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TM 5-627

WAR DEPARTMENT TECHNICAL MANUAL

U. S. Dept. of Army

RAILWAY TRACK MAINTENANCE

REPAIRS AND UTILITIES

WAR DEPARTMENT • SEPTEMBER 1946

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This manual supersedes sections .01 through .04, chapter IX, part VI, of the Repairs and Utilities Manual, OCE, 1942.

RAILWAY TRACK MAINTENANCE

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WAR DEPARTMENT • SEPTEMBER 1946

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Major General
The Adjutant General

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For explanation of distribution formula, see FM 21-6.

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TABLES

This manual supersedes sections .01 and .04, chapter IX, Part VI, of the Repairs and Utilities Manual, OCE, 1942.

SECTION I
INTRODUCTION

1. Purpose and Scope

This manual is a guide to maintenance of Government-owned trackage and fixed installations within rights of way at Army posts, camps, and stations. Standards and procedures for maintaining track structure are described in detail. New construction of railroad structures such as buildings, bridges, trestles, and culverts is not discussed except for general reference to rules and practices applicable to maintenance activities. Technical Manuals covering new construction are listed in FM 21-6. Maintenance procedures common to both roads and railroads will be covered in TM 5-624 (when published).

2. Standards of Maintenance

Government-owned railroads must be maintained in accordance with standards set forth in this manual. Detailed explanations of specific problems are available in publications listed in appendix II. Considerations of efficiency, economy, and safety govern all cases where interpretation of procedures is left to the discretion of the individual. Standards of maintenance for railroad facilities at any post must be consistent with the present and future use of the post. As activities governing the use of facilities change, standards of maintenance should change accordingly. Generally, standards are based on the following:

a. Current Government policies.

b. Permanency of the post, camp, or station.

c. Extent to which railroad facilities are used.

d. Type of traffic.

e. Limiting conditions established by the serving railroad or by State laws.

f. Classification of the track, whether running or access track, receiving- or classification-yard, siding, or dead-storage track.

g. Availability of personnel and material.

3. Record Drawings

Copies of *as built* drawings should be prepared and submitted in accordance with instructions contained in TM 5-601. All revisions, including relocation of existing tracks and additions or deletions of track, should be recorded on the drawings at the time the work is done. Record drawings should be kept available for over-all planning of future work. A color scheme may be used for identifying various weights of rail in track. Other legends may be employed to indicate proposed work, such as rail and tie renewals, tracks to be raised, fills and cuts to be widened, etc. Track charts are used by track-maintenance crews and inspectors for noting future work determined necessary by field inspection, and for indicating progress of field work. For method of preparation, see paragraph 54.

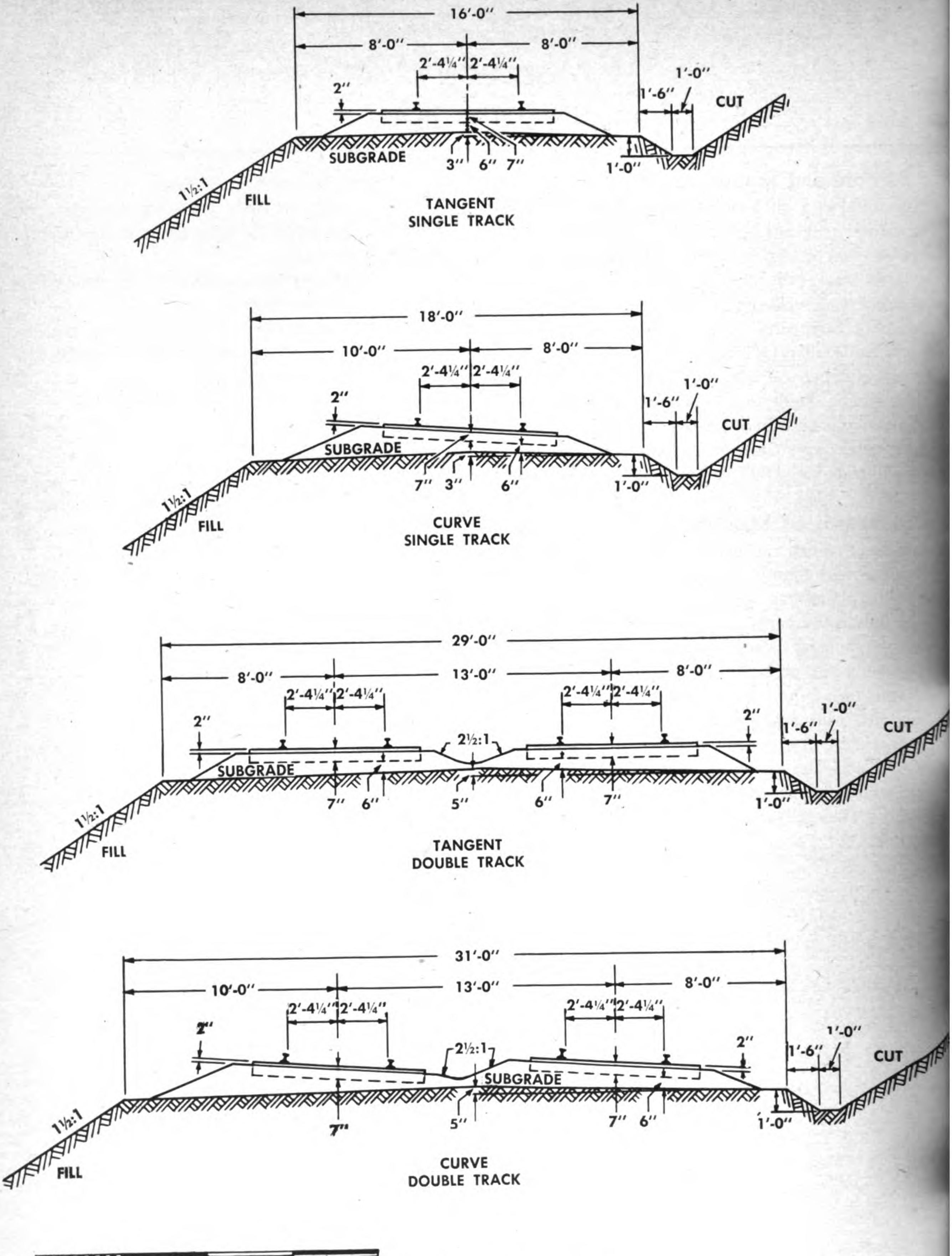


Figure 1. Standard roadway sections.

SECTION II
CONSTRUCTION DETAILS

4. Roadway Sections

Standard roadway cross sections are shown in figure 1.

a. CUTS AND FILLS. (1) *Earth.* Slopes of earth cuts and fills are one and one-half horizontal to one vertical where the fill or subsoil of the cut is fairly stable. Slopes are flattened, or held by riprap or walls, where unstable soil conditions may cause slides. (See figs. 2 and 3.)

(2) *Rock.* Slopes in rock cuts are generally one-fourth horizontal to one vertical or one-half to one, depending on the kind of rock in the cut. (See fig. 4.)

Figure 2. Typical roadway through earth cut and fill.

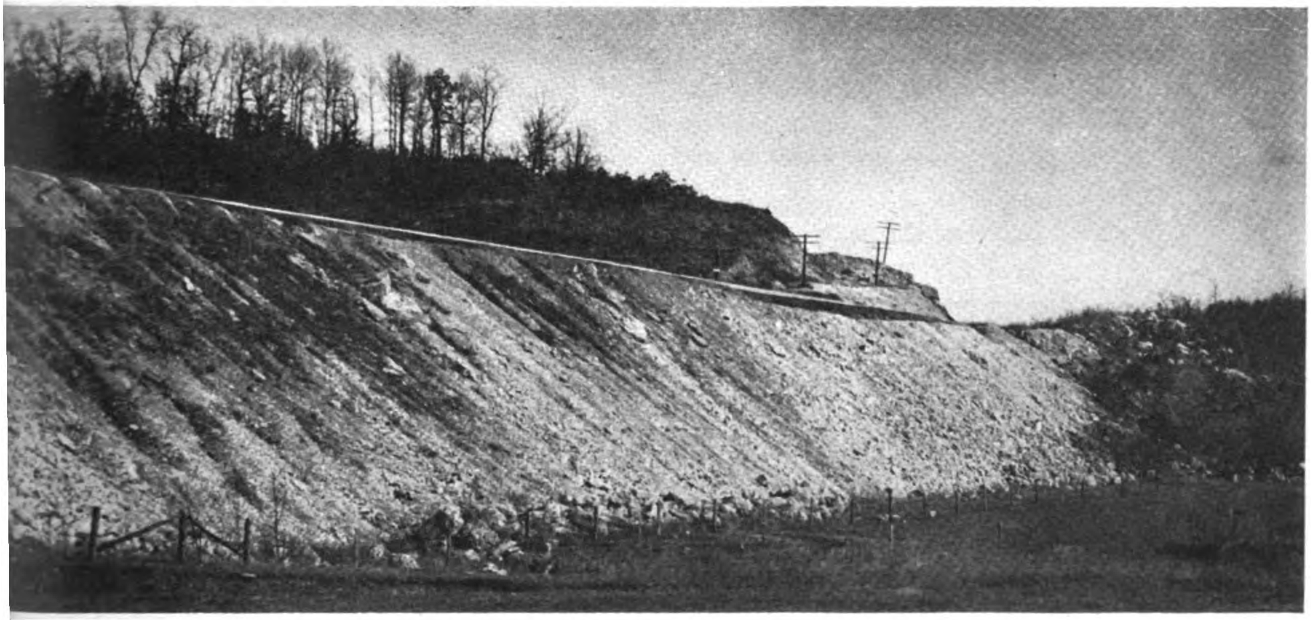


Figure 3. Typical roadway on earth fill.

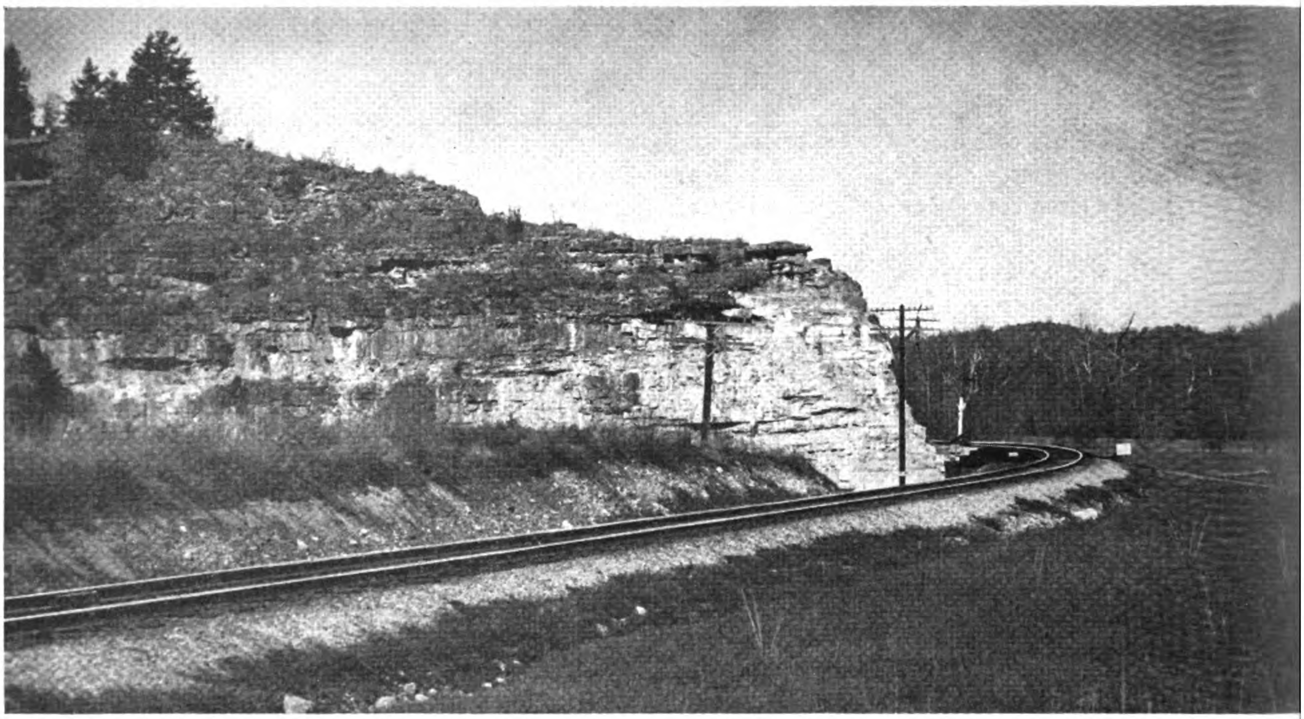


Figure 4. Typical roadway through rock cut.

b. SUBGRADE. (1) *Slope.* The slope of the subgrade toward the outside of the track or tracks is ⅜ inch for each foot.

(2) *Width.* In multiple track lay-outs, the standard 16-foot subgrade is widened 13 feet for each additional track.

c. DRAINAGE. (1) *Drainage ditches.* Drainage ditches are provided at the toe of slopes, at a minimum distance of 9½ feet from the center line of the nearest track. To prevent silting, grade of the ditch is not less than 0.27 percent. The minimum width and depth of the open ditch are each 12 inches. Where the amount of run-off is great, the width of the drainage ditch is increased. If this is not practicable the grade of the ditch is made steeper, or water is diverted. If increase in grade results in scouring the sides or bottom of the ditch, paving with stone rubble, or concrete may be necessary.

(2) *Intercepting ditches.* Intercepting ditches prevent erosion of cut slopes by run-off from adjacent areas. They are cut into the slopes as shown in figure 5.

(3) *Ballast section.* Figure 6 illustrates in detail the typical ballast section. Quantities of ballast and sub-ballast for each 1,000 feet of track are given in figure 6 and table I.

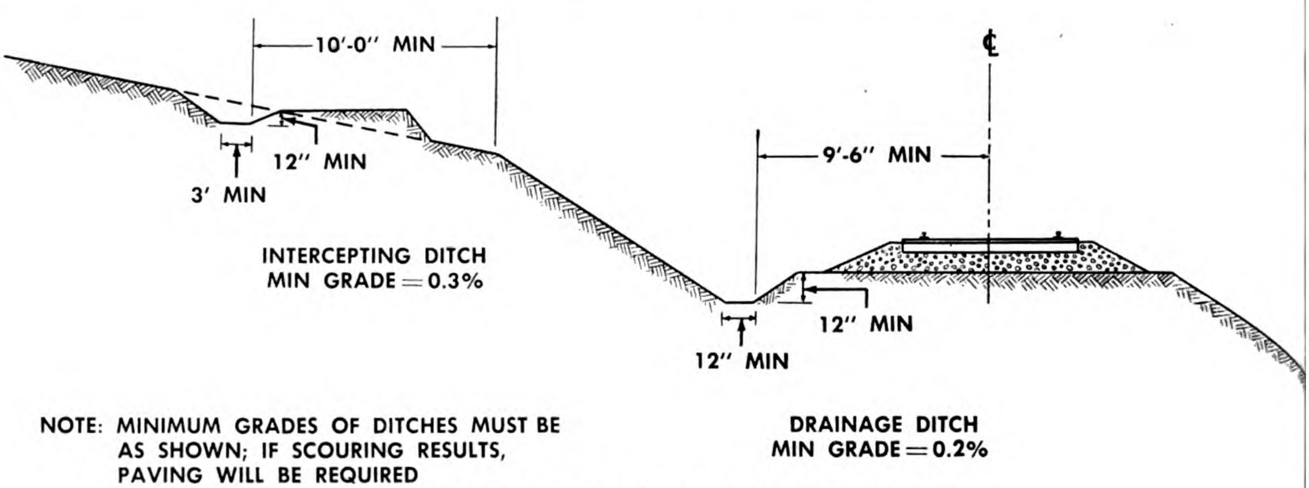


Figure 5. Details of drainage and intercepting ditches.

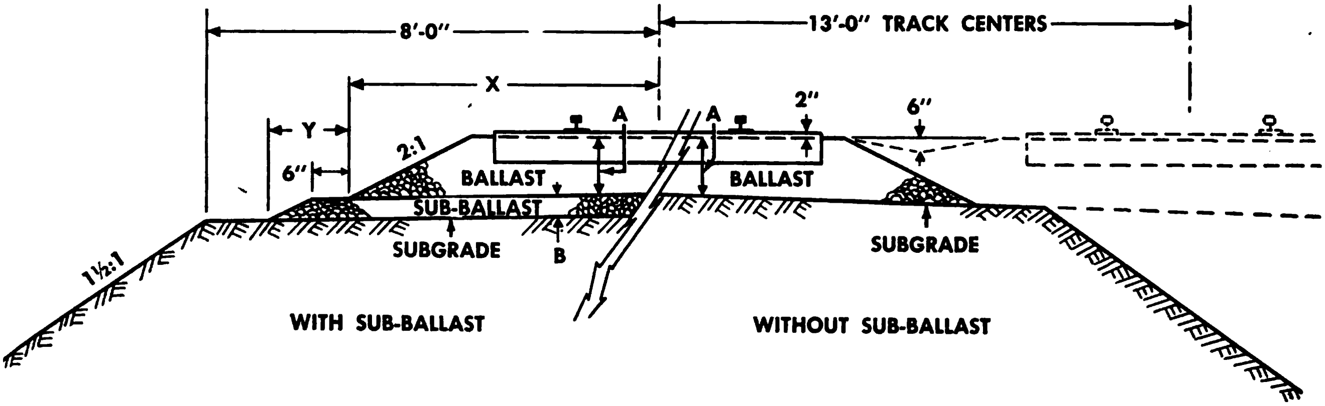


Figure 6. Typical ballast section.

Table I. Quantities of ballast and sub-ballast for each 1,000 feet of track

Section	A	X	B	Y	Quantities of ballast and sub-ballast for each 1,000 feet of track						Section
					Single track (cu yd)		Double track (cu yd)		For additional track (cu yd)		
					Sub-ballast	Ballast	Sub-ballast	Ballast	Sub-ballast	Ballast	
a	12"	6' 6"	8"	1' 10"	374	358	691	753	317	395	a
b	......	....	6"	1' 6"	277	....	517	....	240	....	b
c	......	....	4"	1' 2"	179	....	328	....	158	....	c
d	......	....	0"	....	....	....	....	....	....	....	d
a	10"	6' 2"	8"	1' 10"	357	292	674	619	317	327	a
b	......	....	6"	1' 6"	265	....	505	....	240	....	b
c	......	....	4"	1' 2"	171	....	329	....	158	....	c
d	......	....	0"	....	....	....	....	....	....	....	d
a	8"	5' 10"	8"	1' 10"	342	203	659	434	317	231	a
b	......	....	6"	1' 6"	253	....	493	....	240	....	b
c	......	....	4"	1' 4"	163	....	321	....	158	....	c
d	......	....	0"	....	....	....	....	....	....	....	d
a	6"	5' 6"	8"	1' 10"	325	136	642	291	317	155	a
b	......	....	6"	1' 6"	240	....	480	....	240	....	b
c	......	....	4"	1' 2"	154	....	312	....	158	....	c
d	......	....	0"	....	....	....	....	....	....	....	d

. Alignment

a. General. Curvature of track is limited to 16° r to the maximum curvature recommended by the ırving railroad.

b. Track Centers. (1) Running tracks and ody tracks in yards are 13 feet center to center. ody tracks are 15 feet center to center from parallel ain or running tracks. Ladder tracks are at least 5 feet center to center from any parallel tracks. (See g 7.)

(2) Beginning with a 10° curve, track centers e widened 1 inch for each degree of curvature, to low for overhanging and tilting of cars.

6. Superelevation

a. General. Lateral outward thrusts on curved tracks are overcome by elevating the outer rail. (See fig. 8.) This vertical rise is called superelevation and is used on all curves except those in yards or where train movements are relatively slow. Superelevation is, in general, based on the degree of curvature and train speed. (See table II.) Usually, an elevation of 6 inches is not exceeded for tracks carrying both fast and slow traffic. In no case is the elevation greater than 7 inches. Speed of trains is reduced if necessary.

b. Simple Curves. Full elevation is carried uniformly throughout the length of simple curves.

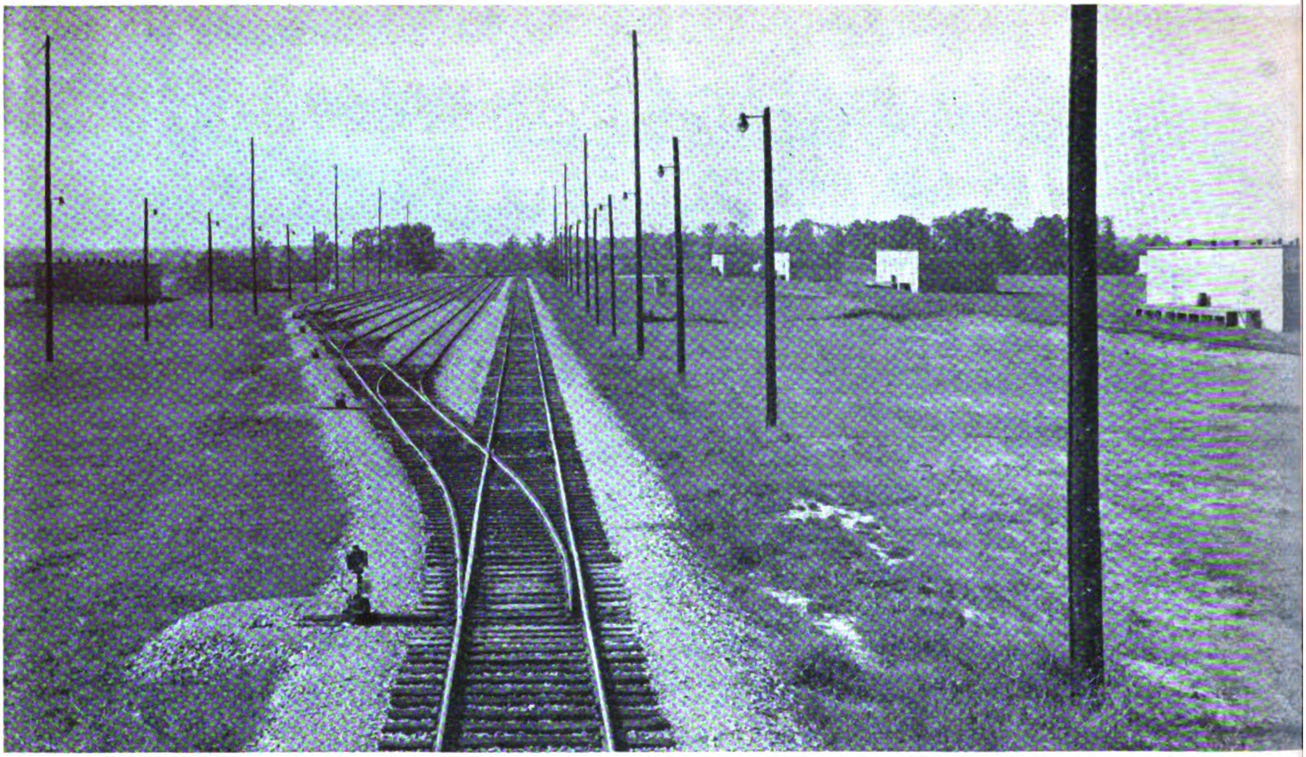


Figure 7. Typical yard lay-out with running track.

Figure 8. Superelevated curved track.

c. Compound Curves. Each section of a compound curve is given its correct elevation, but the change from one elevation to another is uniformly distributed.

d. Reverse Curves. The elevation from one r to the other is changed so that rails are level at t point of reversal. (See fig. 9.)

e. Transition Approach. Superelevation of *able II. Relationship between curvature, speed, and superelevation*

Degree of curve	Superelevation in inches								Degree of curve
	Speeds in miles an hour								
	15	20	25	30	35	40	45	50	
0° 30′						¼	½	½	0° 30′
1° 00′					¼	½	¾	1	1° 00′
1° 30′						¾	1	1½	1° 30′
2° 00′					½	1	1¼	2	2° 00′
2° 30′				¼		1¼	1½	2½	2° 30′
3° 00′					¾	1½	1¾	3	3° 00′
3° 30′				½	1	1¾	2	3½	3° 30′
4° 00′					1¼	2	2½	4	4° 00′
4° 30′				¾	1½	2½	3	4½	4° 30′
5° 00′					2	3	3½	5	5° 00′
5° 30′				1	2½	3½	4	5½	5° 30′
6° 00′			0	1¼	3	4	4½	6	6° 00′
6° 30′			¼	1½	3½	4½	5		6° 30′
7° 00′			½	2	4	5	6		7° 00′
7° 30′			¾	2½	4½	6			7° 30′
8° 00′		0	1	3	5				8° 00′
9° 00′		¼	1½	3½	6				9° 00′
10° 00′		½	2	4					10° 00′
11° 00′		¾	2½	4½					11° 00′
12° 00′		1	3	5					12° 00′
13° 00′		1¼	3½	6					13° 00′
14° 00′		1½	4						14° 00′
15° 00′	0	1¾	4½						15° 00′
16° 00′	¼	2	5						16° 00′
17° 00′		2¼	5½						17° 00′
18° 00′	½	2¾	6						18° 00′
20° 00′	1	3¾							20° 00′
22° 00′	2	5							22° 00′
24° 00′	3								24° 00′
26° 00′	4								26° 00′

spiral easement or tangent transition approach to a simple curve is made in successive stages at a rate of ¼ to ½ inch in 30 feet for a maximum length of 360 feet. Changes from zero to full elevation at the start of a simple, unspiralled curve are made within the transition approach so that full elevation is attained at the start of the curve. Spiral easements are given to all curves where lay-out conditions permit.

