8	1	2	4	6	18	18	10	14	12	6	10	4	6	4	2	1	4	122	6775
9	1	4	2	12	18	16	18	8	6	14	8	2	12	2	4	1	4	132	7321
10	2	4	4	10	18	16	20	8	8	18	6	6	10	4	4	2	4	144	8033
11	4	2	4	16	26	24	18	10	8	14	6	6	16	4	2	4	4	168	9250
12	2	2	6	16	26	24	22	10	10	16	10	4	16	6	2	2	4	178	9818
14	2	4	6	16	26	28	18	12	14	16	16	8	16	6	4	2	4	198	11015
15	4	4	6	20	34	32	22	16	12	16	14	10	20	6	4	4	4	228	12590
16	4	4	8	20	36	30	27	14	14	21	10	10	20	8	4	4	4	238	13128
18	2	6	6	24	34	36	30	18	18	20	14	6	24	6	6	2	4	256	12096
20	6	4	10	24	34	32	35	16	16	29	12	12	24	10	4	6	4	278	15422

METHOD OF PILING TIES

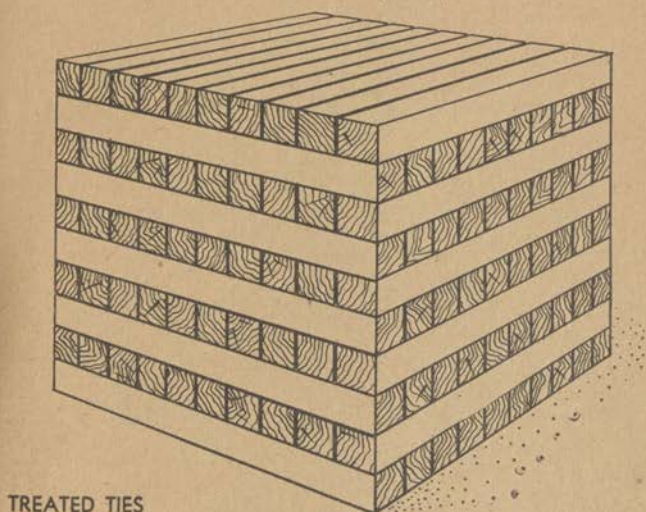
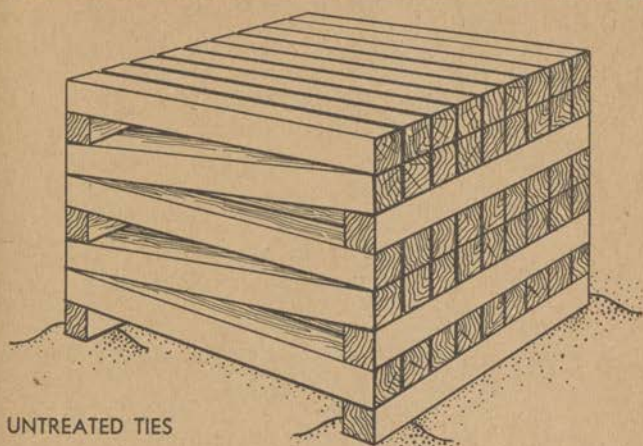


FIGURE 49.

TIE SPACING

20-inch centers

Main track

39-foot rail—24 ties per panel

33-foot rail—20 ties per panel

30-foot rail—18 ties per panel

Side tracks

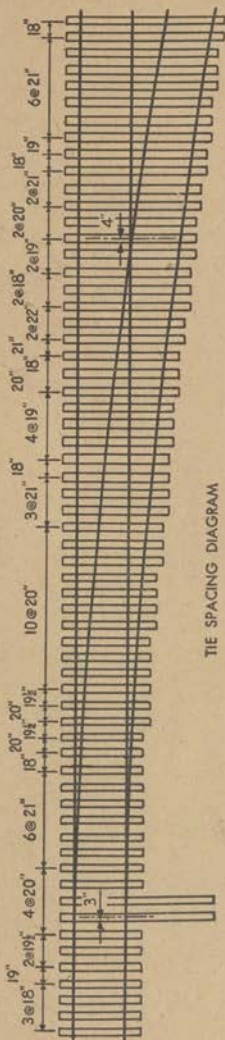
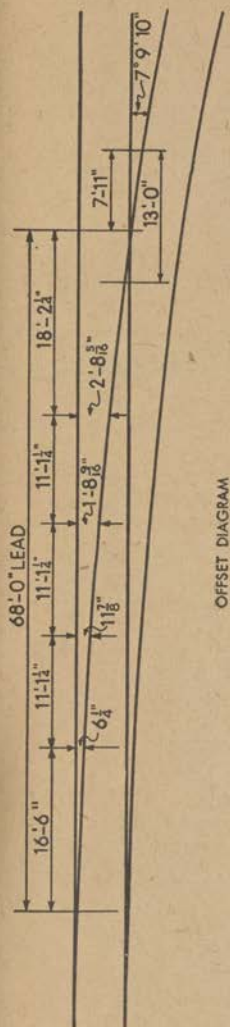
33-foot rail—18 ties per panel