7. Minimum Clearances

Minimum clearances on straight track must conform to details given in figure 10, unless State laws or regulations of the serving railroad require greater clearances.

a. Standard minimum clearance for overhead structures is 18 feet, measured from the top of rail. Overhead clearances less than 22 feet are protected by warning signs and telltales. (See fig. 11.)

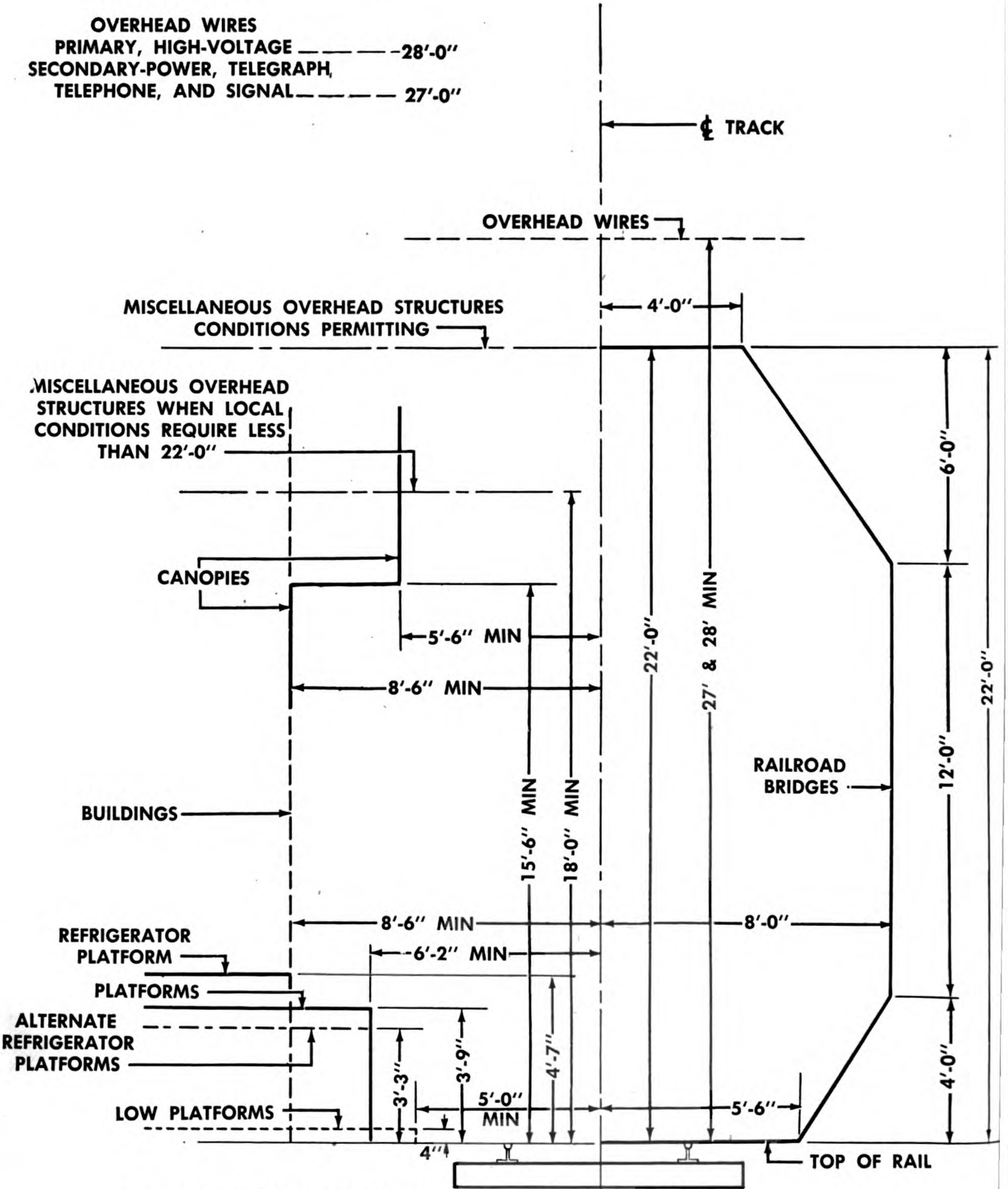
b. Warehouse and engine-house entrances must have minimum clearances of 17 feet vertically, and 7 feet, 3 inches laterally. Clearances are measured from top of rail and center line of track, respectively.

c. Side clearances less than the standard minimum clearances shown in figure 10 are protected by close clearance signs placed at the entrance to be readily visible from approaching trains.

d. Overhead clearances less than 22 feet and side clearances less than standard must be listed in the operating contract with the serving railroad.

e. On curved track, the standard minimum side

Figure 9. Superelevated reverse curve.



NOTE: PROTECT CLEARANCES LESS THAN 22′-0″ BY AN APPROVED TYPE OF WARNING DEVICE CLEARANCES MUST COMPLY WITH EXISTING STATE LAWS.

Figure 10. Minimum clearances.

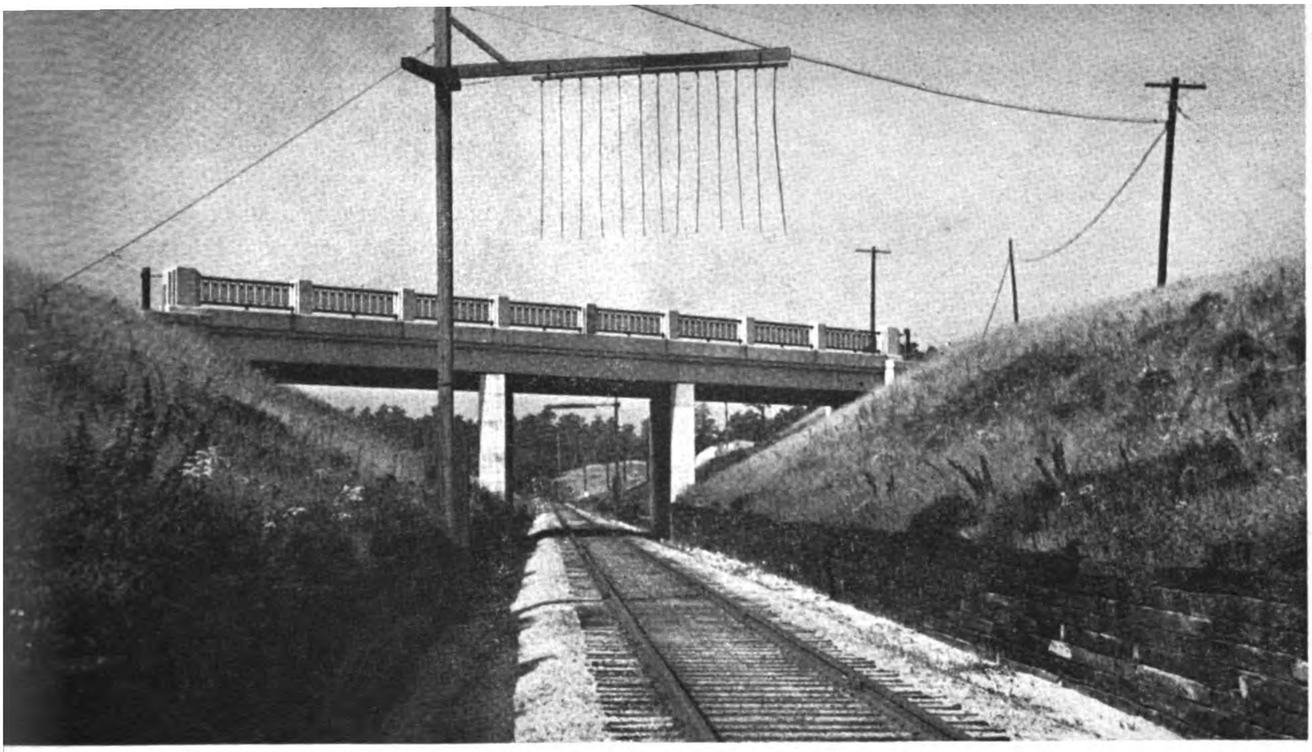


Figure 11. Telltale at overhead structure.

learance shown in figure 10 is increased 1 inch for ach degree of curvature.

꞉. Grades

Iaximum grades of 0.5 percent (6 inches in 100 eet) are recommended for house and storage tracks; rades must not exceed 0.8 per cent (9½ inches in 00 feet). Grades on access or running tracks are imited to those recommended by the serving rail-oad. All changes in gradient are made through ertical curves. The formula for computing vertical urves is given in paragraphs 54 through 59.

꞉. Turn-Outs and Cross-Overs

The number 8 turn-out with 15- or 16½-foot switch oints, rigid bolted frog, T-rail guardrails, and low witch stand is standard. Details of this turn-out are llustrated in figures 12 and 13.

10. Derails

Derails are installed on sidings to derail any cars olling beyond a specified safe distance from the djacent running track. (See fig. 14.) The use of lerails is governed by such local conditions as the elative grades of turn-out and running tracks, and he amount and type of traffic on the track to be rotected. Derails are installed on the rail farthest from the running track and far enough from the clearance point to insure that derailed equipment will not foul the running track.

11. Guardrails Over Bridges or Trestles

a. General. Guardrails are installed between running rails over open-floor deck bridges and trestles on all curves over 4°, or on tangents and curves under 4° if the clear span is 40 feet or more. They are installed according to the following rules:

(1) *Single track.* Two guardrails placed on the ties between traffic rails to provide a 10-inch space between the head of the guardrail and the gauge side of the traffic rail. (See fig. 15.)

(2) *Two tracks.* One guardrail for each track, placed on the ties 10 inches from the gauge of the traffic rails farthest from the parapets.

(3) *Three or more tracks.* One guardrail for each outside track, placed as in (2) above.

b. Weights. The relationship between weights of guardrails and traffic rails is as follows:

Traffic rail	*Guardrail*
130	100
100	85
85	70
75	60

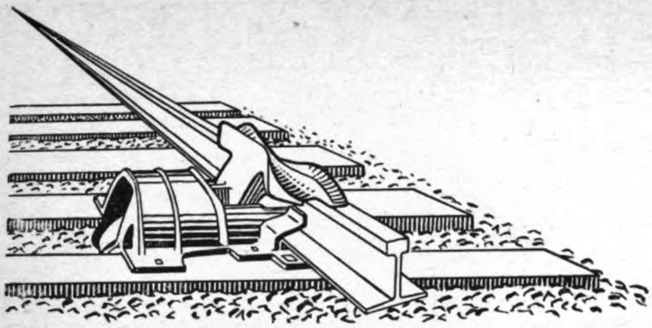


Figure 14. Derail installation.

the road crossing is made at right angles to the tracks. Typical highway crossings are illustrated in figures 16 through 20.

a. GRADE. Roadway approaches to tracks are on a smooth grade (not exceeding 9 inches in 30 feet) with no abrupt breaks or irregularities.

b. HEIGHT AND WIDTH. Where practicable, the width of the crossing extends 2 feet beyond each side of the highway paving. The crossing surface is level with the top of the rails. A level approach is maintained for at least 25 feet from each outside rail.

Figure 15. Two guardrails on single track

12. Highway Grade Crossings

Crossings must not limit the number of vehicles or loads carried by traffic on roads or highways. The maximum view must be provided for highway traffic approaching from either direction. Where possible,

c. FLANGEWAYS. Flangeways 2¼ inches wide and 2½ inches deep are provided along the gauge side of each rail. On curves over 8° the flangeway width is increased to 2½ inches.

d. JOINTS. Rail joints are not located within the

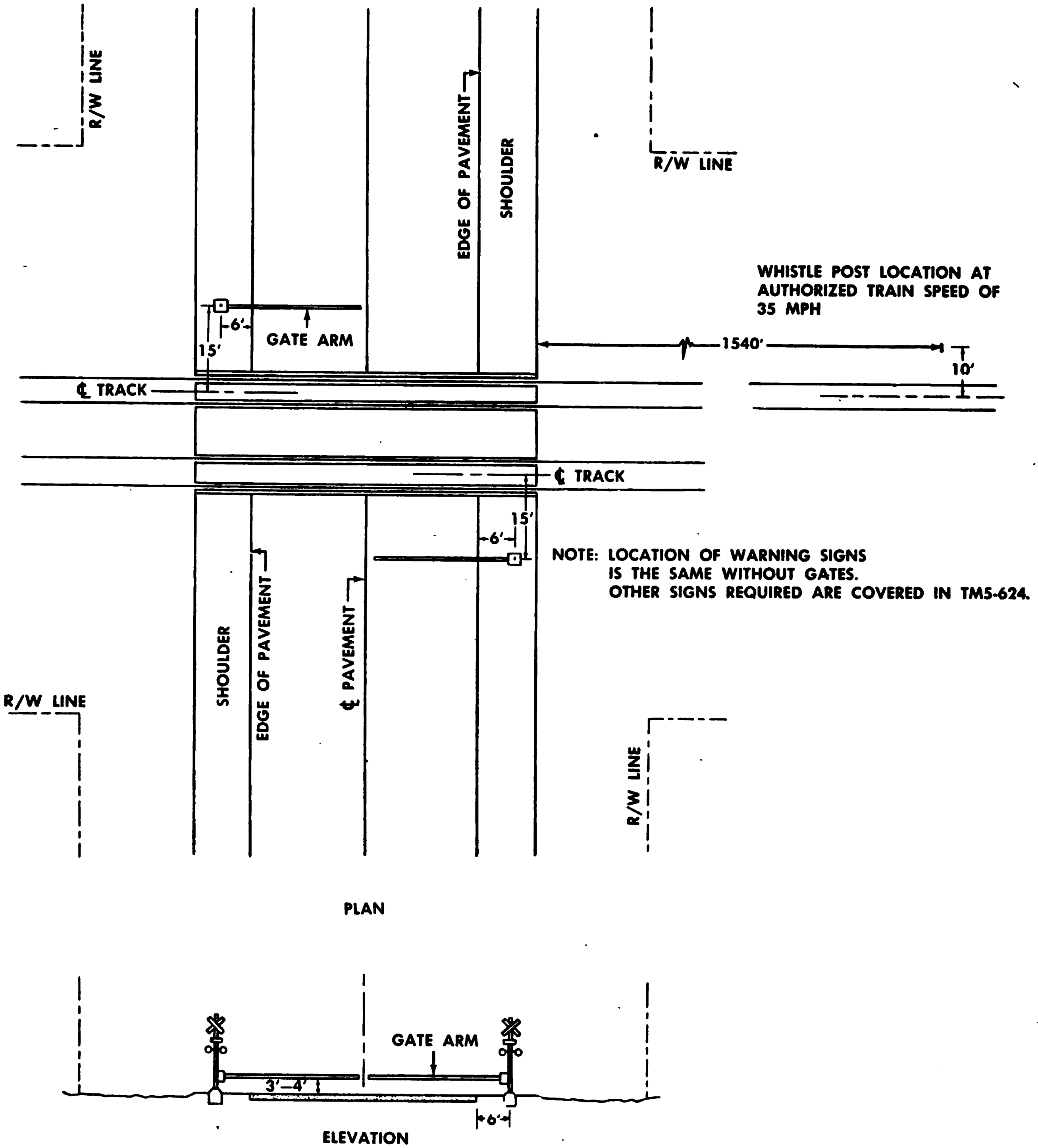


Figure 16. Highway crossing at 90° with tracks.

limits of the crossing. Full-length rails are used, and the joints beyond the crossing are staggered a minimum of 3 feet. Short rails are used to stagger rail joints beyond the crossing to the standard limit of 30 inches from the middle of opposite rails.

e. Surface. The type of crossing surface (planked, bituminous, rail, or concrete) is determined by the type of traffic and the type of highway surface. In any case, the surfacing extends at least 8 inches beyond outside rails and is beveled at each end. Edges of bituminous-surfaced crossings are protected from raveling by plank or concrete curbing.

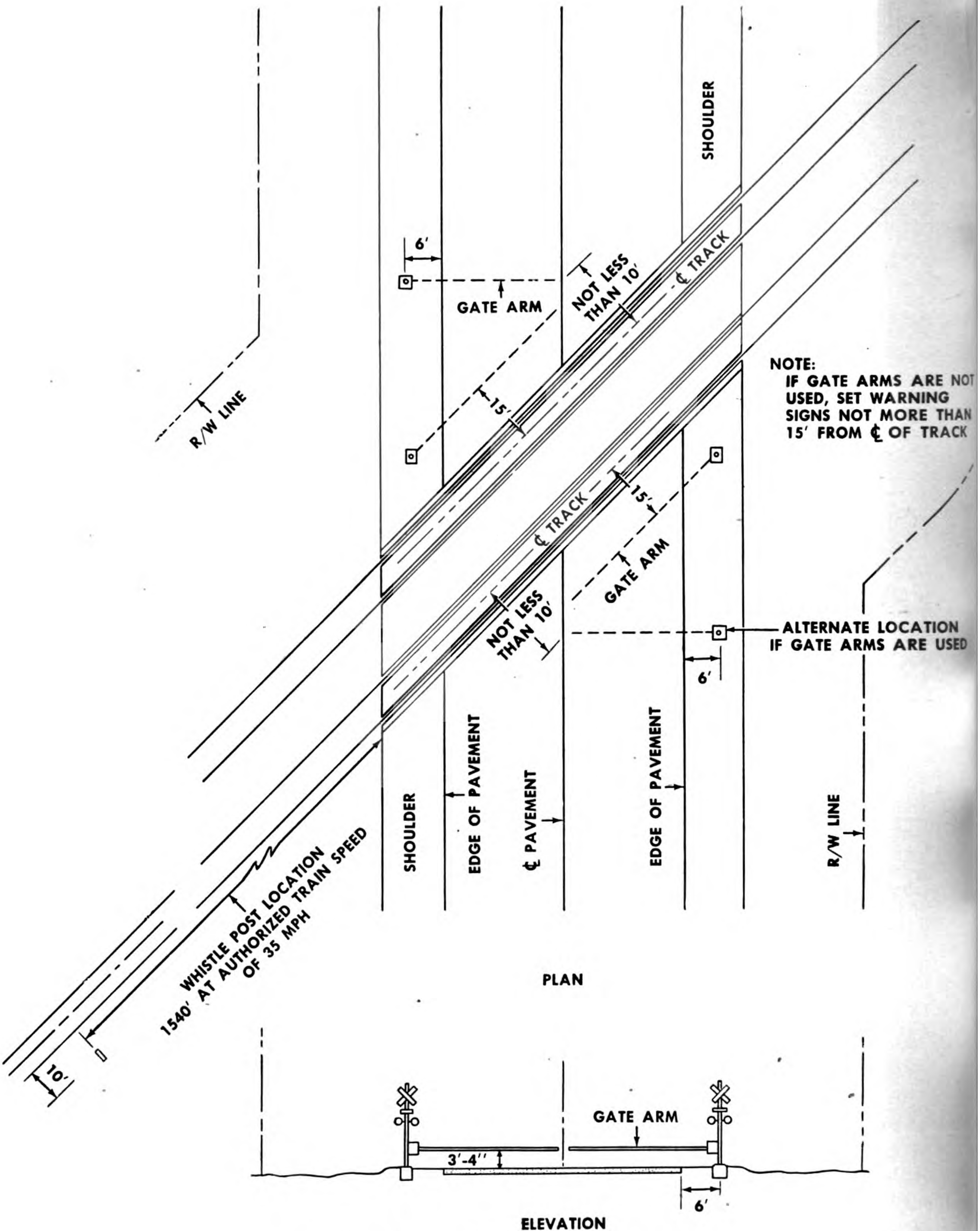


Figure 17. Highway crossing at skew angle with tracks.

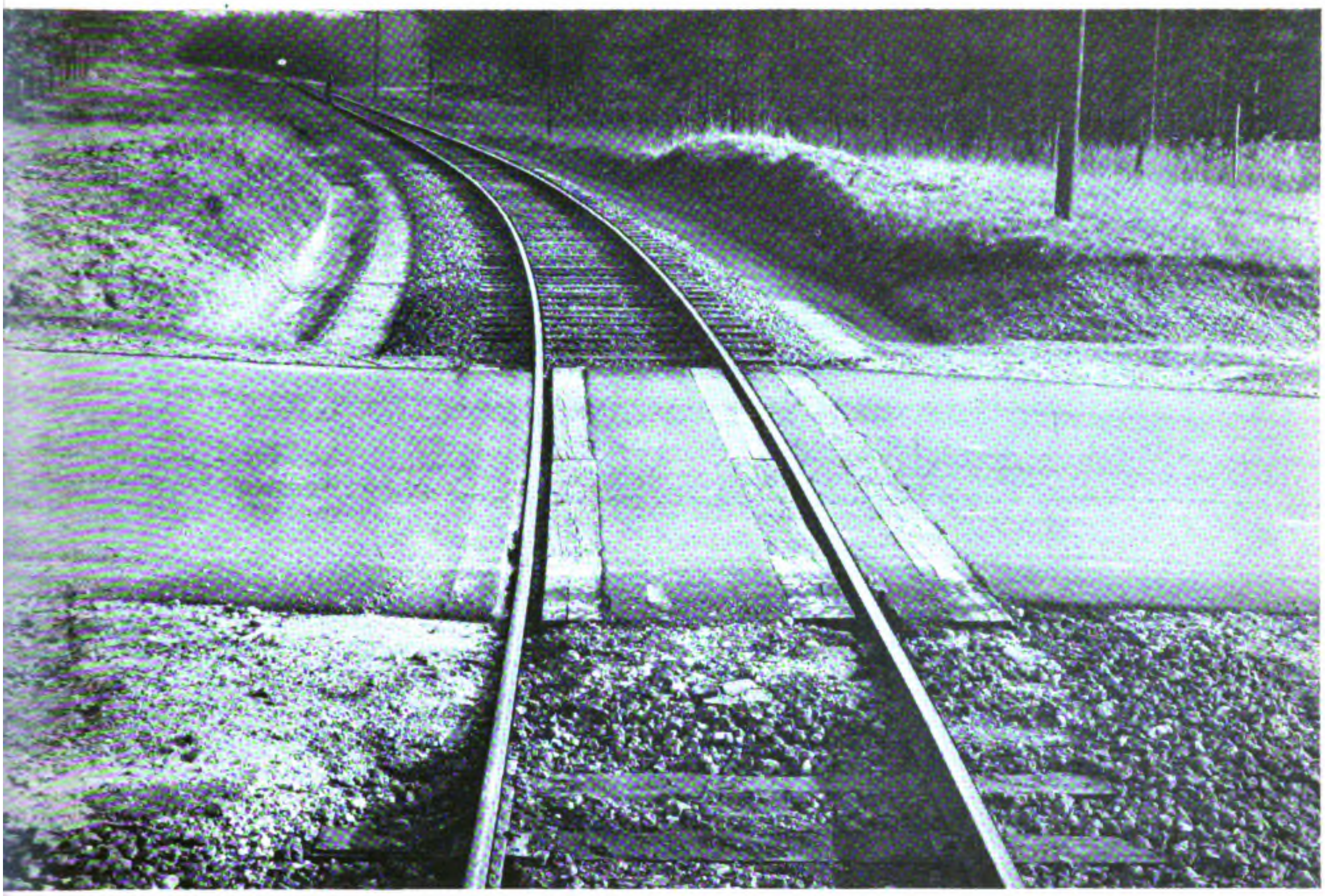


Figure 18. Highway crossing at 90°. Note unrestricted view for traffic.

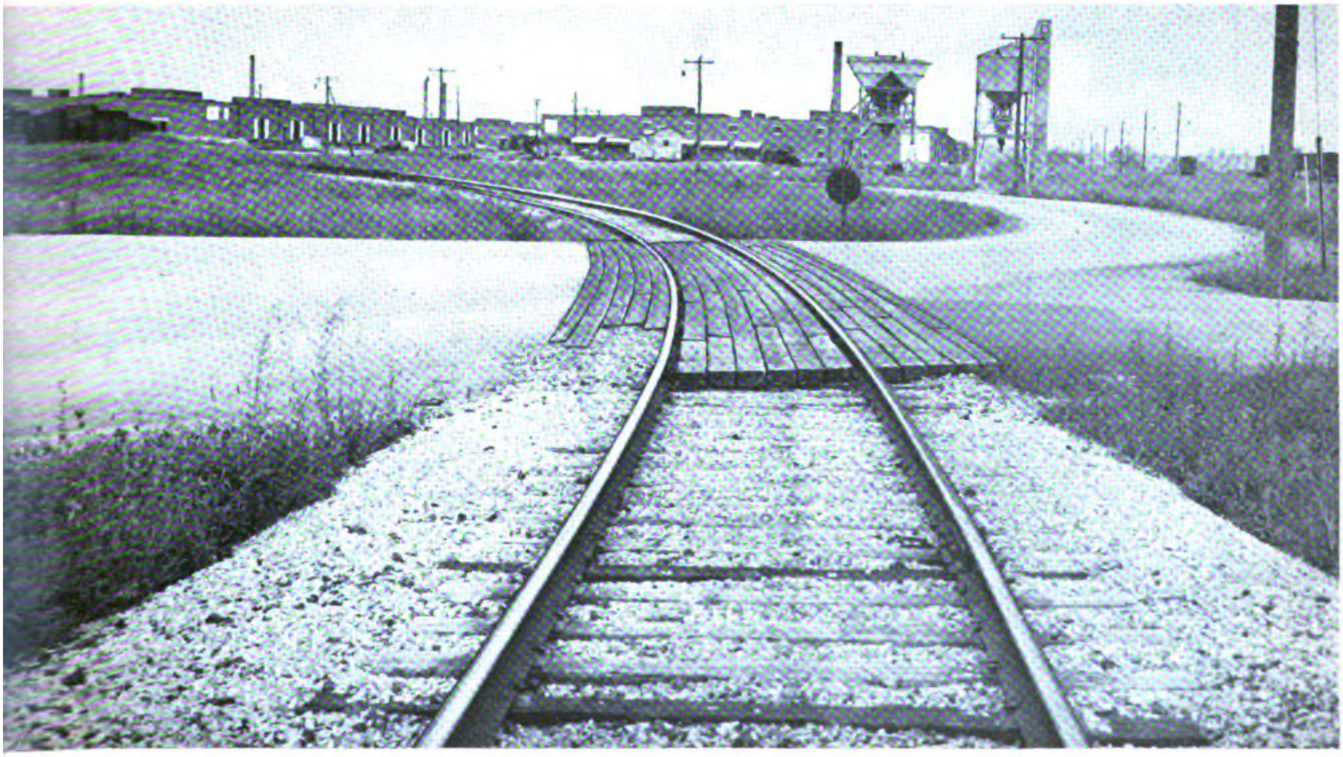


Figure 19. Crossing at skew angle with railroad curve.

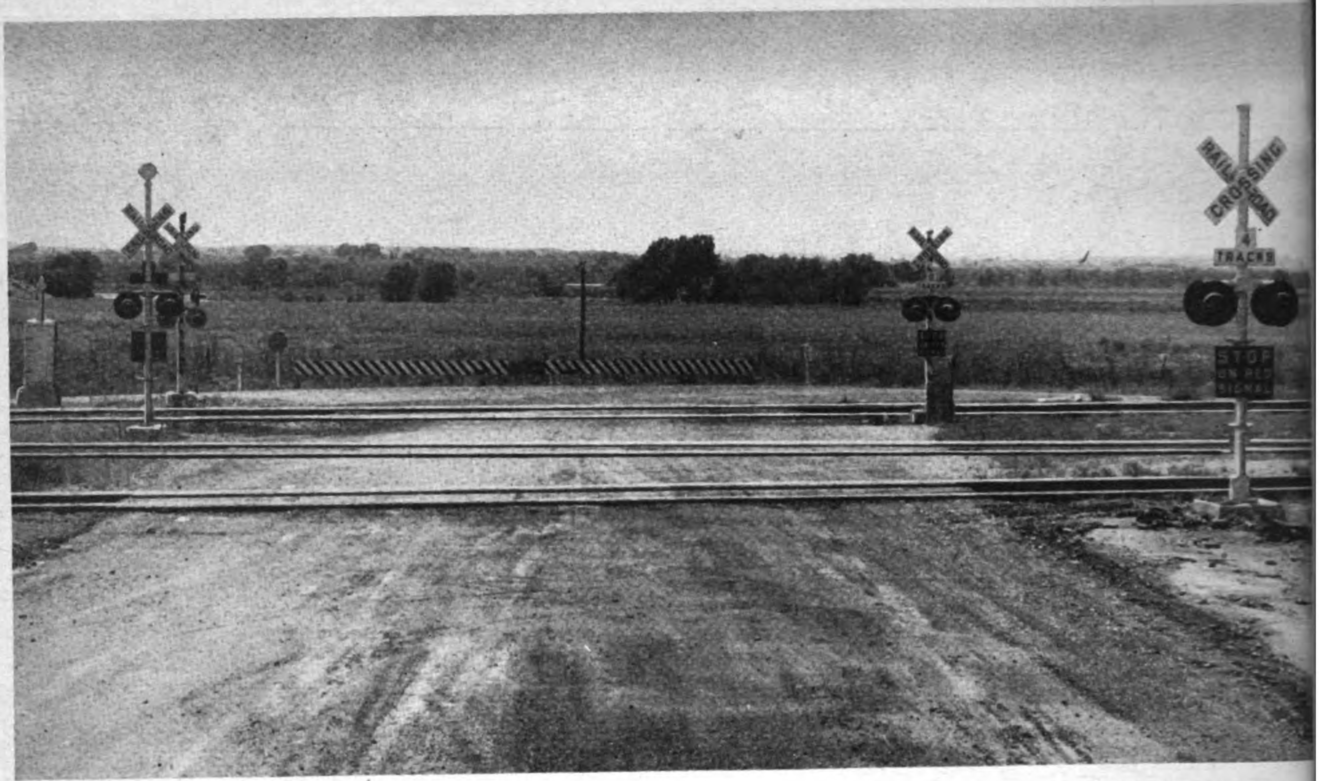
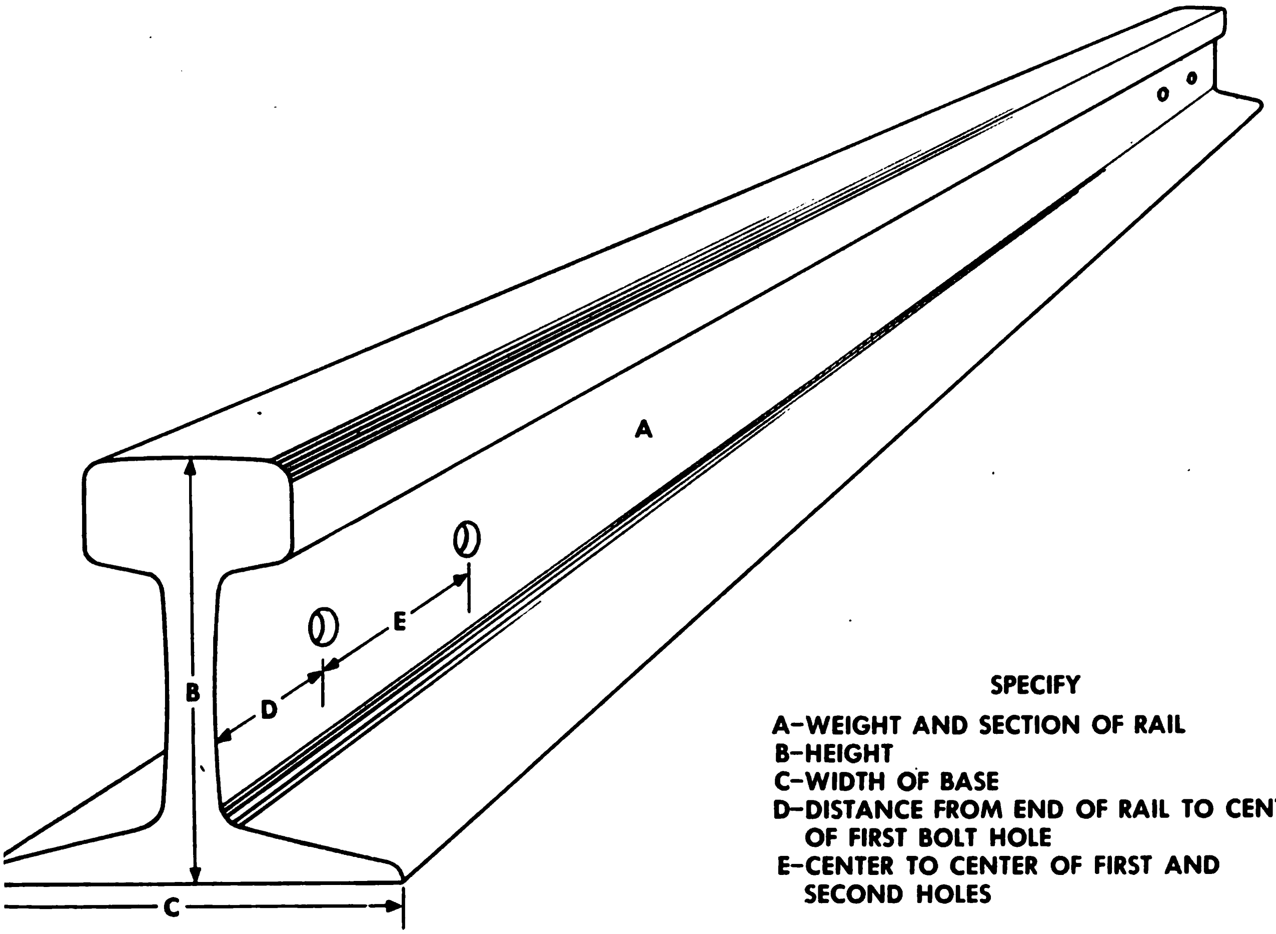


Figure 20. Highway crossing showing road markers and warning signals.

SECTION III
MATERIALS, TOOLS, AND EQUIPMENT

3. Requisitioning

Iaterials, tools, and equipment manufactured speifically for railroad use are needed for maintenance nd repair work. In requisitioning track materials, it is important that proper nomenclature be used and that detailed specifications be given. Figures 21 through 33 show the most common track materials and give instructions for requisitioning.



SPECIFY

A–WEIGHT AND SECTION OF RAIL
B–HEIGHT
C–WIDTH OF BASE
D–DISTANCE FROM END OF RAIL TO CENTER OF FIRST BOLT HOLE
E–CENTER TO CENTER OF FIRST AND SECOND HOLES

UNIT: TONS OR LINEAR FEET

Figure 21. Details for requisitioning rails.

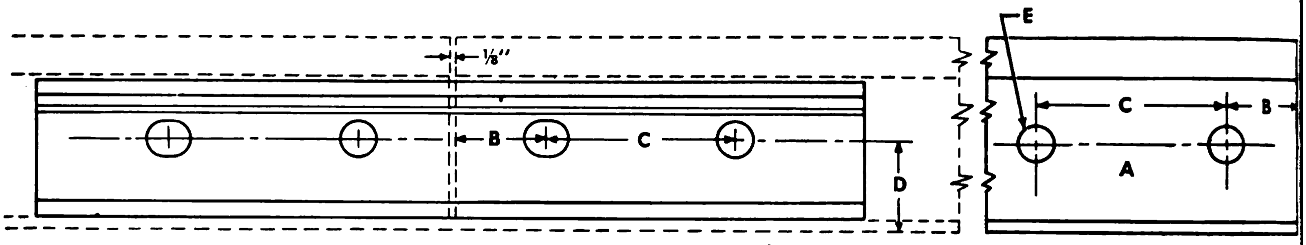
4. Storage

Iaterials on hand either in the warehouse, the secon-gang tool house, or at designated points along 1e track are stored as follows:

a. Rails and Track Accessories. Rails and ·ack accessories kept at points along the railroad for mergency use are stacked in neat piles above probble high water, at least 10 feet from the nearest ·ack. Accessories are protected from rain and snow. :ailroad areas frequented by trainmen or pedestrians are kept free of unneccessary obstructions. Rails are segregated according to weight and section and stacked as shown in figure 34.

b. Scrap Metal. Scrap metal is collected at least once each month and carefully stored at designated locations.

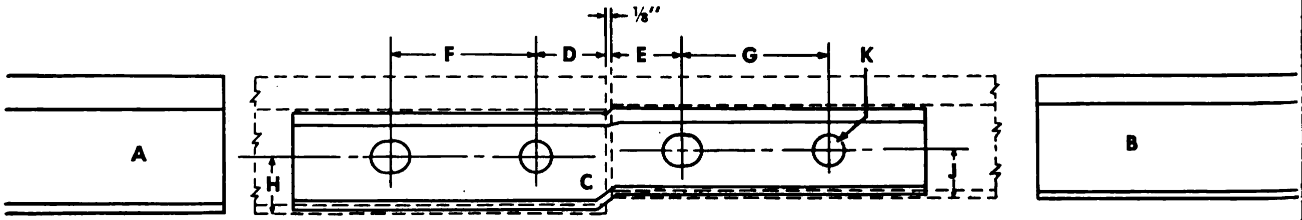
c. Timber and Cross Ties. Timber and cross ties are segregated according to size and type (treated or untreated), and stacked as shown in figures 35 and 36.



SPECIFY
A—WEIGHT AND SECTION OF RAIL
B—DISTANCE, END OF RAIL TO CENTER OF FIRST BOLT HOLE
C—DISTANCE, CENTER TO CENTER OF FIRST AND SECOND BOLT HOLES
D—DISTANCE, CENTER LINE OF BOLT HOLES TO BOTTOM OF RAIL
E—DIAMETER OF BOLT TO BE USED

UNIT: PAIR

Figure 22. Details for requisitioning joint bars.



C=LEFT HAND (LH) OR RIGHT HAND (RH) DEPENDING ON LOCATION OF LARGER RAIL VIEWED FROM CENTER OF TRACK (THIS IS A LEFT-HAND BAR)

SPECIFY

A—WT AND SECTION OF LARGER RAIL
B—WT AND SECTION OF SMALLER RAIL
C—LH OR RH
D—DISTANCE FROM END OF LARGER RAIL TO CENTER OF FIRST HOLE
E—DISTANCE FROM END OF SMALLER RAIL TO CENTER OF FIRST HOLE
F—DISTANCE CENTER TO CENTER OF 1st AND 2nd HOLE, LARGER RAIL
G—DISTANCE CENTER TO CENTER OF 1st AND 2nd HOLE, SMALLER RAIL
K—DIAMETER OF BOLT HOLES IN RAIL. IF DIFFERENT, SPECIFY SIZES

UNIT: EACH; INCLUDES INSIDE AND OUTSIDE BARS

Figure 23. Details for requisitioning compromise joints.

15. Emergency and Replacement Stock

Quantities of material recommended for emergency use and replacement stock are listed below:

a. At each mile post or 5,000-foot station along running tracks:

Two full-length rails of representative weight and section.

Two short-length rails of representative weight and section.

Two compromise joints, complete, of appropriate size.

Two pairs of joint bars with bolts and lock washers.

b. At classification and receiving yards:

One frog of representative number, weight, and section.

One set of switch points (rh and lh).

Two guardrails.

One full-length rail.

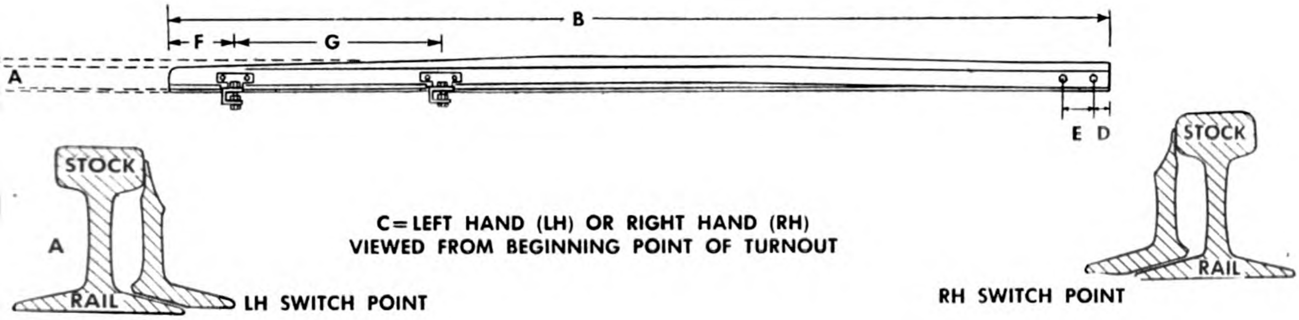
c. At designated central storage area:

For each mile of track, two full-length rails with track fastenings such as joint bars, bolts, spikes, tie plates, etc.

d. Minimum stand-by stock for emergency use at central storage area:

Two sets of switch ties.

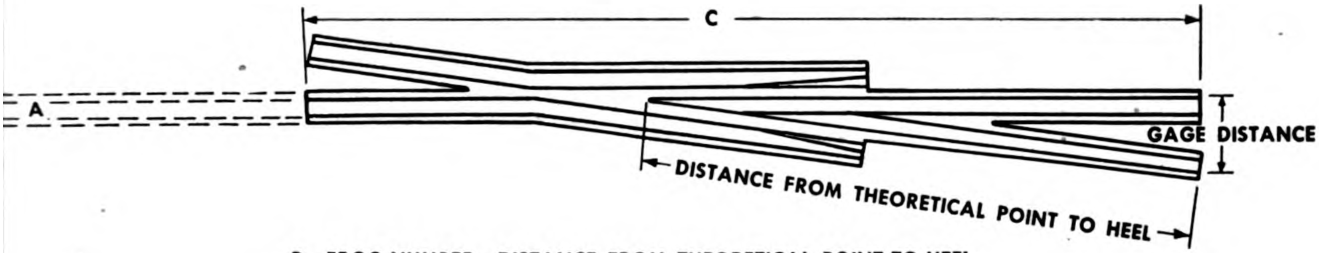
One car (30 to 50 tons) of ballast.



SPECIFY
A—WT AND SECT OF STOCK RAIL
B—LENGTH OF POINT
C—LH OR RH
D AND E—DRILLING (OPTIONAL)
F—DISTANCE OF SWITCH ROD CLIP FROM TIP OF POINT
G—CENTER TO CENTER DISTANCE OF 1st AND 2nd SWITCH ROD CLIPS

UNIT: EACH OR
SET INCLUDING
RH AND LH POINTS

Figure 24. Details for ordering switch points.

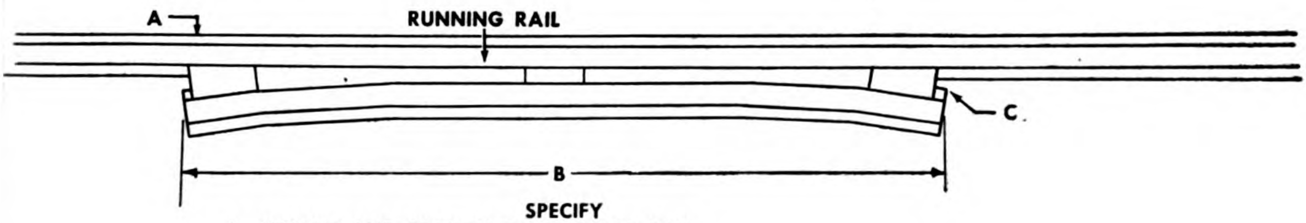


B = FROG NUMBER = $\frac{\text{DISTANCE FROM THEORETICAL POINT TO HEEL}}{\text{GAGE TO GAGE DISTANCE AT HEEL}}$

SPECIFY
A—WEIGHT AND SECTION OF LEAD RAILS
B—FROG NUMBER
C—LENGTH, MEASURED ALONG RUNNING RAIL

UNIT: EACH

Figure 25. Details for requisitioning frogs.



SPECIFY
A—WEIGHT AND SECTION OF RUNNING RAIL
B—LENGTH OF GUARDRAIL
C—NUMBER OF FILLER BLOCKS REQUIRED
D—TYPE OF FASTENING TO RUNNING RAIL (BOLTED OR C CLAMP)

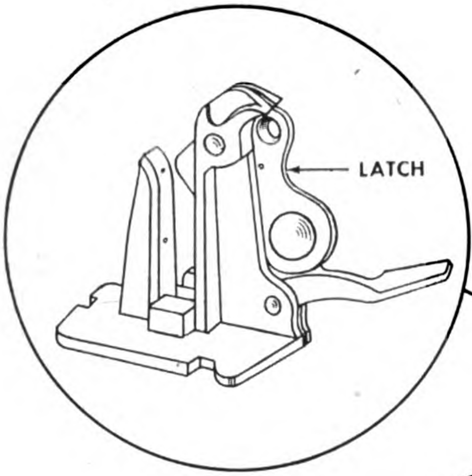
UNIT: EACH

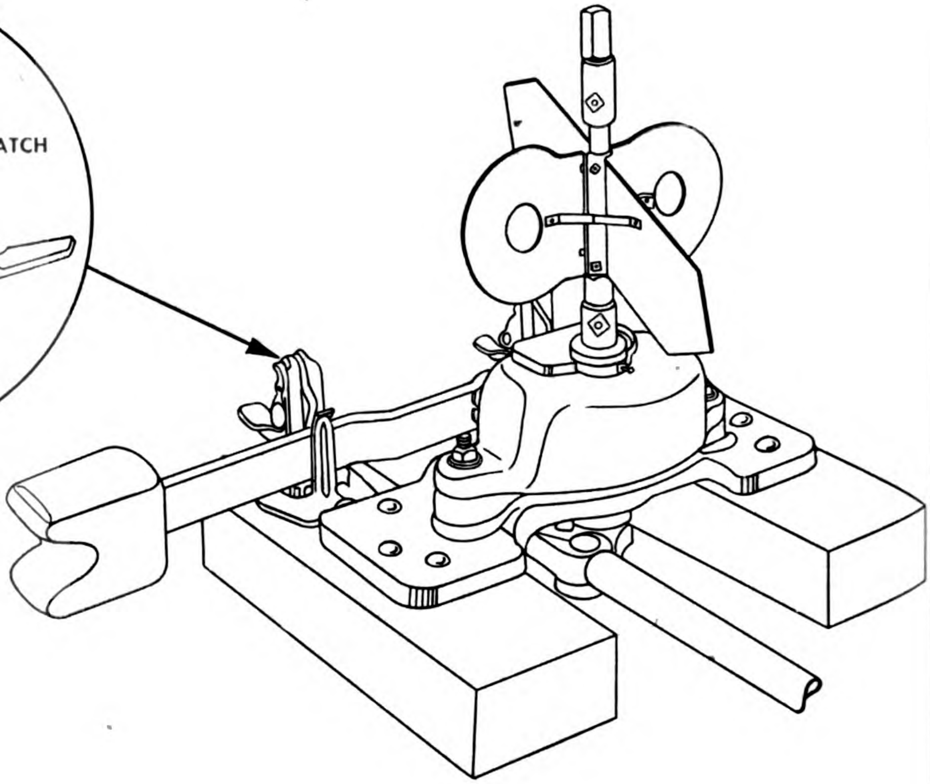
Figure 26. Details for requisitioning guardrails.

16. Tools and Equipment

a. General. Tools and equipment are provided n quantities consistent with the work to be per-ormed. Table III lists tools recommended for each ection gang of 6 to 10 men. Figures 37 through 41 llustrate common types of equipment.