30-foot rail—16 ties per panel

TABLE OF RECOMMENDED LEADS FOR VARIOUS GAUGES
USING STANDARD #8 FROG AND 11'0" OR 16'6" SWITCH
POINTS

Gauge	Switch point	Lead
2-6	11-0	32'0"
3-0	11-0	38'0"
3-1 $\frac{3}{8}$	11-0	38'0"
3-3	11-0	42'0"
3-3 $\frac{3}{8}$	11-0	42'0"
3-5 $\frac{1}{2}$	11-0	42'0"
3-6	11-0	42'0"
4-8 $\frac{1}{2}$	16-6	68'0"
5-0	16-6	68'0"
5-3	16-6	75'0"
5-6	16-6	75'0"

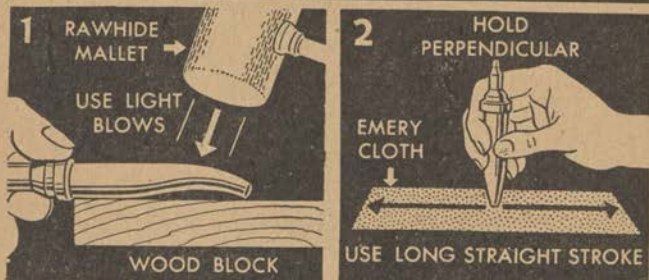
Heel spread at switch = 6 $\frac{1}{4}$ "



BILL OF TIMBER			
55 PCS.			
TOTAL			
9 PC	8'-6"	3 PC	13'-6"
6 PC	9'-0"	3 PC	14'-0"
2 PC	9'-6"	2 PC	14'-6"
4 PC	10'-0"	3 PC	15'-0"
	10'-6"	3 PC	15'-6"

FIGURE 50.

HOW TO RECONDITION OXY-ACETYLENE HAND-CUTTING NOZZLES



1. If the nozzle is bent it usually can be straightened satisfactorily. To do this, place it on a wood block and straighten by repeated light blows of a rawhide mallet. Do not use heavy blows.

2. Square up the flame end of the nozzle by rubbing it on Aloxite or emery cloth. Orifices must be round with sharp edges and no burrs. As much as $\frac{1}{4}$ in. can be removed from nozzle end.

3. To clear gas passages, select the correct size drill as specified in the blowpipe instruction book—and proceed as illustrated. Work the drill up and down carefully—do not twist it. If the drill does not enter the orifice easily, do not force it—start with smaller sizes. The last inch of gas passage must be clean, to size and not bell-mouthed.



4. To clean the nozzle seats, heat up the seat end below the nozzle nut ring to a dull red heat—then quench in water. This loosens the scale so that it can be wiped off with a damp cloth. The heating softens the nozzle seats somewhat so that when connected to the blowpipe, they are burnished and dressed by the harder seating surfaces in the blowpipe head. If there are dents or nicks which are not eliminated by this procedure, the nozzle should be discarded.

FIGURE 51.

RECOMMENDED PRACTICES FOR WELDING

Use proper size torch tip. If number is not clear, check with cleaning drill.

Keep tips clean and free from carbon and slag.

Keep cleaning drills handy and use them on tips.

Use a friction lighter to light a blowpipe.

Do not use excessive pressures.

Close cylinder valves when torch is not in use.

Do not leave torches burning when not in use.

Between jobs, release regulator screw, to prevent loss of gas through hose leakage.

Use correct diameter hose.

Use correct length of hose.