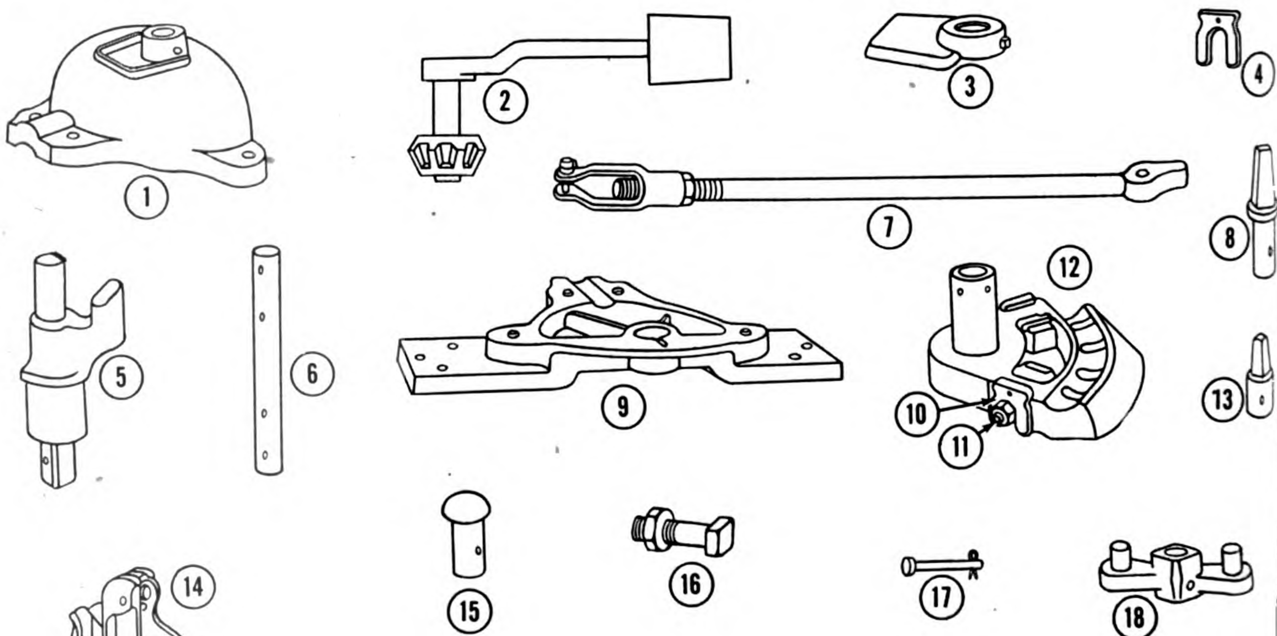
b. Storage, Care, and Maintenance. (1) Tools must be stored neatly in tool houses when not in use. Small tools are kept in tool boxes; long and pointed tools, such as lining bars, picks, and forks, are stored separately, with pointed ends downward. Heavy and bulky tools are placed on the floor of the





1. *Top.*
2. *Throwing lever.*
3. *Cover.*
4. *Shim.*
5. *Spindle lug.*
6. *Mast.*
7. *Adjustable rod.*
8. *Plug lamp tip.*
9. *Bottom.*
10. *Shim.*
11. *Bolt.*
12. *Segment gears.*
13. *Socket lamp tip.*
14. *Latch.*
15. *Dummy plug.*
16. *Bolt.*
17. *Cross pin.*
18. *Double crank.*

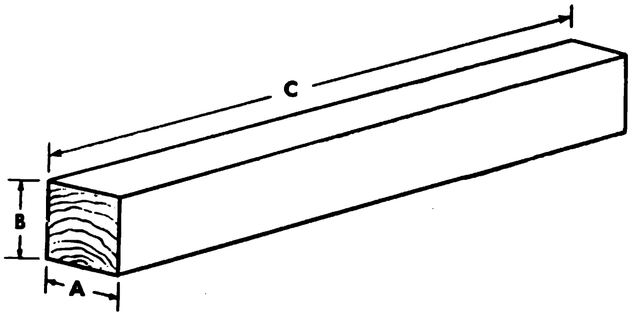
SWITCH STAND REPAIR PARTS



SPECIFY
REPAIR PARTS BY NAME OF MANUFACTURER
REPAIR PARTS BY NAME OR DESCRIPTION

(UNIT COMPLETE): EACH

Figure 27. Details for requisitioning switch-stand repair parts. Figure illustrates low stand with parallel throw.

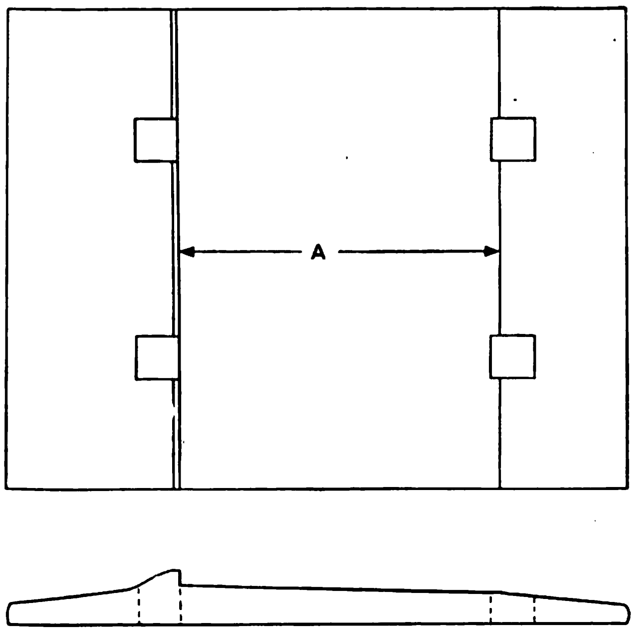


SPECIFY

A—WIDTH OF TIE
B—THICKNESS
C—LENGTH
D—WHETHER TREATED OR UNTREATED

UNITS
CROSS TIES: EACH
SWITCH TIES: SETS; SPECIFY NUMBER OF TURNOUT EACH; SPECIFY LENGTH
BRIDGE TIES: EACH

Figure 28. Details for requisitioning switch ties, cross ties, and bridge ties.



SPECIFY
A—WIDTH OF BASE OF RAIL, OR WEIGHT AND SECTION OF RAIL

UNIT: EACH

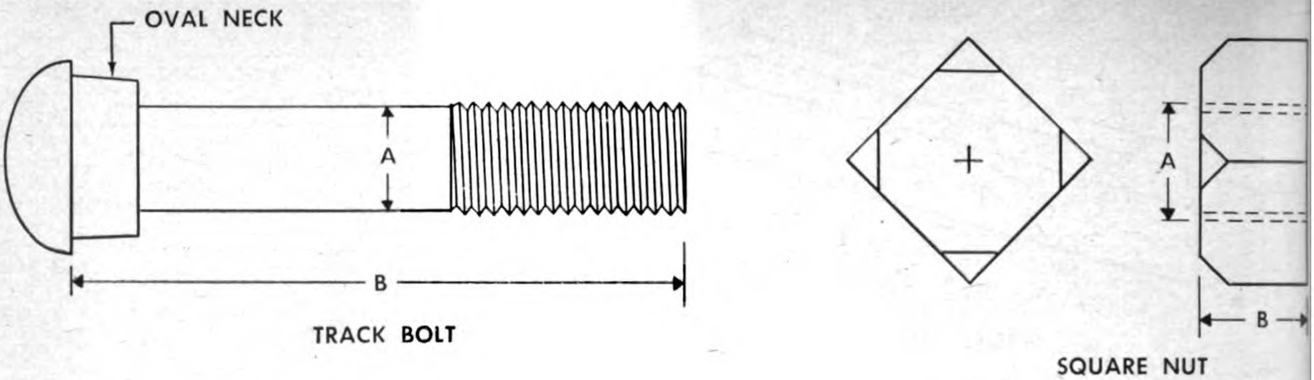
Figure 29. Details for requisitioning tie plates.

tool house in such a way as not to present a stumbling hazard. All tools must be kept free from rust.

(2) Cutting tools such as chipping hammers,

Table III. List of tools

Item	Description	No. required
Adze	Carpenter	1
Adze	Track	1
Ax	Full-head single-bit	1
Bars	Claw	2
Bars	Lining	4
Bars	Pinch	2
Bars	Tamping (Chisel-end)	4
Buckets	Galvanized, 10-quart	1
Bender	Rail	1
Cars	Push	1
Cars	Motor	1
Can	Oil	1
Chisels	Track	2
Digger	Post-hole	2
Drills	Rail (heavy-duty), portable	1
Forks	Rail	1
Forks	Ballast	4
Files	Flat, 10-inch	2
Frogs	Rerailing (left and right)	2
Gauge	Track	2
Goggles	Safety	3
Grinder	Tool (emery)	1
Grinder	Stone	1
Handles	Tool (assorted) (various)	12
Hatchet	Single-edge, full head	1
Hook	Brush	2
Hammer	Claw	1
Jacks	Track, 15-ton	4
Level	Track	2
Movers	Car	1
Mauls	Spike	4
Picks	Clay	4
Picks	Tamping	4
Pullers	Spike	2
Punch	Track (round)	1
Punch	Tie plug	1
Rake	Garden	1
Sledge	Double-face, 8-pound	1
Shovel	Scoop	2
Shovel	Track	6
Scythe	Long-handle	4
Spot Board	Track-raising	1
Saw	Rail (portable)	1
Saw	Crosscut	1
Saw	Hack	1
Stones	Whet, 10-inch	2
Tongs	Tie	3
Tongs	Rail	4
Tongs	Timber	2
Tape	Metallic (50-foot)	1
Wheelbarrow	Rubber-tired	1
Wrenches	Track (double-ended)	2
Wrenches	Track (single-ended)	4
Wrenches	Adjustable, 10-inch	2

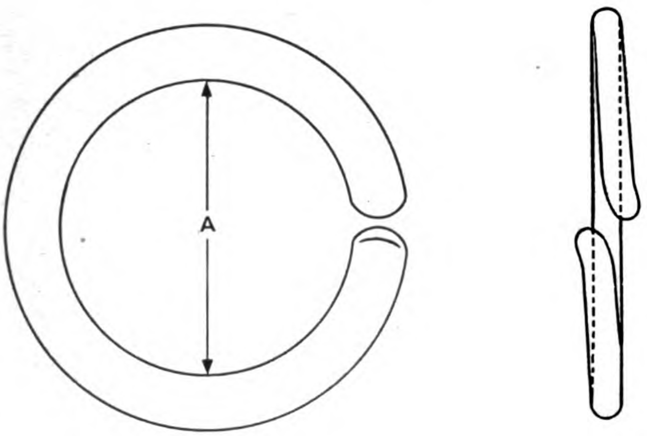


SPECIFY
A—DIAMETER OF BOLT
B—LENGTH OF BOLT
C—ROUND OR OVAL NECK

UNIT: KEG (APPROX 150 PER KEG)

NOTE: THE ITEM TRACK BOLT INCLUDES SQUARE NUT

Figure 30. Details for requisitioning track bolts.

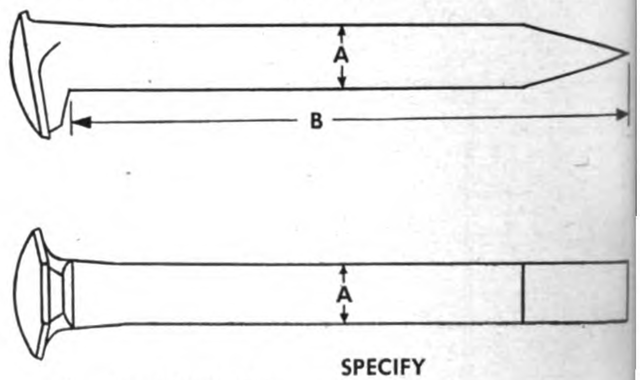


SPECIFY
A—DIAMETER

UNIT: EACH

NOTE: SPRING WASHERS ARE NOT INCLUDED WITH TRACK BOLTS

Figure 31. Details for requisitioning spring lock washers.



SPECIFY
A—THICKNESS
B—LENGTH

UNIT: KEG (APPROX 360 PER KEG)

Figure 32. Details for requisitioning track spikes.

drills, chisels, and saws are kept sharpened and ready for immediate use.

(3) All safety precautions must be rigidly adhered to in use, handling, and storage. Defective or worn out tools must be turned in for repair or replacement. Tools and equipment must be kept clear of passing trains. When loaded on trucks, track cars, or trailers they must be placed so that they will not fall off when the vehicle is bumped or moved. (See fig. 42.)

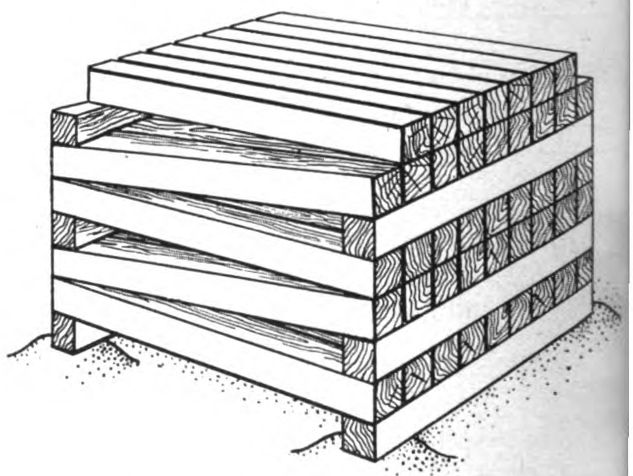


Figure 36. Method of stacking untreated ties.

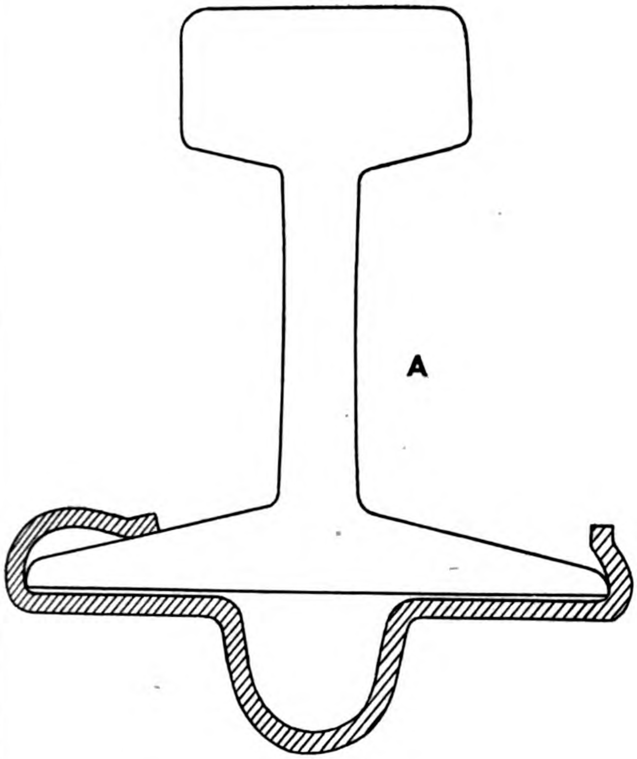


Figure 33. Details for requisitioning rail anchors.

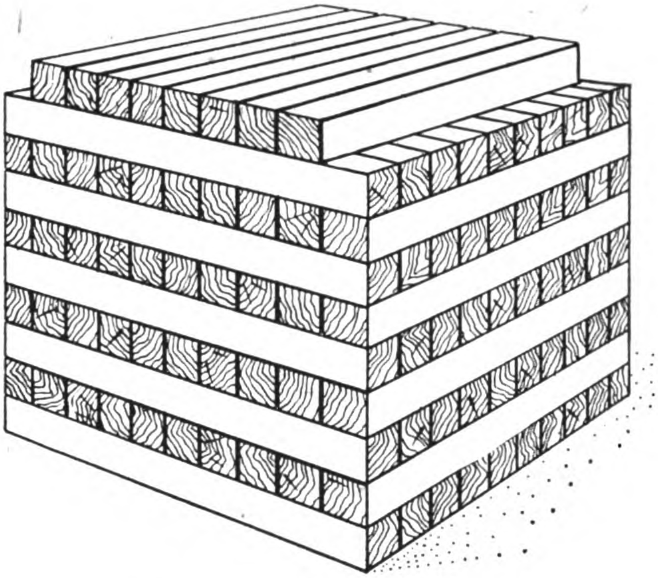


Figure 35. Method of stacking treated ties.

(4) In some cases equipment may include power-operated machinery, or work trains made up of cranes, shovels, snowplows, spreaders, and related equipment. Operation and preventive maintenance of power-operated equipment are covered in individual equipment manuals.

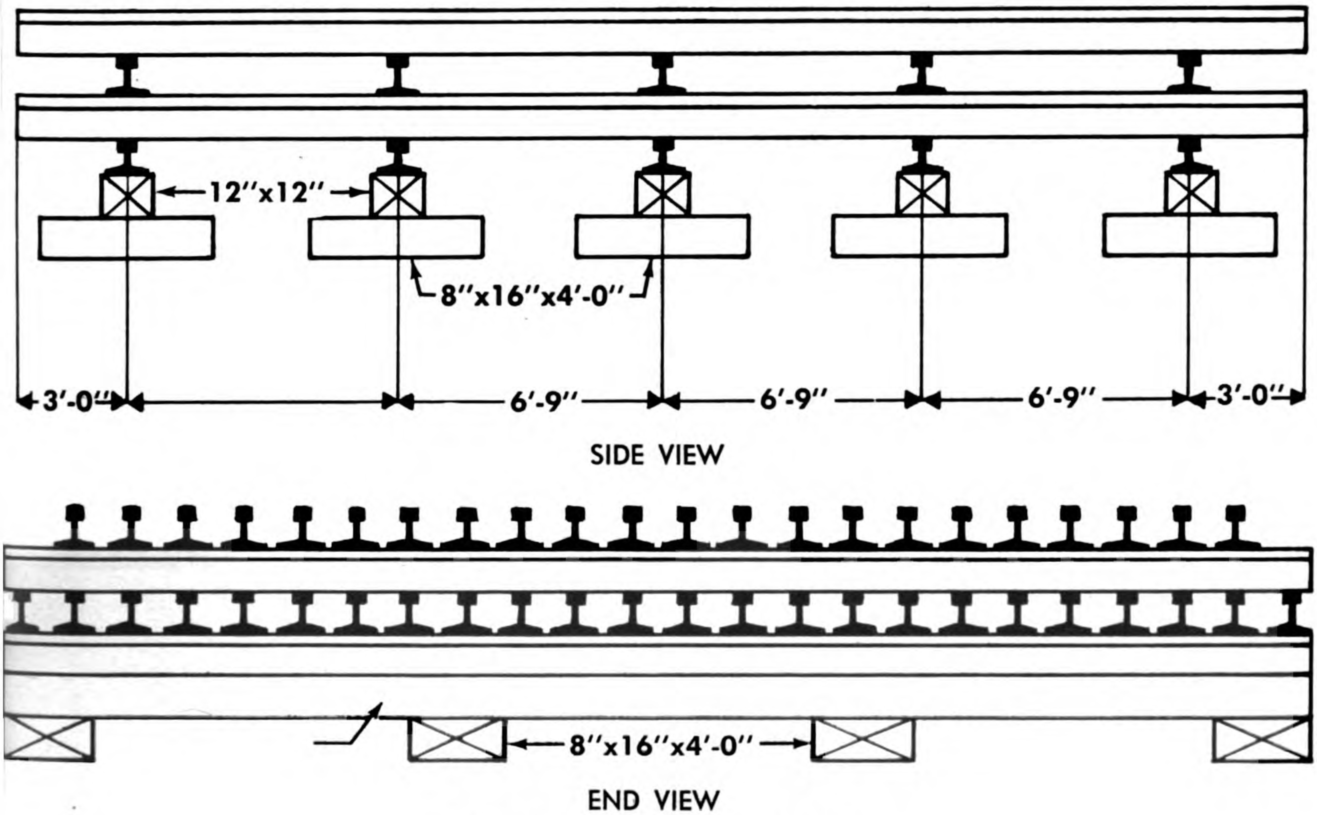
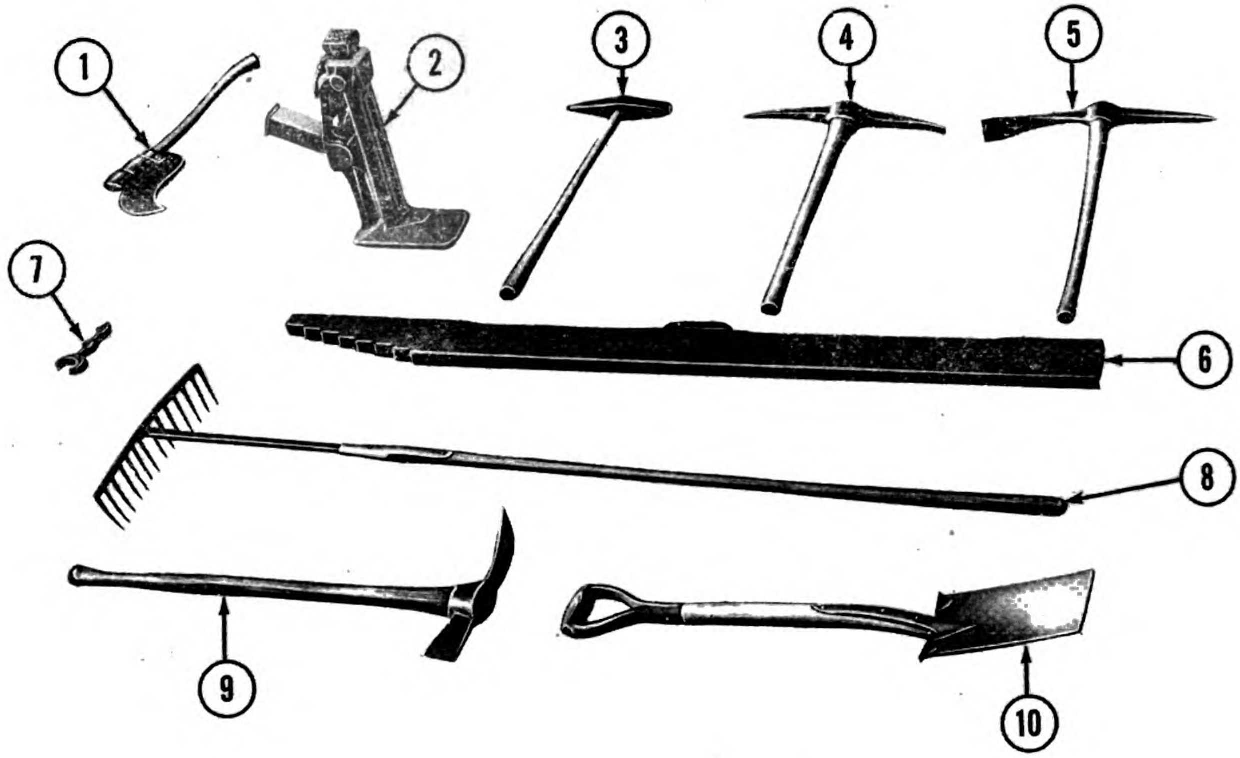
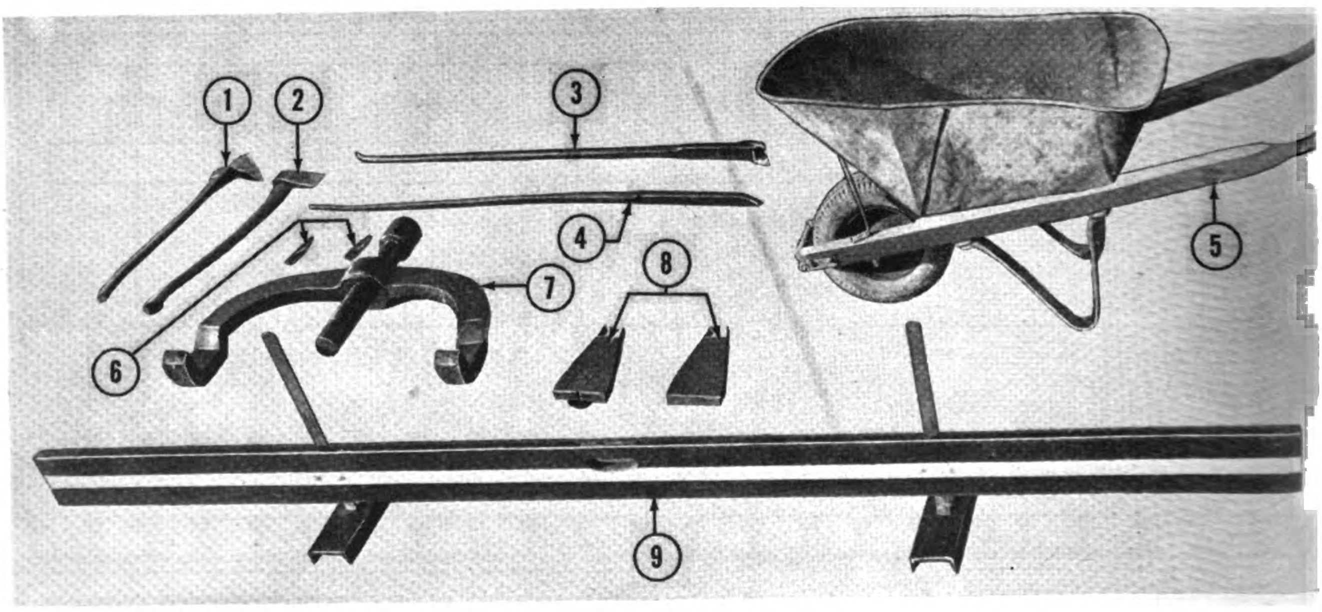


Figure 34. Method of stacking rails.



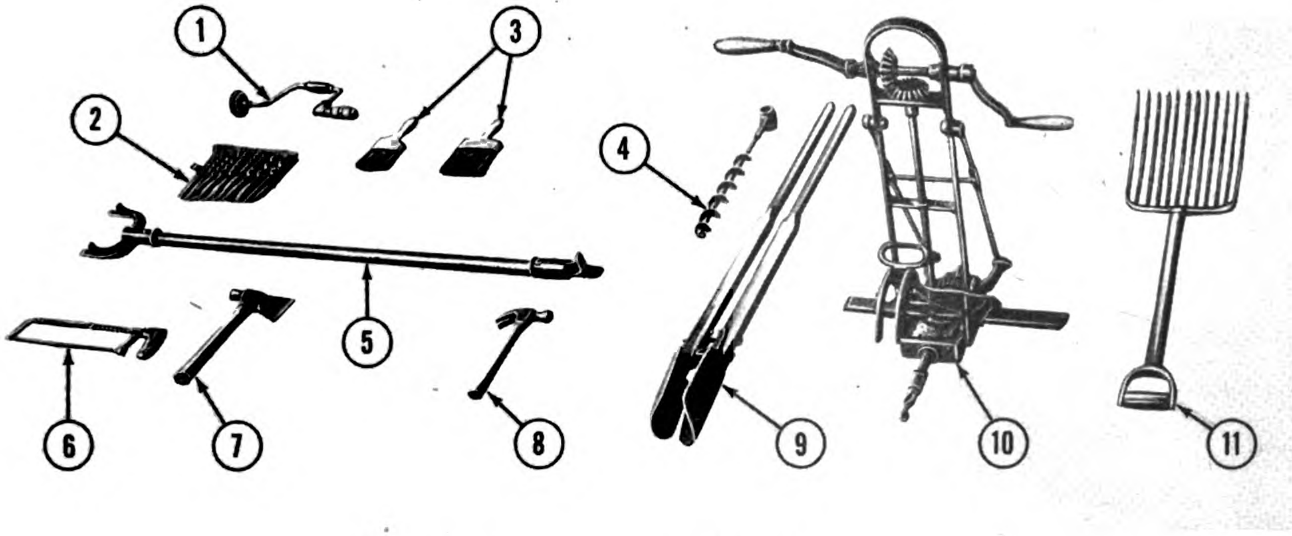
1. *Brush hook.*
2. *Track jack.*
3. *Spike maul.*
4. *Pick.*
5. *Tamping pick.*
6. *Level board.*
7. *Spike-claw extension.*
8. *Rake.*
9. *Mattock.*
10. *Spade.*

Figure 37. Track tools.



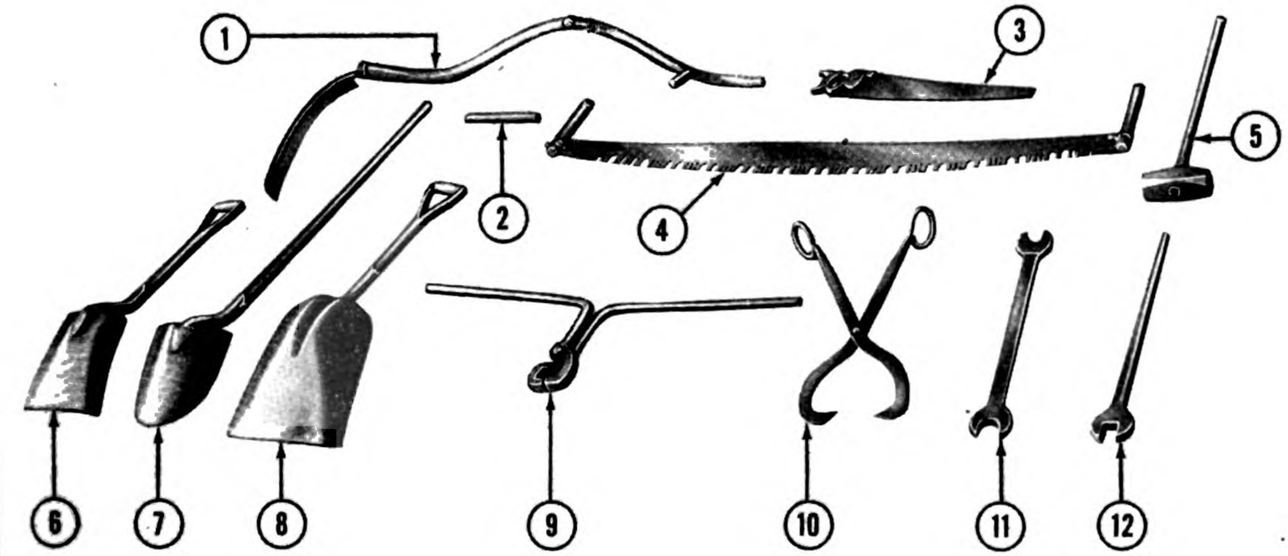
1. *Tie adze.*
2. *Ax.*
3. *Claw bar.*
4. *Lining bar.*
5. *Wheelbarrow.*
6. *Track drills.*
7. *Rail bender.*
8. *Sighting blocks.*
9. *Spot board.*

Figure 38. Track tools.



1. *Drill brace.*
2. *Wood drills.*
3. *Paint brushes.*
4. *Boring tool.*
5. *Track gauge.*
6. *Hacksaw.*
7. *Hatchet.*
8. *Claw hammer.*
9. *Post-hole digger.*
10. *Rail drilling machine.*
11. *Ballast fork.*

Figure 39. Track tools.



1. *Scythe.*
2. *Sharpening stone.*
3. *Handsaw.*
4. *Two-man ripsaw.*
5. *Eight-pound sledge hammer.*
6. *Square-pointed shovel.*
7. *Round-pointed, long-handled shovel.*
8. *Ballast scoop.*
9. *Rail tong.*
10. *Tie tong.*
11. *Double-end track wrench.*
12. *Single-end track wrench.*

Figure 40. Track tools.

Figure 41. Typical section-gang track car.

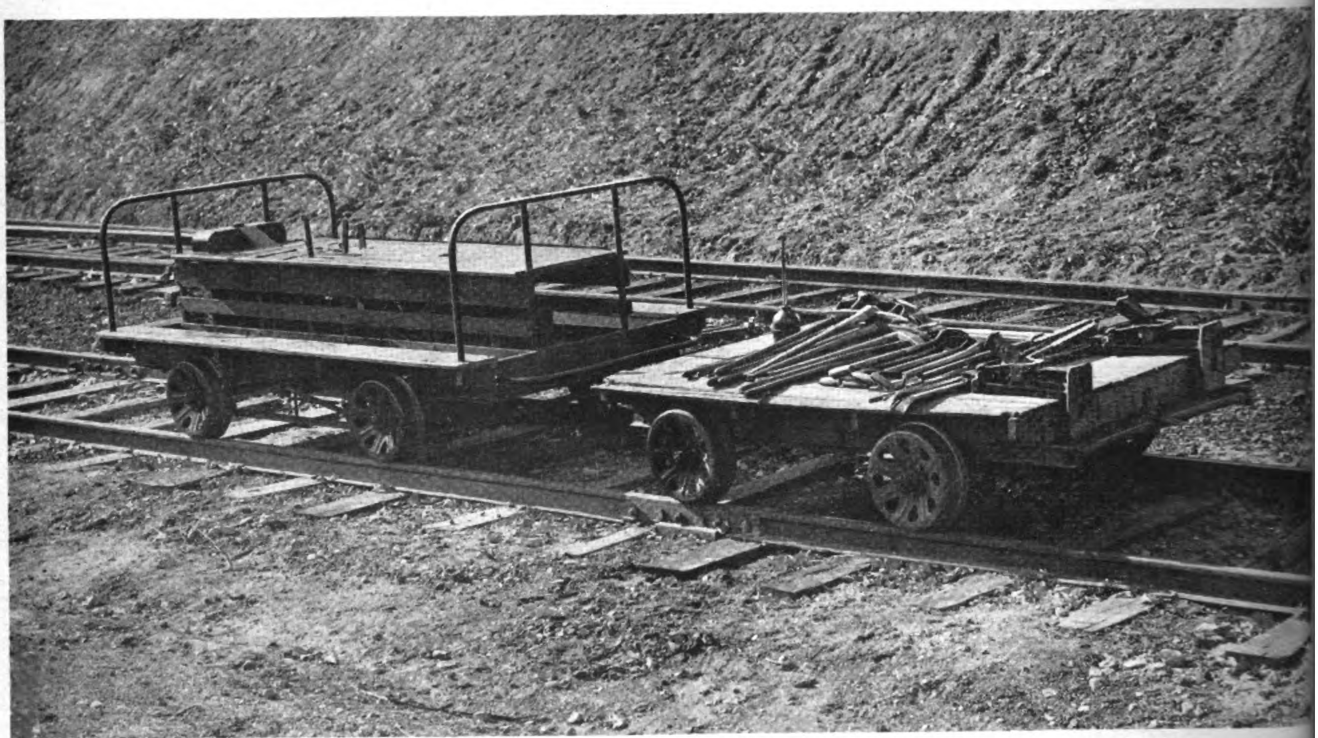


Figure 42. Typical track car and trailer illustrating method of carrying track tools.

SECTION IV
MAINTENANCE OF TRACK ELEMENTS

17. General

This section discusses construction and maintenance of elements making up the track structure.

18. Ballast

Ballast provides uniform support for the track, resistance against lateral movement of the track structure, and rapid drainage of water falling onto the roadbed.

a. Types and Sizes. Ballast is composed of the following materials, graded between maximum and minimum sizes listed. (See table IV.)

(*c*) Clean space between tracks to bottom of ballast, or if possible, to 6 inches below bottom of ties.

(*d*) Clean berm to bottom of ballast, preferably not less than 8 inches below bottom of ties.

(*e*) Clean across ditches or drains.

(*f*) Dress subgrade.

(*g*) Clean the ballast removed, using forks or screens.

(*h*) Replace cleaned ballast in track and add enough new ballast to make a standard section.

(*i*) Collect refuse material and place it along slopes of fills.

Table IV. Ballast materials

Type		Maximum size	Minimum size	Percent fines allowable (by weight)
Crushed rock				
Traprock		2½ inches	¾ inch	10
Limestone		2½ inches	¾ inch	10
Granite		2½ inches	¾ inch	10
Slag	Broken and screened	2½ inches	1 inch	15
Gravel	Screened and washed	1½ inches	½ inch	10
	Screened	1½ inches	½ inch	20
	Pit-run	Large rocks removed		
Cinders		Large lumps removed		

b. Application. (1) *Crushed rock or slag.* Ballast of crushed rock or broken slag is used on main or running tracks serving heavy traffic, or where authorized train speeds are 25 mph or more.

(2) *Gravel.* Screened or pit-run gravel ballast is used in such secondary installations as classification yards, passing tracks, and warehouse sidings, where train speeds are less than 25 mph.

(3) *Cinders.* Cinders are used on other yard tracks, house and stub tracks, and dead-storage tracks. Cinders also are used on more important tracks in places where adverse subsoil conditions may result in settlement or where frost may cause heaving.

c. Reconditioning Ballasted Track. Reconditioning is necessary when stone or slag ballast becomes clogged with dirt or other foreign material to such an extent that drainage is impaired. Cinder ballast is removed and replaced. Other ballast is reconditioned as follows:

(1) *Stone, slag, or screened-gravel ballast.* (*a*) Clean shoulder down to subgrade.

(*b*) Clean crib to bottom of ties.

(2) *Pit-run or cinder ballast.* (*a*) Skeletonize the track by stripping or by raising the track on the old ballast. (See fig. 43.)

(*b*) Remove the ballast from outside the track to the original depth of the ties.

(*c*) Dress subgrade and widen cuts or fills wherever necessary.

(*d*) Clean existing cross drains, or construct new ones; be sure they are deep enough to provide adequate drainage. Never locate cross drains at rail joints.

(*e*) Distribute enough clean ballast to provide for the lift and width desired.

(*f*) Resurface track to uniform grade.

(*g*) Collect refuse material and place it along slopes of fills.

d. Distribution of New Ballast. Except where the distribution of new ballast is for an intended raise out-of-face, the track is surfaced before distribution of new ballast. Delivering ballast to the job in hopper cars helps in handling and distribution.

Figure 43. Track skeletonized to receive ballast.

(1) Ballast is distributed from hopper cars by opening one of the hopper doors and allowing ballast to flow onto the track. A cross tie is placed across both rails immediately in front of the rear truck of the car. As the car is moved forward, the cross tie screeds the ballast level with top of rails. (See fig. 44.)

(2) If less than a full bed of ballast is required, distribution is regulated by controlling the opening of the hopper door by means of a chain looped around the latches, and varying the speed of the car.

(3) Distribution of ballast also is regulated by cutting notches in the tie to receive the track rails. (See (1) above.) The screeded ballast is the same distance below the top of the rails as the depth of the notches in the tie. Notches more than 3 inches deep are not recommended.

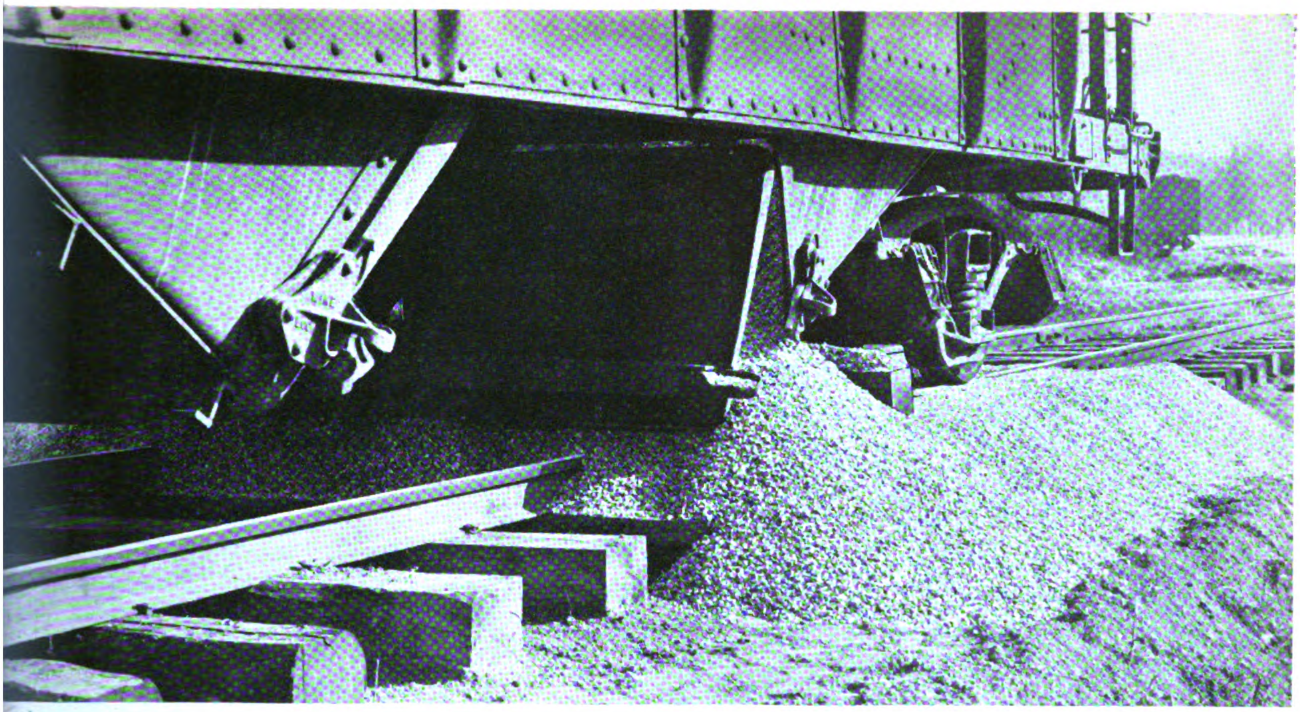
(4) Ballast is tamped in place promptly after distribution. Until it is properly placed in track, ample flangeways must be provided along the gauge side of each rail. At turnouts, all excess ballast is removed from frogs, guardrails, and movable parts of switches. (See fig. 45.)

e. PLACING BALLAST. Only the ballast necessary to dress the section to standard dimensions is distributed. Where track is raised after ballast has been distributed, rails are brought to the desired elevation and to uniform surface, and ballast is tamped under the ties. (For tamping procedure, see par. 32.) The ballast section is then dressed to standard dimensions, the toe of the ballast slope trimmed to good line, and all excess ballast removed.

19. Ties

Cross ties are made from various kinds of serviceable hard or soft woods. The wood should be free from defects that may reduce strength or durability, such as decay, large splits, shakes, numerous knots, or grain with slant greater than one in fifteen. The service life of ties depends on the kind of wood, the method of treatment used, the mechanical protection afforded, the severity of usage, and climatic conditions.

a. UNTREATED TIES. Ties for use without preservative treatment should have sapwood no wider than one-fourth the width of the top, between 20 and



igure 44. Distributing ballast from hopper car. Track being reballasted has been skeletonized. Quantity distributed is for a 6-inch track raise and full ballast bed.

Figure 45. Raising track and placing ballast after distribution.

40 inches of the middle of the tie. These are designated as *heart* ties; those with more sapwood are designated as *sap* ties.

Ties made from the following kinds of wood are generally used without preservative treatment.

- Catalpa
- Cedar
- Chestnut
- Cypress
- Douglas fir
- Larch
- Locust, black
- Mulberry
- Oak, white
- Pine
- Redwood
- Sassafras
- Walnut, black

b. Treated Ties. Treated ties are used on permanent projects and in other locations where the experience of the serving railroad indicates their advisability.

Creosote and zinc chloride are the most widely used preservatives. Adequate distribution of the preservative and thorough penetration of the wood are essential. All adzing and boring should be done prior to treatment; preboring tends to improve penetration in the part of the tie most vulnerable to decay, and prevent destruction of wood fibres during spiking.

Ties made from the following kinds of wood are suitable for treatment:

- Ash
- Beech
- Birch
- Catalpa (sap)
- Cedar (sap)
- Chestnut (sap)
- Cypress (sap)
- Douglas fir (sap)
- Elm
- Fir
- Gum
- Hackberry
- Hemlock
- Hickory
- Larch (sap)
- Locust, black (sap)
- Locust, honey
- Maple, hard or soft
- Mulberry (sap)
- Oak, red
- Oak, white (sap)
- Pine (sap)
- Poplar
- Redwood (sap)
- Sassafras (sap)
- Spruce
- Sycamore
- Walnut, white

c. Size and Spacing. Ties are usually 6 b inches, or 7 by 9 inches, by 8 feet. The standard n ber of ties for various rail lengths and types of tr is as follows:

	26-foot rail	*30-foot rail*	*33-*
For main or running tracks	14	16	[illegible]
For storage tracks and sidings	12	14	[illegible]
For last 60 feet of stub tracks	10	12	[illegible]

Additional ties are used where necessary to gauge on sharp curves. Number of ties is incre or decreased proportionately for lengths of rail o than those listed.

(1) *Switch ties.* Switch ties are sized and sp as directed on standard plans for turn-outs (O drawings 617-106 and T/O .40.2. (See fig. 12.)

(2) *Bridge ties.* Bridge ties are sized and spac to conform with the design of the bridge structur

d. Inspection. Inspect ties in track each sprin Mark defective ties with a marking tool or spot-pa them. Inspections are made by an experienced a responsible workman. If tracks have received norm maintenance, the average number of ties renew each year should not exceed two for each rail lengt the maximum should be three for each rail leng Except in cases of emergency, track forces do n remove any tie unless it has been marked for renew by the inspector. Unmarked ties considered unsu able for continued use are brought to the attenti of the inspector.

e. Renewal. Weather permitting, begin ren ing ties early in spring and complete the work rapidly as possible.

(1) Use proper tools in handling ties; for e ample, use tie tongs instead of picks. Wear glo when handling creosoted ties. (See fig. 46.)

(2) Use largest and best ties at rail joints, w faces spaced not less than 12 inches from faces adjacent ties. Space intermediate ties uniformly b tween joints.

(3) Set ties at right angles to the track, obliquely to suit irregular rail joints.

(4) Spike all new ties to the rail at the pro gauge, and tamp them in accordance with instructi in paragraph 32.

Figure. 46. Correct method of installing cross ties.

(5) Raise tracks as little as possible for removal ties; otherwise the ballast is disturbed and runs der adjacent ties, spoiling the surface. Dig troughs ballast at the end of the tie to facilitate removal.

(6) Adze any irregular ties to provide adequate aring for tie plates or rail. However, excessive zing reduces the life of the tie. If a tie is being cut the rail base, tamp adjacent ties so they take their are of the load. (See fig. 47.)

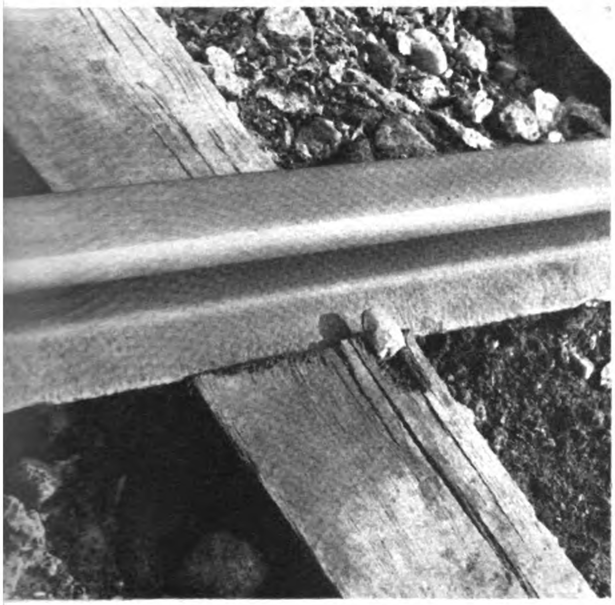


Figure 47. Typical rail-cut tie.

(7) Draw all spikes from ties removed from track.

(8) Ties which are removed can be used in house or stub sidings or as cribbing or shoring. After salvable ties have been selected and stored, store remaining ties for firewood, or burn them immediately.

f. INSTALLATION. Place ties with wide heartwood face down, at right angles to rails.

(1) Bring ends of standard-length ties to a uniform line with the rail as follows:

(*a*) *Single track:* Line the east side of track running north and south, and north side of track running east and west. (See fig. 48.)

(*b*) *Double track:* Line the outside ends of ties. (See fig. 49.)

(*c*) *Three or more tracks:* Line the outside ends of outside tracks and line the ties of inside tracks with the line rail. (See fig. 50.)

(2) When it is necessary to use ties of less than standard lengths, center ties in the track, regardless of line.

20. Rail

a. RAIL SECTIONS. Rails of varying weights and sections are in use in Government-owned trackage.

(1) *T-rail.* Table V and figure 51 list various weights and sections of T-rails.

(2) *Girder rail.* Rail laid in paved streets is a special type called girder rail. This rail is rolled with

Table V. *Details of T-rail sections*

H—Height.
B—Base.
Hd—Head.
W—Web.
D—Depth of head.
F—Fishing height.

E—Depth of base.
A—Head angle.
A²—Base angle.
S—Slope of head.
N—Center line of bolts.
Dimensions in inches.