Check hose periodically for leaks by immersing in water while under pressure.

Check hose connections for leaks, using soap and water.

Handle hose with care. Wash off oil and grease. Keep out of range of hot oxide and sparks. Cut out damaged sections and splice ends together, using a standard splicing nipple. Do not attempt to repair hose with tape.

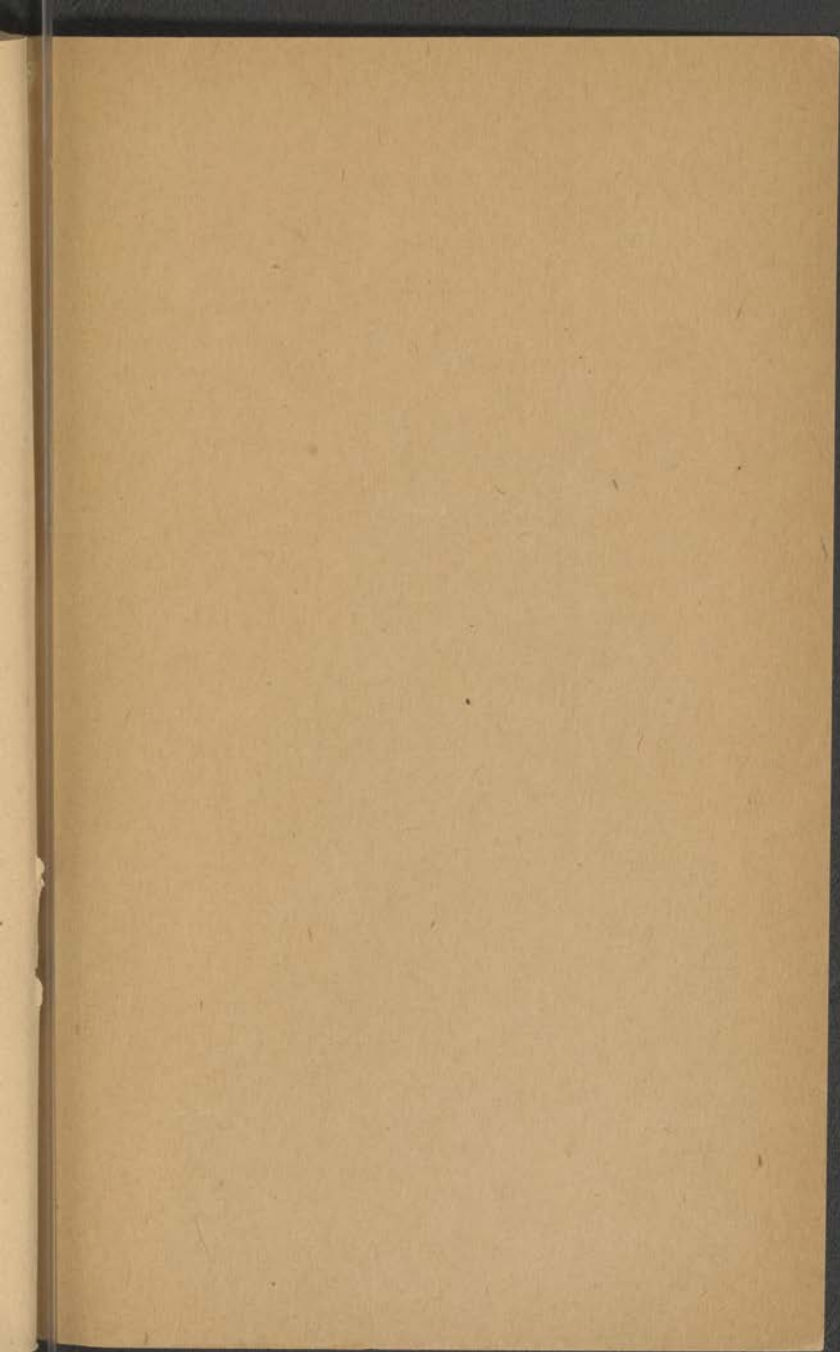
Use all of gas in each cylinder before connecting a new one.

Do not abuse cylinders.

When using cutting or welding blowpipes, operators will wear proper goggles at all times.



U OF NT LIBRARIES 78203



UNT LIBRARIES DENTON TX 76203



1002600657

W1. 35: 55-275
1944 mecat p 589