Type	Weight per yard	Ill. Steel Co. Old No.	Ill. Steel Co. Carnegie Steel Co. T C & I Co.	Midvale Steel Co.	Bethlehem Steel Co.	Lackawana Steel Co.	Colorado F & I Co.	Height	Base	Head	Web	Depth of head	Fishing height	Depth of base	Head angle	Base angle	Slope of head	CL of bolts
ARA-A	100	10020	10020	565	163	10031		6	5 1/2	2 3/4	9/16	1 9/16	3 3/8	1 1/16	4 to 1	4 to 1	1/16 to 1	2 3/4
ARA-A	90	9020	9020	563	170	9031	902	5 5/8	5 1/8	2 9/16	9/16	1 15/32	3 5/32	1	4 to 1	4 to 1	1/16 to 1	2 37/64
ARA-A	80	8020	8020	....	169	8031	801	5 1/8	4 5/8	2 1/2	33/64	1 7/16	2 23/32	31/32	4 to 1	4 to 1	1/16 to 1	2 21/64
ARA-A	70	7020	7020	....	....	....	....	4 3/4	4 1/4	2 3/8	1/2	1 11/32	2 1/2	29/32	4 to 1	4 to 1	1/16 to 1	2 5/32
ARA-A	60	6020	6020	....	....	....	....	4 1/2	4	2 1/4	15/32	1 15/64	2 29/64	13/16	4 to 1	4 to 1	1/16 to 1	2 5/128
ARA-B	100	10030	10030	564	161	10032	1002	5 41/64	5 9/64	2 21/32	9/16	1 45/64	2 55/64	1 5/64	13°	13°	3°	2 65/128
ARA-B	90	9030	9030	561	162	9032	905	5 17/64	4 49/64	2 9/16	9/16	1 39/64	2 5/8	1 1/32	13°	13°	3°	2 11/32
ARA-B	80	8030	8030	569	171	8032	....	4 15/16	4 7/16	2 7/16	35/64	1 15/32	2 15/32	1	13°	13°	3°	2 15/64
ARA-B	70	7030	7030	....	174	....	....	4 35/64	4 3/64	2 3/8	33/64	1 23/64	2 17/64	59/64	13°	13°	3°	2 7/128
ARA-B	60	6030	6030	....	....	....	....	4 3/16	3 11/16	2 1/8	31/64	1 1/4	2 1/16	7/8	13°	13°	3°	1 29/32
ASCE	100	10001	10040	536*	247	1000	....	5 3/4	5 3/4	2 3/4	9/16	1 45/64	3 5/64	31/32	13°	13°	Str.	2 65/128
ASCE	90	9002	9040	535	245	900	....	5 3/8	5 3/8	2 5/8	9/16	1 19/32	2 55/64	59/64	13°	13°	Str.	2 45/128
ASCE	85	8504	8540	531	235	850	851	5 3/16	5 3/16	2 9/16	9/16	1 35/64	2 3/4	57/64	13°	13°	Str.	2 17/64
ASCE	80	8004	8040	530	251	800	800	5	5	2 1/2	35/64	1 1/2	2 5/8	7/8	13°	13°	Str.	2 3/16
ASCE	75	7506	7540	529	214	750	753	4 13/16	4 13/16	2 15/32	17/32	1 27/64	2 35/64	27/32	13°	13°	Str.	2 15/128
ASCE	70	7010	7040	532	237	700	701	4 5/8	4 5/8	2 7/16	33/64	1 11/32	2 15/32	13/16	13°	13°	Str.	2 3/64
ASCE	65	6507	6540	534*	236	650	653	4 7/16	4 7/16	2 13/32	1/2	1 9/32	2 3/8	25/32	13°	13°	Str.	1 31/32
ASCE	60	6015	6040	533	244	600	603	4 1/4	4 1/4	2 3/8	31/64	1 7/32	2 17/64	49/64	13°	13°	Str.	1 115/128
ASCE	55	5501	5540	537*	130	550	....	4 1/16	4 1/16	2 1/4	15/32	1 11/64	2 11/64	23/32	13°	13°	Str.	1 103/128
ASCE	50	5005	5040	542	129	500	500	3 7/8	3 7/8	2 1/8	7/16	1 1/8	2 1/16	11/16	13°	13°	Str.	1 23/32
ASCE	48	4803	4840	....	....	....	482	3 11/16	3 49/64	2 5/64	1/2	1 1/16	1 31/32	21/32	13°	13°	Str.	1 41/64
ASCE	45	4504	4540	549	266	450	451	3 11/16	3 11/16	2	27/64	1 1/16	1 31/32	21/32	13°	13°	Str.	1 41/64
ASCE	40	4004	4040	545	138	400	401	3 1/2	3 1/2	1 7/8	25/64	1 1/64	1 55/64	5/8	13°	13°	Str.	1 71/128
ASCE	35	3502	3540	575	265	350	351	3 5/16	3 5/16	1 3/4	23/64	61/64	1 25/32	37/64	13°	13°	Str.	1 15/32
ASCE	30	3002	3040	576	269	300	301	3 1/8	3 1/8	1 11/16	21/64	7/8	1 23/32	17/32	13°	13°	Str.	1 25/64
ASCE	25	2502	2540	577	264	250	....	2 3/4	2 3/4	1 1/2	19/64	25/32	1 31/64	31/64	13°	13°	Str.	1 29/128
ASCE	20	2001	2040	578	20-A	200	....	2 5/8	2 5/8	1 11/32	1/4	23/32	1 15/32	7/16	13°	13°	Str.	1 11/64
ASCE	16	1601	1640	579	16-A	160	....	2 3/8	2 3/8	1 11/64	7/32	41/64	1 23/64	3/8	13°	13°	Str.	1 7/128
ASCE	12	1201	1240	580	66	120	....	2	2	1	3/16	9/16	1 3/32	11/32	13°	13°	Str.	57/64
ASCE	8	801	840	....	....	....	....	1 9/16	1 9/16	13/16	5/32	15/32	13/16	9/32	13°	13°	Str.	11/16
AREA	100	....	10025	....	....	....	10025	6	5 3/8	2 11/16	9/16	1 21/32	3 9/32	1 1/16	14° 02′	14° 02′	3° 02′	2 45/64
AT & SF	90	9021	9021		173	9033*	903	5 5/8	5 3/16	2 9/16	9/16	1 15/32	3 5/32	1	4 to 1	4 to 1	1/16 to 1	2 37/64
[illegible]	70		....			703		4 3/4	4 3/4	2 7/16	[illegible]	1 13/32	2 19/32	3/4	12°	12°	Str.	2 3/64

Type	Weight per yard	Ill. Steel Co. Old No.	Ill. Steel Co. Carnegie Steel Co. T C & I Co.	Midvale Steel Co.	Bethlehem Steel Co.	Lackawana Steel Co.	Colorado F & I Co.	Height	Base	Head	Web	Depth of head	Fishing height	Depth of base	Head angle	Base angle	Slope of head	CL of bolts
Can Pac	85	....	8524	....	176	856	....	5 1/8	5	2 1/2	9/16	1 7/16	2 11/16	1	4 to 1	4 to 1	1/32 to 1	2 11/32
Can Pac	65	6508	6508	....	....	654	....	4 31/64	4 3/8	2 1/4	15/32	1 9/32	2 11/32	55/64	4 to 1	4 to 1	1/32 to 3/4	2 1/32
C of NJ	135	....	....	....	290	....	....	6 1/2	6	3 5/32	3/4	2	3 9/32	1 7/32	14°	14°	4°	2 55/64
C & A	70	7002	....	....	....	....	....	4 3/8	4	2 35/96	35/64	1 17/24	1 11/12	3/4	12°	12°	1/24 to 5/16	1 17/24
C & NW	100	10035	10035	....	....	1006	....	5 45/64	5 9/64	2 9/16	9/16	1 39/64	2 61/64	1 9/64	13°	13°	3°	2 79/128
C & NW	90	....	9035	....	....	904	....	5 17/32	5 3/32	2 1/2	1/2	1 17/32	2 31/32	1 1/32	13°	13°	3/64 to 1	2 23/64
C & NW	72	7201	7250	581*	302	....	....	4 3/4	4 3/4	2 3/8	9/16	1 13/32	2 1/2	27/32	14°	14°	Str.	2 3/32
CB & Q	85	8506	8543	....	85–C	855*	852*	5 3/16	5 3/16	2 21/32	9/16	1 35/64	2 3/4	57/64	13°	13°	5°	2 17/64
D & RG	90	....	....	....	....	....	906	5 1/2	5 1/8	2 9/16	9/16	1 5/8	2 7/8	1	14°	14°	4°	2 7/16
D & RG	85	....	....	....	....	....	850	5 1/4	5 1/4	2 1/2	9/16	1 3/4	2 5/8	7/8	13°	13°	4°	2 3/16
D & RG–C & S	85	....	....	....	....	....	853	5 3/8	4 7/8	2 1/2	9/16	1 15/32	2 29/32	1	4 to 1	4 to 1	1/16 to 1	2 29/64
DL & W	105	....	....	....	105–C	1052	....	6	5 3/8	2 3/4	5/8	1 23/32	3 1/4	1 1/32	13°	13°	4°	2 21/32
DL & W	101	....	10133	....	299	10130	....	5 7/16	5 3/8	2 3/4	5/8	1 23/32	2 11/16	1 1/32	13°	13°	4°	2 3/8
DL & W	91	....	9133	....	91–B	911	....	5 1/4	5 3/8	2 5/8	5/8	1 41/64	2 11/16	59/64	13°	13°	4°	2 17/64
DL & W	75	....	....	....	75–C	753	....	4 11/16	5	2 1/2	1/2	1 43/64	2 13/64	13/16	18°	12° 45′	1/16 to 1	1 117/128
Dudley	90	....	....	....	....	901	....	5 1/2	5	2 21/32	9/16	1 1/2	3 1/32	31/32	4 to 1	4 to 1	1/16 to 1	2 31/64
EJ & E	100	....	10050	....	....	....	....	5 9/16	5	2 21/32	9/16	1 37/64	2 51/64	1 3/16	4 to 1	4 to 1	1/16 to 1	2 75/128
Frictionless	125 1/2	....	....	....	125.5–F	....	....	7	5 1/2	1 13/16	11/16	2 3/8	3 13/32	1 7/32	18°	14°	Str.	2 3/4
Frictionless	98	....	....	....	305	....	....	5 27/32	5	2 1/2	9/16	1 31/32	2 25/32	1 3/32	15°	13°	15° 30′	2 31/64
Frictionless	97	....	....	....	97–B	....	....	5 7/8	5 9/64	2 1/4	9/16	1 15/16	2 55/64	1 5/64	13°	13°	1/4 to 1 1/4	2 65/128
Frictionless	93	....	....	....	....	932	....	6 1/8	5 1/2	2 1/8	19/32	1 13/16	3 3/8	15/16	13°	13°	3/16 to 1 1/4	2 5/8
Frictionless	92	....	....	....	304	....	....	5 7/16	5 3/8	1 15/16	5/8	2 3/32	2 5/16	1 1/32	13°	13°	4°	2 3/16
Frictionless	90	....	9039	....	....	....	....	5 5/8	5 1/8	2 1/4	9/16	2	2 5/8	1	13°	13°	1/4 to 1 3/8	2 5/16
Frictionless	90	....	9029	....	....	....	....	6 3/32	5 1/8	1 59/64	9/16	1 15/16	3 5/32	1	4 to 1	4 to 1	1/16 to 1	2 37/64
Frictionless	79 1/2	....	....	....	79.5–C	....	....	5 3/16	5 3/16	1 15/16	9/16	2 1/32	2 9/32	7/8	13°	13°	4°	2 1/64
Grt Nor	100	....	10036	....	....	1008	....	5 3/4	5	2 3/4	9/16	1 5/8	3	1 1/8	1 to 4	1 to 4	1/16 to 1	2 5/8
Grt Nor	90	9010	9034	560	160	9030	904	5 3/8	5	2 5/8	5/8	1 1/2	2 7/8	1	13°	13°	5°	2 7/16
Grt Nor	90	....	9036	....	....	....	....	5 3/8	5	2 5/8	19/32	1 15/32	2 7/8	1 1/32	13°	13°	5°	2 7/16
Grt Nor	85	8509	8553	....	....	854*	....	5	5	2 21/32	21/32	1 19/32	2 1/2	29/32	14°	14°	5°	2 5/32
Grt Nor	80	8009	....	....	....	802*	....	5	5	2 13/32	5/8	1 5/8	2 1/2	7/8	14°	14°	5°	2 1/8
Grt Nor	77 1/2	77501	....	....	....	775*	....	5	5	2 3/8	5/8	1 11/16	2 1/2	13/16	14°	14°	5°	2 1/16
Hock Val	80	....	....	540*	....	....	....	5	4 59/64	2 31/64	29/64	1 95/128	2 25/64	111/128	13°	13°	4°	2 1/16
Interb'g'h	100	10005	10005	....	100–E	1005	....	5 3/4	5 3/4	2 7/8	9/16	1 45/64	3 5/64	31/32	13°	13°	8°	2 65/128
Interb'g'h	90	....	9050	....	90–E	902	....	5	5	2 7/8	11/16	1 25/32	2 11/32	7/8	13°	13°	8°	2 3/64
Lehigh Val	136	....	....	....	136–C	....	....	7	6 1/2	2 15/16	21/32	1 7/8	3 7/8	1 1/4	4 to 1	4 to 1	4°	3 1/16
Lehigh Val	110	....	11033	....	110–B	....	....	6	5 1/2	2 7/8	19/32	1 7/8	3 1/16	1 1/16	4 to 1	4 to 1	4°	2 3/4
Mo Pac	85	8507	8550	....	....	853*	....	5 7/32	5 1/4	2 15/32	75/128	1 3/4	2 39/64	55/64	13°	13°	2° 30′	2 21/128
Mo Pac	75	7512	7550	528	289	754	....	4 3/4	4 3/4	2 9/16	9/16	1 7/16	2 15/32	27/32	13°	13°	Str.	2 5/64
Nat Ry Mex	75	....	....	....	128	....	....	5	5	2 3/4	1/2	1 3/8	2 7/8	3/4	12°	12°	Str.	2 3/16

Type	Weight per yard	Ill. Steel Co. Old No.	Ill. Steel Co. Carnegie Steel Co. T C & I Co.	Midvale Steel Co.	Bethlehem Steel Co.	Lackawana Steel Co.	Colorado F & I Co.	Height	Base	Head	Web	Depth of head	Fishing height	Depth of base	Head angle	Base angle	Slope of head	CL of bolts
NYC	120	....	....	....	....	1201	....	7	6	3	21/32	1 5/8	4 5/16	1 1/16	4 to 1	4 to 1	1/16 to 1	3 7/32
NYC	105	....	10522	....	105–B	1051	....	6	5 1/2	3	5/8	1 5/8	3 13/32	31/32	4 to 1	4 to 1	1/16 to 1	2 5/8
NYC	100	10003	10022	....	175	1001	....	6	5 1/2	3	19/32	1 5/8	3 13/32	31/32	4 to 1	4 to 1	1/16 to 1	2 5/8
NYC	95	....	....	....	....	951	....	5 1/32	5 1/2	3	5/8	1 9/16	2 15/32	1	4 to 1	4 to 1	1/16 to 1	2 15/64
NYC	80	8008	8022	543*	220	801	....	5 1/8	5	2 21/32	17/32	1 1/2	2 3/4	7/8	4 to 1	4 to 1	1/16 to 1	2 1/4
NYC & St L	85	8521	8521	....	172	8531	....	5 3/8	4 7/8	2 17/32	17/32	1 29/64	2 15/16	63/64	4 to 1	4 to 1	1/16 to 1	2 29/64
NYNH & H	107	....	....	....	107–D	1072	....	6 1/8	5 1/2	2 3/4	19/32	1 23/32	3 11/32	1 1/16	13°	13°	4°	2 47/64
NYNH & H	100	10004	10034	....	100	1002	....	6	5 1/2	2 3/4	19/32	1 23/32	3 11/32	15/16	13°	13°	4°	2 39/64
Nor Pac	66	6602	6602	547*	....	....	....	4 17/32	4 1/2	2 5/16	17/32	1 27/64	2 11/32	49/64	13°	13°	Str.	1 15/16
PS–Penn	130	....	13031	589	130–B	13030	....	6 5/8	5 1/2	3	11/16	2	3 13/32	1 7/32	18°	14°	Str.	2 3/4
PS–Penn	125	....	12531	584*	308	12530	....	6 1/2	5 1/2	3	21/32	1 7/8	3 13/32	1 7/32	18°	14°	Str.	2 59/64
PS–Penn	100	10031	10031	558	96–A	10030	....	5 11/16	5	2 43/64	9/16	1 13/16	2 25/32	1 3/32	15°	13°	3/32 to 1	2 31/64
PS–Penn	85	8530	8531	559	67–A	8530	....	5 1/8	4 5/8	2 1/2	17/32	1 21/32	2 15/32	1	15°	13°	Str.	2 15/64
PRR	100	10002	....	520	96	1003*	....	5 1/2	5 1/2	2 13/16	5/8	1 7/8	2 11/16	15/16	13°	13°	4°	2 9/32
PRR	85	8503	8533	500	67	852*	....	5	5	2 9/16	17/32	1 3/4	2 3/8	7/8	13°	13°	4°	2 1/16
PRR	70	7005	7033	504*	....	....	....	4 1/2	4 1/2	2 7/16	1/2	1 19/32	2 1/8	25/32	13°	13°	4°	1 27/32
P & R	100	....	10032	....	165	1007	....	5 5/8	5 3/8	2 21/32	9/16	1 45/64	2 55/64	1 1/16	13°	13°	3/64 to 1	2 63/128
RG So	52	....	....	....	....	....	521	4	4	2 1/8	25/64	1 23/64	2	41/64	13°	13°	Str.	1 41/64
Russian	67 1/2	....	....	587	....	....	....	5 3/64	4 21/64	2 23/64	15/32	1 29/64	2 11/16	29/32	1 to 3	1 to 3	Str.	2 1/4
Sea A Ln	85	....	8522	....	261	851	....	5 1/4	5	2 11/16	17/32	1 5/8	2 3/4	7/8	14°	14°	1/16 to 1	2 1/4
Sea A Ln	75	....	7522	....	221	....	....	5	5	2 9/16	1/2	1 3/8	2 3/4	7/8	14°	14°	3°	2 1/4
Soo Ln	85	8520	8520	....	....	....	....	5 3/8	4 7/8	2 1/2	9/16	1 15/32	2 29/32	1	14° 02′ 11″	14° 02′ 11″	3° 34′ 35″	2 29/64
UP	90	9003	9023	....	....	....	901*	5 3/4	5 3/8	2 3/4	17/32	1 1/2	3 3/8	7/8	13°	13°	Str.	2 9/16
UP	75	7513	7523	....	75–B	....	754	5	5	2 9/16	33/64	1 3/8	2 13/16	13/16	13°	13°	Str.	2 1/4
UP	75	7524	7524	....	....	....	757	4 15/16	4 7/16	2 7/16	33/64	1 3/8	2 5/8	15/16	4 to 1	4 to 1	1/16 to 1	2 1/4
Miscell	75	....	....	....	92	....	....	5	5	2 1/2	9/16	1 7/16	2 47/64	53/64	13°	13°	Str.	2 1/8
Miscell	70	....	....	....	97	703	....	4 3/4	4 3/4	2 7/16	1/2	1 13/32	2 19/32	3/4	12°	12°	Str.	2 3/64
Miscell	67	6704	6704	515*	....	....	....	4 1/2	4 1/2	2 13/32	1/2	1 5/8	2 1/8	3/4	13°	13°	1/16 to 3/4	1 13/16
Miscell	67	....	6733	....	....	....	....	4 1/2	4 1/2	2 13/32	1/2	1 5/8	2 1/8	3/4	13°	13°	1/16 to 3/4	1 13/16
Miscell	65	6501	....	....	....	....	....	4 3/8	4 7/16	2 3/8	29/64	1 1/2	2 5/32	23/32	14° 30′	12° 30′	1/16 to 3/4	1 51/64
Miscell	65	6504*	....	....	....	....	....	4 1/2	4 1/2	2 7/16	1/2	1 31/64	2 19/64	23/32	13°	13°	4°	1 7/8
Miscell	60	6001	6051	....	....	....	....	4 1/4	4 1/16	2 5/16	1/2	1 7/16	2 1/8	11/16	14°	12° 50′	1/10 to 1	1 3/4
Miscell	60	6017	6033	503*	....	....	....	4 1/4	4 13/64	2 21/64	29/64	1 55/128	2 7/64	91/128	13°	13°	5°	1 49/64
Miscell	56	5610	5610	....	....	....	....	4 1/4	3 31/32	2 7/32	13/32	1 7/16	2 1/8	11/16	14°	12° 50′	1/10 to 1	1 13/16
Miscell	56	....	....	511*	....	....	....	4	3 53/64	2 19/64	29/64	1 51/128	1 59/64	87/128	12°	12°	1/32 to 5/8	1 41/64
Miscell	56	5616	5633	....	....	....	....	4 1/4	4 1/8	2 1/4	3/8	1 27/64	2 1/8	45/64	13°	13°	5°	1 49/64
Miscell	56	...	....	....	....	....	562	4 1/4	4 1/8	2 1/4	53/128	1 7/32	2 17/64	49/64	13°	13°	Str.	1 115/128

*Not rolled now.

Note. See figure 51 for key.

Figure 48. Ties in track; single track.

a horizontal flangeway for railroad-car wheels. A typical girder rail section is shown in figure 52.

b. RAIL FAILURES. Rails evidencing any of the failures discussed below must be removed immediately from track at such hazardous locations as bridges, trestles, or culverts; near retaining walls; through turn-outs, especially at points of switch and opposite frogs; and at any other location where derailment might result in serious damage to life or property. Broken rails are removed immediately from any track.

(1) *Transverse fissure.* A transverse fissure is a crosswise break in the railhead, starting from a center or nucleus inside the head and spreading outward. The broken rail shows a smooth area around the nucleus which may be either bright or dark, round or oval. (See fig. 53.)

(2) *Compound fissure.* A compound fissure is a horizontal split in the railhead which, in spreading, turns either up or down in the head. (See fig. 54.)

(3) *Horizontal split.* A horizontal split is a horizontal break beginning inside the head of the rail and spreading outward; it is usually indicated on the side of the head by a lengthwise seam or crack, or by a flow of metal. (See fig. 55.)

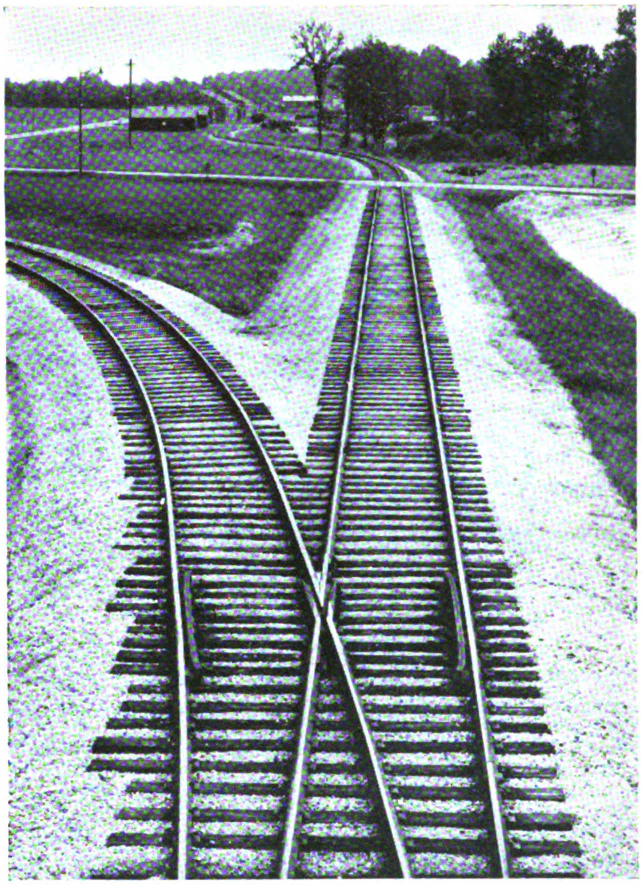


Figure 49. Ties in track; double track.

Figure 50. Ties in track; multiple-track lay-out.

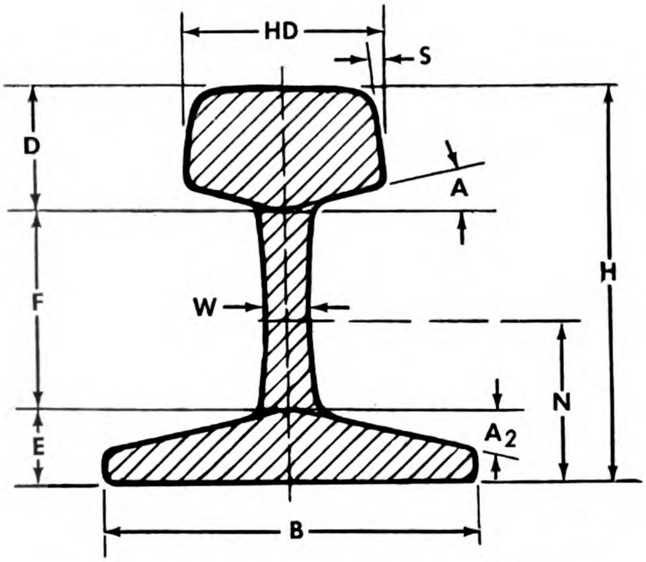


Figure 51. Details of T-rail. (See table V for key.)

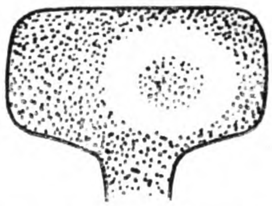


Figure 53. Transverse fissure.

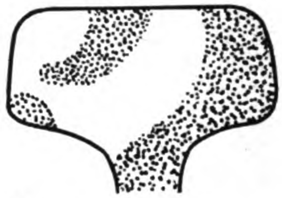
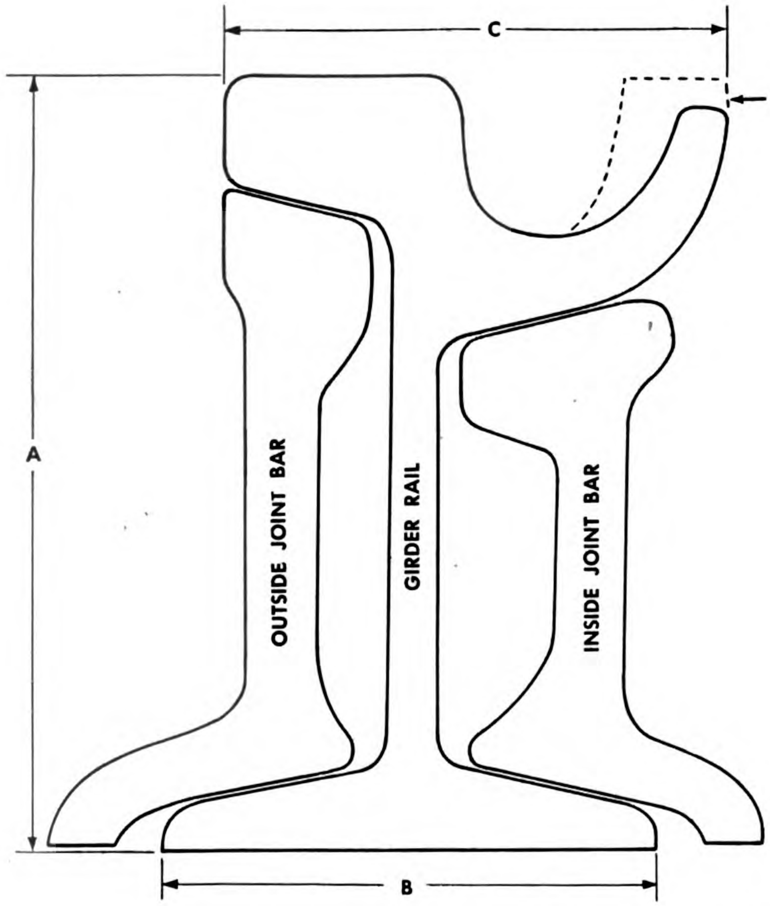


Figure 54. Compound fissure.



R E SECTIONS

WEIGHT OF RAIL (LB)	A	B	C
128	7"	6"	6"
149 *	7"	6"	6⅛"
12 FT	9"	5¾"	5⅞"
174 *	9"	5¾"	5⅞"

* GIRDER GUARDRAIL TO BE USED GIRDER RAIL FROG

Figure 52. Details of typical girder rail.

(4) *Vertical split.* A vertical split occurs through or near the middle of the head. A crack or rust streak may show under the head close to the web, or pieces may split off the side of the head. (See fig. 56.)

(5) *Crushed head.* Crushed head is a flattening or crushing down of the head. (See fig. 57.)

(6) *Piped rail.* Piped rail is a rail split vertically, usually in the web. (See fig. 58.)

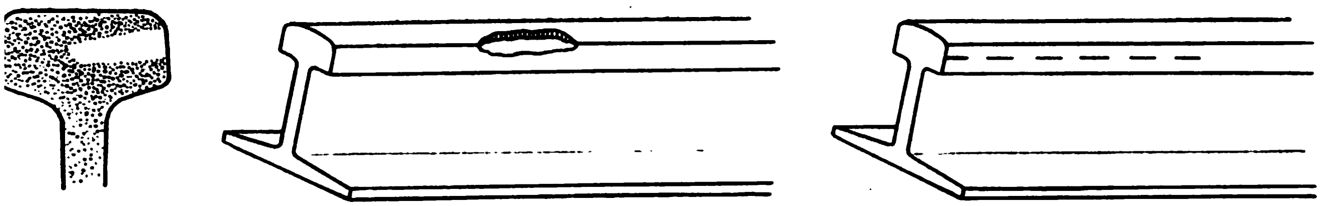


Figure 55. Three indications of horizontal split head.

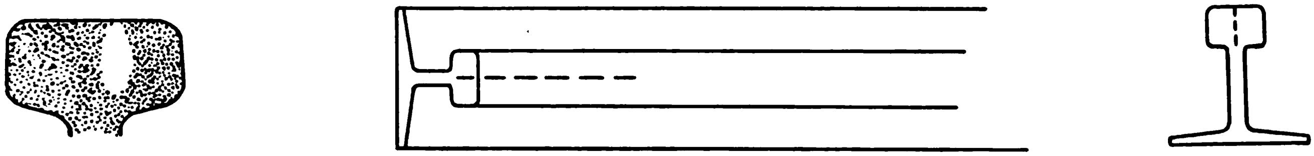


Figure 56. Three indications of vertical split head.

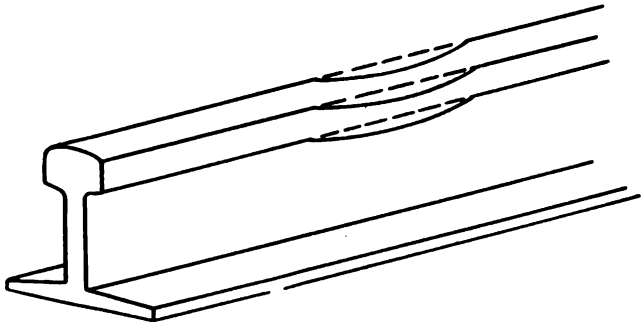


Figure 57. Indication of crushed head.

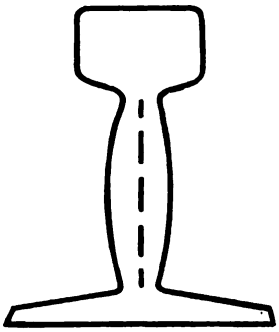


Figure 58. Piped rail.

(7) *Split web.* Split webs have lengthwise cracks extending into or through the web. (See fig. 59.)

(8) *Broken base.* Broken base is illustrated in figure 60.

(9) *Square or angular break.* Square and angular breaks are illustrated in figure 61.

(10) *Damaged rail.* Any rail damaged or injured by wrecks; broken, flat, or unbalanced wheels; slipping; or other causes, is a damaged rail.

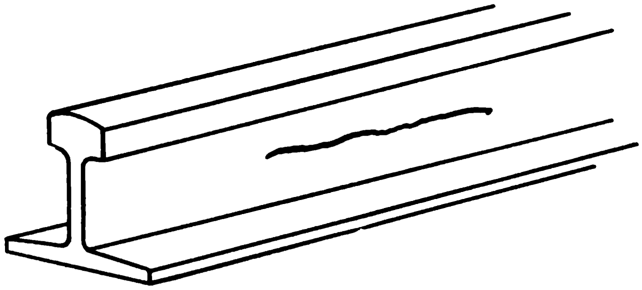


Figure 59. Indication of split web.

(*c*) Replacement of Rail. Where rails are to be replaced or interchanged the following rules apply:

(1) Before placing any rail in track, inspect it thoroughly for possible failures.

(2) Do not place badly worn rails in running tracks; save them for use in house or storage tracks.

(3) Reset curve-worn rails with the worn side

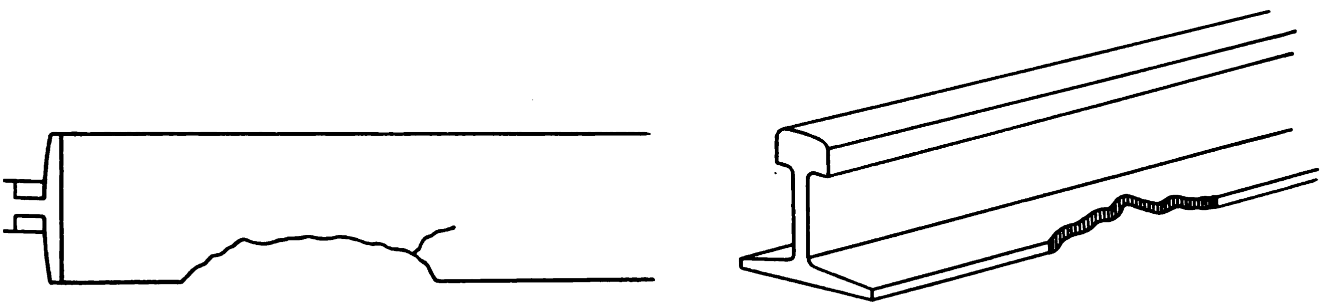


Figure 60. Two indications of broken base.

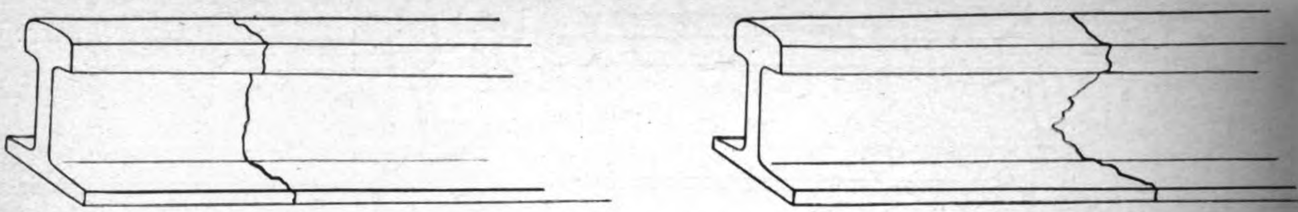


Figure 61. Views of square and angular breaks.

facing away from the gauge side. On curves, use the worn rail as the low or inside rail.

(4) Match weight, section, and amount of wear of adjacent rails as closely as practicable. Do not connect rails with full heads to rails with worn heads where the gauge of track at the joints would be altered appreciably.

(5) When, by necessity, rails of different weights or sections are connected, use compromise bars to match the weights and sections of the two rails. (See par. 23.)

(6) Do not use rails less than 15 feet long in running or access tracks, in classification or receiving yards, or where there is considerable movement of cars. Reserve such rails for dead-storage tracks or extreme ends of stub tracks.

(7) Remove broken or cracked rails from track immediately. If it is not feasible to replace the broken rail at once, use a pair of fully bolted joint bars at the break as an emergency measure. Remove the broken or defective rail as soon as possible. Bolt holes may be burned with acetylene torch for temporary connections in emergencies only. (See figs. 62 and 63.)

(8) Drill the full number and correct size of bolt holes to coincide with the holes in the joint bars used. Hold joint bars in place with rail or C-clamps while the bolt holes are drilled, to insure correct spacing. (See fig. 64.)

(9) If rail is broken or defective and safety at normal speeds is questionable, give slow orders (par. 52) for that section of track and move trains under direction of a flagman. Never use these measures at hazardous locations; stop traffic until defective rails are replaced.

(10) As soon as possible, remove rails which have been cut with an acetylene torch to make a temporary closure. Cut off at least 6 inches of the torch-cut end of the rail with rail saw or cutting tool before using the rail in track again.

d. HANDLING RAIL. Bolts, nuts, and rail anchors must not be damaged in removing rail from track. A crane is used for loading rails. (See fig. 65.) If it is necessary to load or carry rails by hand (fig. 66), rail tongs are used and the following precautions observed:

(1) Divide the gang equally at ends of the rail.

Figure 62. Effect of cutting bolt hole with acetylene torch: broken web and head.

Figure 63. Effect of cutting bolt hole with acetylene torch: broken web and base.

(2) Designate one man to call directions and prohibit others from doing so.

(3) Never attempt to throw rail unless the force is sufficient to throw it clear.

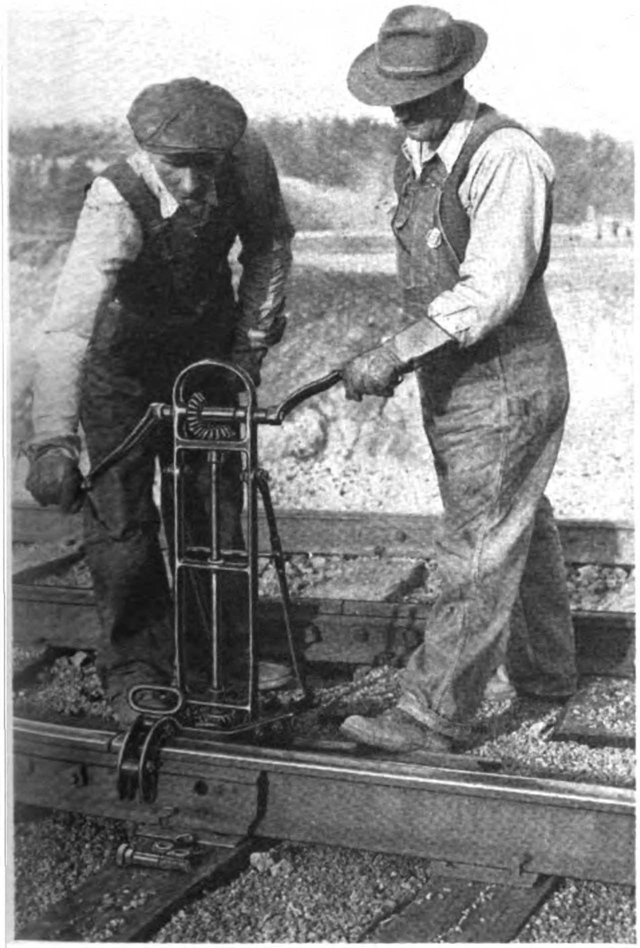


Figure 64. Drilling bolt holes in rail.

(4) Always load where men can get away readily if the rail should fall.

e. Distribution of Rails. Rails are distributed so they can be laid without unnecessary handling.

(1) Place rails base down, parallel with the track and with sufficient bearing to prevent bending or swinging.

(2) If there is danger of trainmen falling over rails distributed along the track, report rail location so trainmen can be warned.

(3) In yards and station grounds, stack rails well out of the way of trainmen, and in a place convenient for redistribution.

f. Preparation for Laying Rails. Before rails are renewed, the track is placed in good surface and line, and ties are adzed if old rails or tie plates have marked them.

(1) Use a roller bender to precurve rails for curves over 8°. Be sure curvature is uniform throughout the length of the rail.

(2) Straighten rails that have sharp crooks or bends.

(3) Distribute bolts, spikes, tie plugs, tie plates, and rail anchors as close as possible to the site where they will be used, shortly before rail is laid. If trains are using the track, do not put such articles on top of ties or in cribs. See that they are not buried or lost.

g. Laying Rails. (1) Never lay more rail than can be taken care of during the day in which it is laid, so rail or fastenings will not be damaged by normal traffic. Tamp loose ties to provide a good bearing under the new rail. Follow standards for spiking

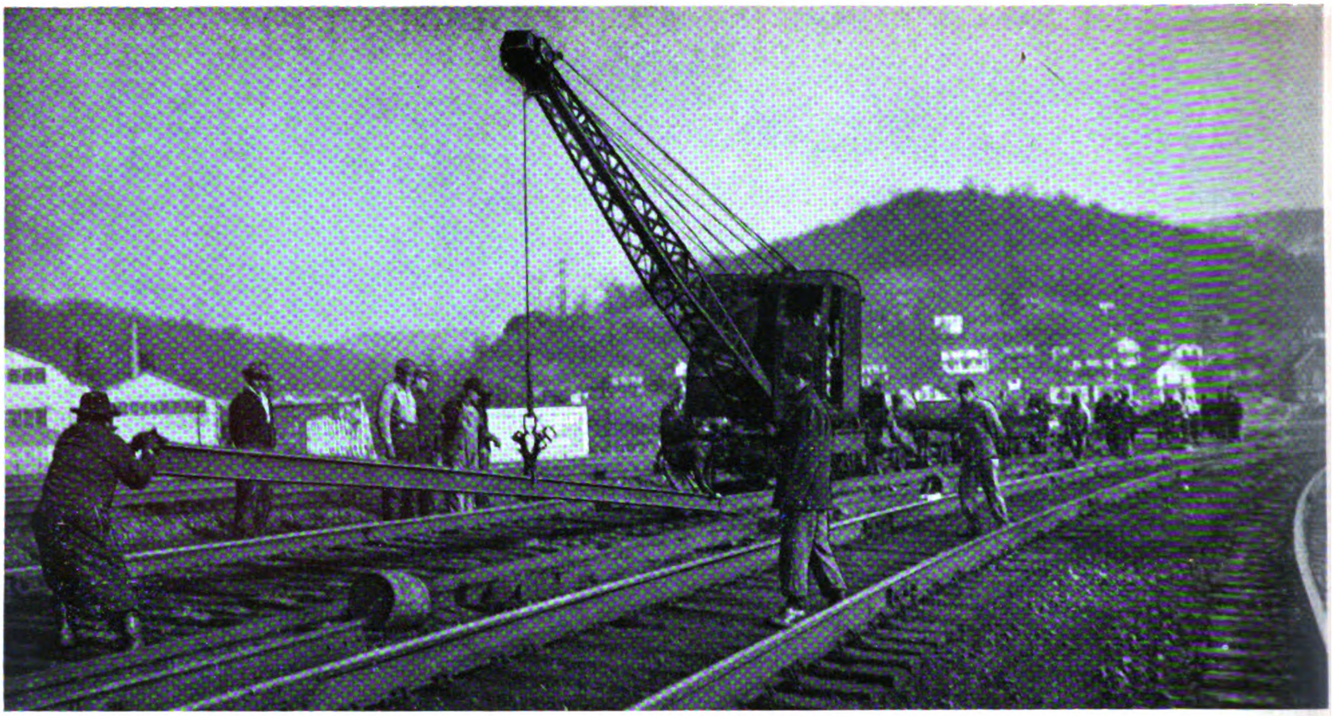


Figure 65. Laying rail with crane.

Figure 66. Handling rail manually.

and bolting (pars. 24, 25, and 34), and apply necessary rail anchors before permitting trains to pass over the rail.

(2) See that insulating joints in track circuit are spiked and supported as soon as possible; insulating fibers are easily damaged.

(3) Lay rails one at a time. To insure good adjustment, bring rail ends squarely together against suitable rail expansion gauges and bolt them before spiking. Under special conditions, certain departures from this plan are permissible:

In areas of heavy traffic, when trains cannot conveniently be diverted to other tracks, stretches of rail not over 1,000 feet long may be bolted together and then lined into place. Proper allowance for expansion must be maintained; requisite rail expansion gauges must remain in place until rails are placed in final position.

(4) Slush fishing spaces with oil before applying joint bars.

(5) Do not use rails less than 15 feet long in main tracks except in the following instances, where rails not less than 10 feet long may be used:

(*a*) Temporary closures.

(*b*) Connections within turn-outs.

(*c*) Temporary connections for rails of different weights and types.

(6) Use rails of the same section in road crossings, switch connections, open-floor bridges, trestles, and viaducts, to avoid use of compromise joints at these locations.

(7) Make temporary connections for passage of trains with a piece of old rail not less than 10 feet long connected to the new rail by a compromise joint with the full number of bolts and spikes. (See pars. 23, 24, and 34.) A *full length* of old rail must be continuous with the new rail before passage of trains at normal sped is authorized.

(8) Never use switch points to make temporary connections. This is a dangerous practice.

(9) Provide holes for complete bolting of cut rails, according to standard drilling practices and the following rules:

(*a*) New holes are drilled, and not punched, slotted, or burned with a torch. They are not drilled between existing holes.

(*b*) The distance from the end of a rail to the center of the first bolt hole is at least twice the diameter of the hole.

(*c*) The distance between centers of any two holes of the same size is at least four times the diameter of the hole; and in the case of holes of different sizes, at least three and three-fourths times the mean diameter of the two holes.

h. ALLOWANCE FOR EXPANSION. Rail expansion shims of soft wood not over 1 inch wide, of the prescribed thickness, are placed between ends of adjacent rails to permit expansion. They may be left in place.

(1) Allowances for expansion are:

Temperature of rail (° F.)	*Expansion space (in.) for 33-foot rails*
0 to 25	1/4
26 to 50	3/16
51 to 75	3/16
76 to 100	1/8
Over 100	None

(2) Use the standard rail thermometer to test rail temperature. Lay the thermometer along the base of the rail close to the web so it is shaded from the sun; leave it there long enough to record rail temperature accurately. The foreman in charge is responsible for checking temperature frequently and seeing that proper rail expansion gauges are used.

(3) When the temperature of the rail is 100° F. or more, or at locations where temperatures are fairly constant, as in tunnels, lay rails close together without allowance for expansion.

(4) In all other locations, leave a space of 1/16 inch for each 33-foot rail for every 25° below 100° F.

(5) At insulating joints, leave 3/8 inch between rails. Use insulated end posts between rail ends.

i. RAIL JOINTS. Connect rails with standard joint bars fully bolted. Lay rails so joints of one line are opposite the middle of the rails in the other line, with permissible variations as follows:

(1) Except through turn-outs and at paved road crossings, the staggering of joints must not vary more than 30 inches from the center of the opposite rail; preferably not more than 18 inches.

(2) Joints must not be placed within the limits of switch points, opposite guardrails, or within 6 feet of the ends of open-floor bridges or trestles.

(3) Battered rail ends may be built up by an approved method of welding. (See par. 56.)

j. BONDED RAILS. Where highway or train signals are actuated through track circuit, or at gasoline loading stations where rails are grounded, bond rails at the joints by rail bond wires. Drill holes in web of rail the size of lugs at end of bond wires, and drive lugs into them to secure a firm fit. Do not break wires nor remove bonded rails unless a signal maintainer is present, except in emergencies. In emergencies, a broken rail, switch, or frog may be renewed without waiting for the signal maintainer. In such cases, tighten the joints to make as good contact as possible with the rails, and notify the signal maintainer that bond wires have been broken.

k. CUTTING RAILS. Use the rail saw and rail cutter for cutting rail; the rail saw is preferred. When using a rail cutter, the striker and the man holding the cutter must not face each other. Both must wear prescribed safety goggles. The cutter must be sharp and the head properly rounded. Use a sledge weighing not over 8 pounds; do not use the spiking hammer. Place the rail on a block with base of rail up and the block a slight distance behind the cut. Do all cutting on the base and web of the rail. Do not drop rails to expedite cutting; use the cutting hammer until the cut is completed. In cases of extreme emergency, rails may be cut with gas cutting torches by qualified operators, but torch-cut rails in running tracks must be replaced as soon as possible.

21. Tie Plates

Tie plates are used on permanent projects and in locations where the experience of the serving railroad indicates their advisability. They are not used in temporary projects except over bridges, trestles, or culverts; through turn-outs and cross-overs; and on curves above 4° on access and running tracks. Tie plates must have full bearing on ties, and outside shoulders must be against the outside base of the rails. The tie may be adzed to provide bearing for the plate; however, excessive adzing reduces the life of the tie.

22. Joint Bars

Joint bars are applied with the full number of bolts, nuts, and spring washers. Rail weighing 75 pounds or more a yard is bolted so that nuts alternate between the inside and outside of the rail. On lighter rail all nuts face the outside of the track. (See fig. 67.)

a. Keep joints tightly bolted to prevent injury to the rail ends. Use standard track wrenches only. In newly laid rail, tighten bolts three times or more during the first month: once when rail is laid, again the following day, and again within 1 week.

b. Take up wear in fishing spaces of rail and joint bars by joint shims of the correct type.

c. Oil all track bolts when installed, and each time they are tightened. Check and oil bolts at least once every 3 months.

23. Compromise Joints

Compromise joints are used wherever rails of different weights or sections are connected. The bars conform to the weight and *section* of each rail at the connection. Proper weights and sections are specified for right or left hand of the larger rail, as viewed from the track center. Rules governing the maintenance of joint bars apply to compromise joints. Figure 68 shows a typical installation of a compromise joint.

24. Spikes

The standard 5½-inch spike is used for all track spiking except when tracks are being shimmed. Shimming spikes are 5 inches plus the thickness of

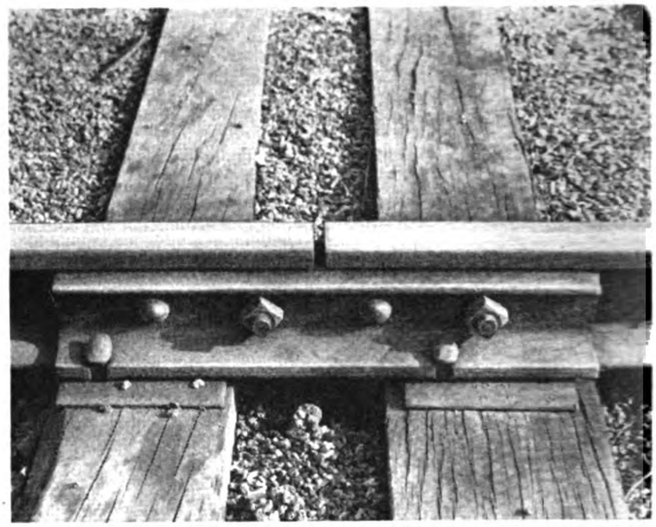


Figure 67. Typical joint-bar installation.

Figure 68. Typical installation of compromise joint.

the shim taken at ½-inch intervals. (See par. 34 for spiking instructions for various types of track.)

25. Bolts, Nuts, and Lock Washers

All joints must be fully bolted with the proper size, type, and number of bolts, nuts, and lock washers for the type of joint bar used. (See fig. 123.)

26. Rail Anchors

Rail anchors are used in track subject to serious movement from rail expansion or from traffic on steep grades. They must grip the base of the rail firmly and have full bearing against the face of the tie opposite the direction of creeping. The following general rules apply:

a. At locations where rail anchors are required, ties must be firmly tamped and fully imbedded in ballast.

b. The proper tools must be used to apply or remove rail anchors.

c. When the bearing of the rail anchor has been disturbed by removal of the tie, the anchor must be removed and reset.

d. Ballast and ice must be kept away from rail anchors.

27. Gauge Rods

Gauge rods are used on sharp curves that are difficult to hold to gauge. Two to four are used for each rail length, applied so rods are at right angles to the rail and jaws have a firm grip on the base of the rail. Some types of gauge rods prevent rails from canting or tipping. Where tipping has been encountered, this combination rod should be used.

28. Turn-Outs and Cross-Overs

a. GENERAL. The No. 8 turn-out with split switch, low switch stand, and rigid bolted frog has been adopted as standard on all Government-owned trackage to provide uniformity and to expedite replacement of turn-outs, cross-overs, and their component parts. In projects involving new construction or alterations and additions to existing track, the No. 8 turn-out must be used unless a substitute is approved by higher authority. (See standard plan 617-106, fig. 12.)

b. REPLACEMENT. Whenever turn-outs or cross-overs other than No. 8 are to be replaced, the No. 8 turn-out is used except where the realignment of connecting tracks is controlled by fixed structures or other local conditions, or where the change in lay-out involves excessive cost.

c. LOCATION. Turnouts are located on tangent track wherever possible, to minimize wear on switch points, frogs, and guardrails. When a turn-out is from the inside of a curve, the degree of curvature of the turn-out is approximately its normal degree plus the degree of curvature of the main line; if outside, the degree of curvature of the turn-out is the difference of these two. Thus, if a No. 8 frog with an angle of 11° 47′ is installed on the inside of a 4° curve, the curvature through the turn-out is equal to 11° 47′ plus 4°, or 15° 47′. Safety against derailment and economy in maintenance, require that turn-outs be located so that the total curvature does not exceed 16°. Figure 69 shows a turn-out on the inside of a curve and figure 70 a typical double-ladder turn-out installation.

d. POSITION. To facilitate switching, it is desirable that all turn-outs to spur tracks lead in the same direction. (See fig. 71.)

e. SWITCH TIES. Switch ties are the length and spacing specified in standard plans for the turn-out. Policies governing installation and maintenance of cross ties apply to switch ties.

f. SWITCHES. The following instructions are supplemented and illustrated by standard plan 617-106 (fig. 12) covering the No. 8 turn-out. Lengths of switch points adopted as standard for various turn-outs are as follows:

Number of turn-out	*Length of switch point*
No. 15	30 feet
No. 12	30 feet
No. 10	15 feet
No. 8	15 feet
No. 6	15 feet
No. 4	11 feet 6 inches

Note. The 16½-foot switch point may be used instead of the 15-foot point.

(1) Match switch points to weight and section of stock rail. When points are renewed, renew stock rail also, if necessary to secure a proper fit. Connect points to the operating rod to provide ample flangeway between the open point and the stock rail. Check both switch points for this adjustment. The correct throw of the switch is 4¾ inches, with allowable minimum limits of 4 inches in running tracks and 3½ inches in secondary tracks. Provide all vertical bolts on switch connections with cotter pins and place them with nuts facing up. Center the slide and heel plates on the tie to provide even bearing for the switch point.

(2) Inspect each switch at least once each week to determine that it operates freely, that points fit accurately, and that rods do not foul on ties or ballast. Keep all operating mechanisms clean and thoroughly lubricated.

(3) Maintain surface, line, and gauge throughout. Keep the gauge side of the main track point in line with the gauge side of the stock rail in advance of the point. Bend the stock rail with a rail bender at the proper place so the point fits snugly to the rail when closed. Paragraph 34*e* gives details of bend in stock rail to receive switch points of various lengths.

g. SWITCH STANDS. The switch operating mechanism consists of a hand-operated switch stand with

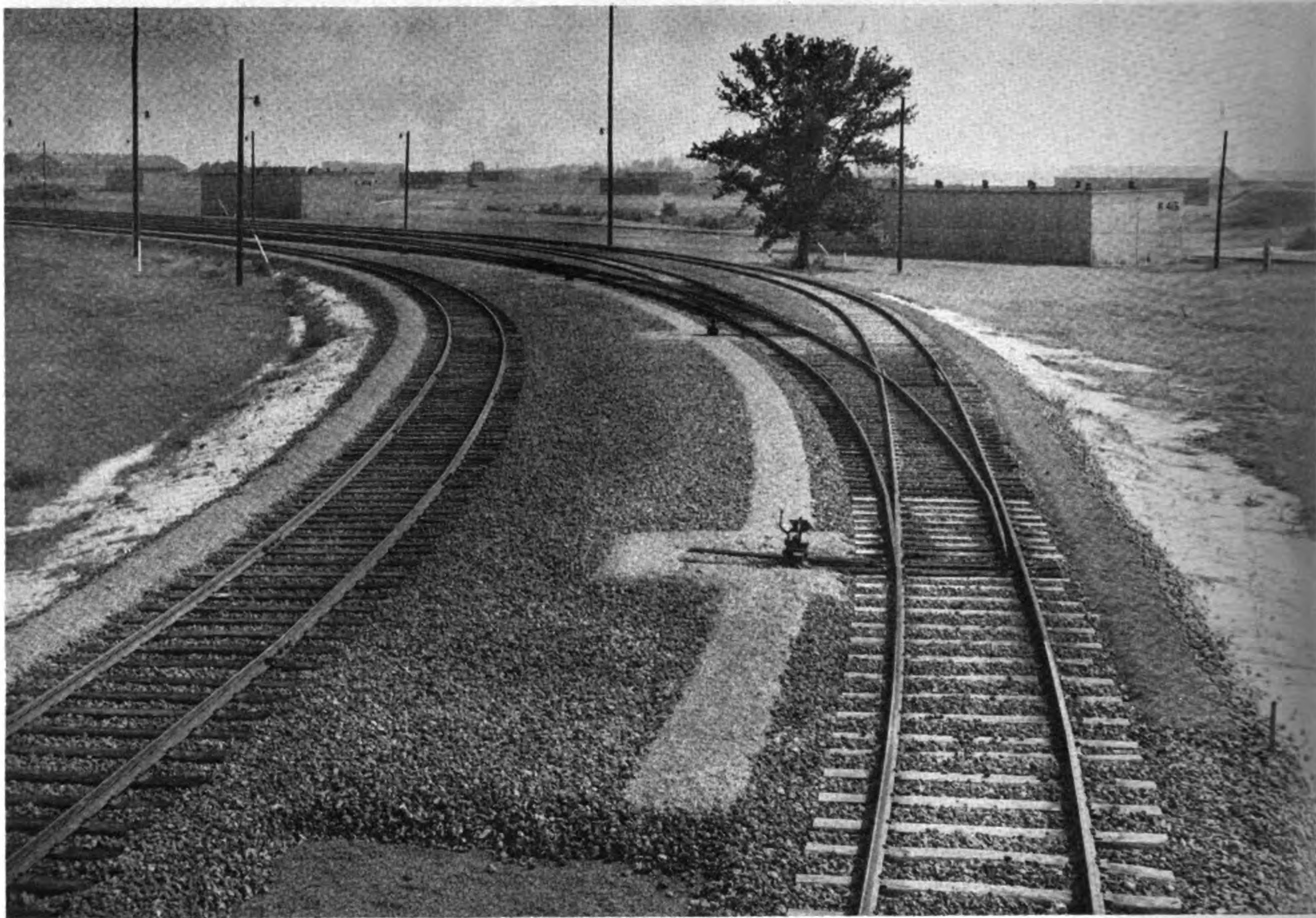


Figure 69. Turn-out on inside of curve.

throw lever, and a connecting rod. The switch stand is placed on the two 15-foot header ties at the point of switch. Where practicable the switch stand is located on the right side of the track with respect to the normal direction of traffic. The switch stand is installed and maintained according to the following requirements:

(1) Hand lever operates parallel to the track.

(2) Throw of stand is adjustable from 4½ inches to 5½ inches; the adjustment is made so either switch point has a minimum throw of 4¾ inches.

(3) Center of stand is approximately 6 feet 6 inches from center line of track.

(4) Colored targets are provided to indicate switch points clearly at locations where such indication is necessary. (See fig. 72.)

(5) For night operations, switch targets have red and green reflectors or red and green lanterns mounted on the spindle. Green indicates switch normal and red indicates switch reversed. (See fig. 73.)

h. FROGS. The standard rigid bolted frog is used unless a variation is specifically authorized by higher authority. It is installed in conformity with standard plan 617-106. (See fig. 12.)

(1) The frog number corresponds to the turn-out number.

(2) The frog is of the same weight and section as the rails through the lead.

(3) All frogs are fastened to switch ties by frog tie plates, fully spiked. Spikes must be kept fully driven; all bolts must be tight, with cotter pins in place; any broken bolts must be replaced immediately.

(4) Correct line, surface, and gauge must be maintained with running rails and guardrails.

i. GUARDRAILS. Guardrails 7 feet 6 inches in length with 15-foot running rails and filler blocks have been adopted as standard. Two guardrails are required for each turn-out placed as detailed on standard plan 617-106 (fig. 12).

(1) Regardless of track gauge, gauge from the actual point of frog to the flangeway side of the guardrail is 4 feet 6⅝ inches. If curvature through the turn-out exceeds 8°, the distance is increased to 4 feet 6¾ inches.

(2) Guardrails are placed so at least 22 inches

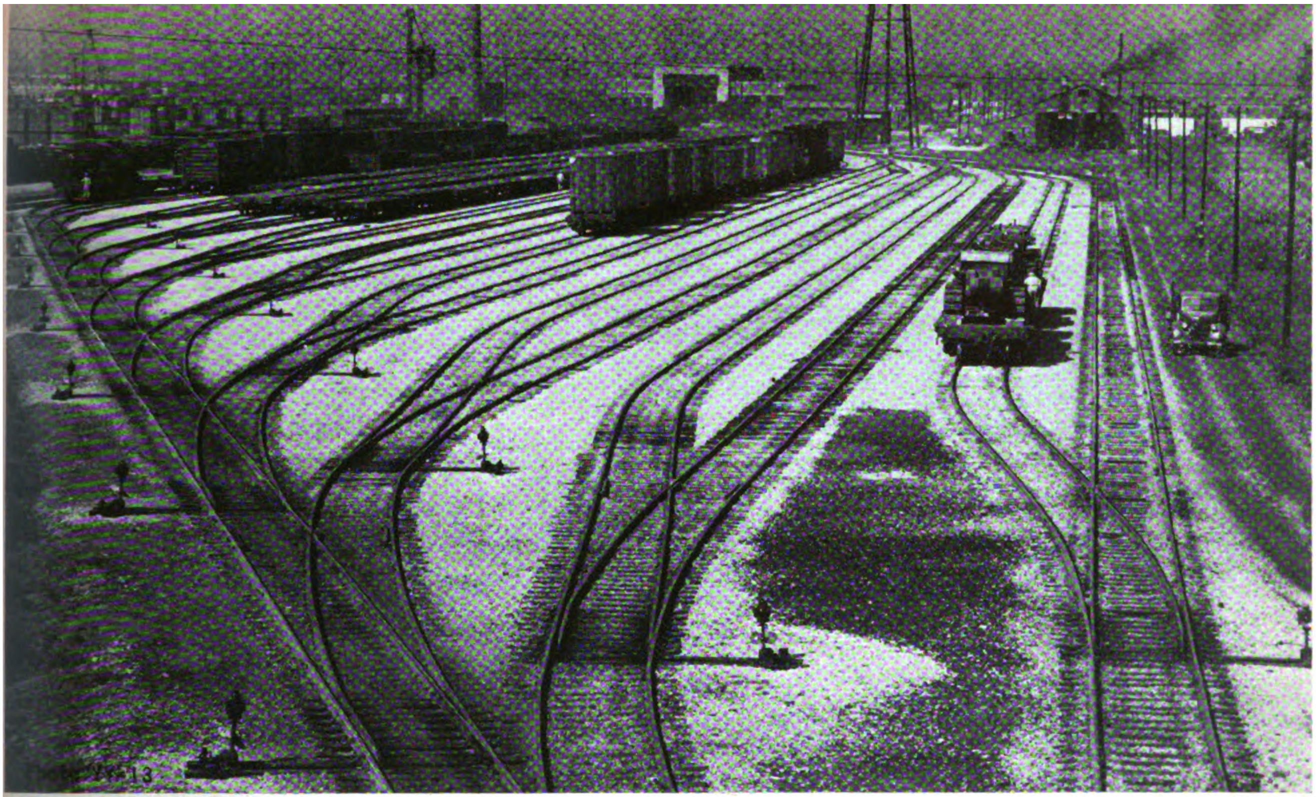


Figure 70. Typical double-ladder turn-out installation.

Figure 71. Typical cross-over installation.

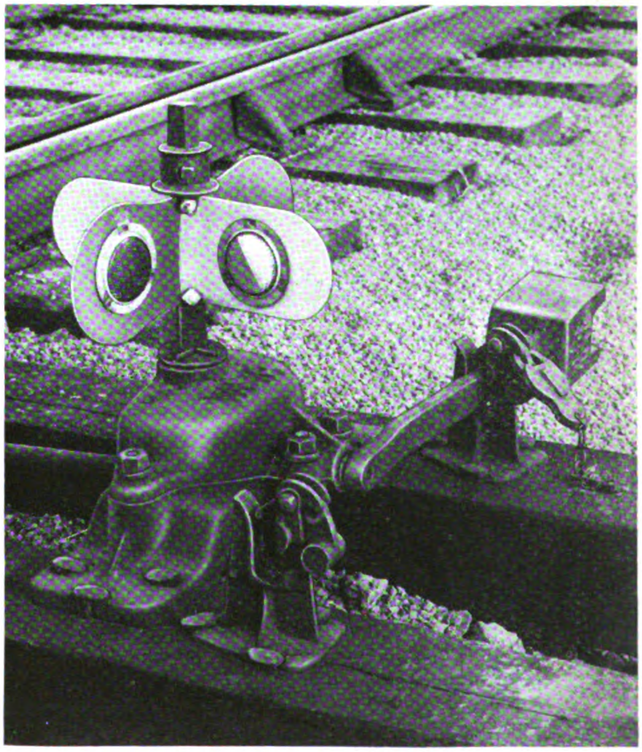


Figure 72. Switch stand with target and reflectors.

Figure 73. Typical switch-stand installations with target and lamp.

of the straight portion of the guarding face is ahead of the frog point.

(3) Ends of guardrails are placed on a tie or otherwise protected to prevent loose or dragging objects from catching.

j. DERAILS. Derails must be kept in good operating condition. Frequent inspections are made to see that the clearance point has not changed because of shifting or movement of running track. Derails are painted a light chrome yellow to make them clearly visible. Where derails are not used, a chrome yellow strip 10 inches wide is painted across the web and base of each rail of the connecting track at the clearance point.

SECTION V
SPECIFIC MAINTENANCE OPERATIONS

9. General

'his section is a guide to specific maintenance opera-ons on railroad tracks and appurtenances.

0. Lining Track

'rack is lined at the same time it is surfaced.

a. TANGENTS. On tangent track, the line rail is rought to correct line by eye or by use of the transit. 'he other rail is brought to line by correcting to roper gauge. Figures 74 and 75 illustrate these perations.

Figure 74. Tangent track.

b. CURVES. Lining of track on curves is more mplicated because the curve must not only be uni-rm throughout its length, but in most cases an sement into the curve must be provided from both ngents. (See fig. 76.)

(1) Compound or reverse curves must be pro-ded with easements from one curve into the other.

(2) A transit is employed and curves are staked it in laying out new work or in making major anges to existing track lay-out. The string-line ethod can be used to advantage for minor adjust-ents. The latter method consists of measuring the iddle ordinate of an arc subtended by a 62-foot ord at each 31-foot station along the outer rail of the curve. This measurement in inches indicates the degree of curve. Field operations and methods of calculation are given in paragraphs 54 through 59.

31. Surfacing Track

a. GENERAL. All tracks must be laid and maintained to correct surface, line, and gauge. *Surfacing-out-of-face* refers to raising the track structure to a new grade. *Spot surfacing* refers to raising low spots to the original uniform surface. Correct surface implies that a plane across the top of the rails at right angles to the rails is level on tangents and has the correct inclination on curves when superelevation is used. The track level is used in all surfacing work. (See fig. 77.)

(1) Pay special attention to surface and line of track at ends and approaches to bridges, trestles, and culverts, through turn-outs and crossings, and at platforms.

(2) Work against the current of traffic when raising track, except on heavy grades where it is desirable to work upgrade.

(3) Before raising track during hot weather, be sure that rails will not warp or buckle. Consider the amount of rail openings at joints, tightness of

Figure 75. Operation of lining tangent track.

bolts, position of rail anchors, and amount of ballast in cribs and at ends of ties. Where there is danger of buckling, loosen track joints in both directions from the danger point to allow for expansion.

(4) In bonded track territory, see thaat ballast clears the base of the rail to prevent leakage of current. Separate ballast and base of rail by a space of 1 inch.

b. OPERATION. There are two methods of surfacing track with track jacks: (1) where the lift is less than 2 inches; and (2) where the lift is more than 2 inches. Figures 78 and 79 illustrate the procedures followed in each case.

(1) In beginning a raise of less than 2 inches,

Figure 76. Curved track.

space jacks 8 to 12 feet apart. Place the first jack approximately 10 feet ahead of point 0. Raise both jacks to give even grade from 0 to 2. Tamp the ties to a point approximately halfway between 1 and 2. Bring the other rail to proper surface with the aid of the track level. Then move the first jack about 10 feet ahead of the second, raise the rail at that point, and tamp the ties as between 1 and 2. Follow

Figure 77. Use of track level to surface track.

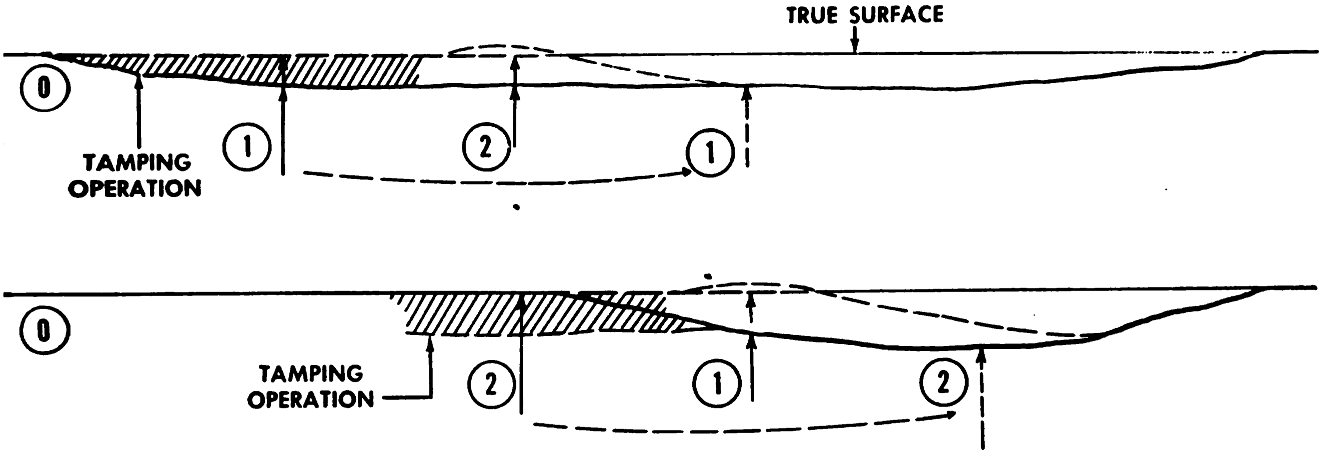


Figure 78. Surfacing track when raise is less than 2 inches.

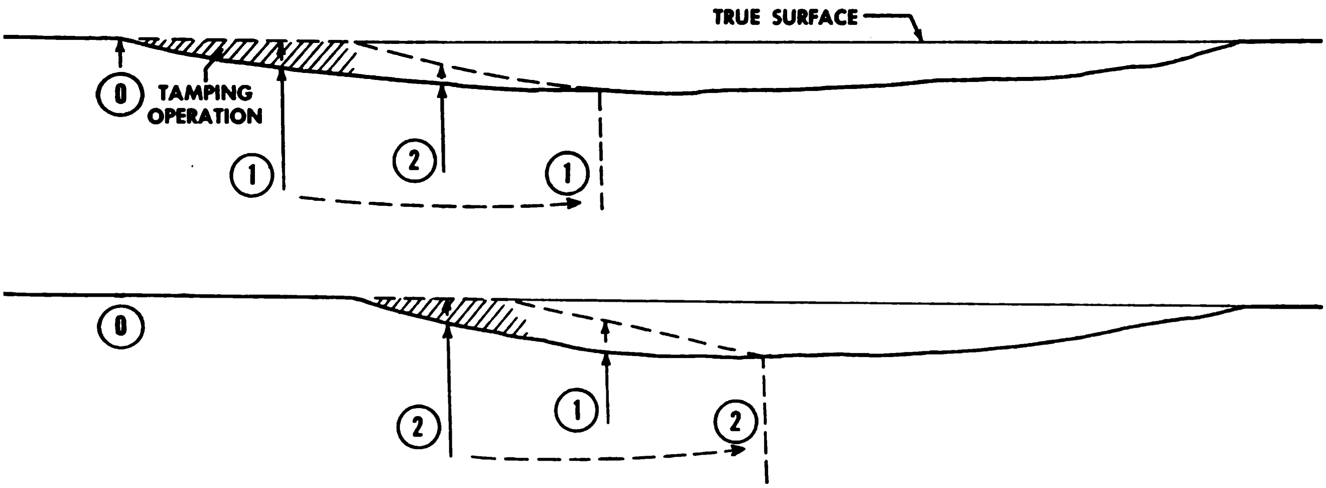


Figure 79. Surfacing track when raise is more than 2 inches.

he same procedure to bring the other rail to proper urface, using the track level to determine the amount f lift.

(2) To lift the track more than 2 inches, locate oth jacks as above, but reduce the spacing between acks to avoid permanent bending of the rail.. Raise he first jack to bring the rail to grade between 0 nd 1. Then raise the second jack enough to provide easonable run-off between the new grade and the ow spot. Tamp ties to a point approximately one-ourth the distance between 1 and 2. Raise the second ack to bring the rail to proper grade and move the irst jack ahead the proper spacing. Tamp as before nd continue the same operations through the full ength of track to be raised.

Caution: In both methods, jacks must be placed head of rail joints to prevent strain on joint bars.

(3) In raising or surfacing track, the inner rail n curves and the line rail on tangents are the grade rails. Bring them to surface with the aid of the spot board, or refer them to grade stakes. Bring the second rail to surface with the aid of the track level. Figure 80 shows the method of spot-surfacing track.

(4) Bring both rails to grade, tamp ties, set tie plates, gauge track, and drive spikes fully before jacks are moved ahead.

(5) Place track jacks in cribs between the ties outside the rail and set them true vertically. If jacks must be placed between rails, set them in trip position and provide flag protection.

32. Tamping

Systematic and uniform tamping is of great importance in maintaining correct surface and line.

a. Start tamping directly under the rail. Pack ballast firmly under the tie, being careful not to shatter the material.

b. Tamp both sides of each tie. Best results are

Figure 80. Spot-surfacing track. Note jacks are outside of track.

obtained by tamping outside the rail to within 3 inches of the end of the tie, and inside the rail for 12 inches.

c. Pay special attention to tamping at rail joints. Tamp adjacent ties first, then tamp joint ties to provide proper bearing.

d. Where cinder ballast is used, tamp the entire length of the tie, using square-pointed shovels. (See fig. 81.)

e. Use ballast forks or tamping picks for hand tamping of slag, stone, or gravel ballast.

f. Where long lengths of track are to be raised,

Figure 81. Hand tamping with square-pointed shovels.

use a mechanical tie tamper. Mechanical tampers are of three types:

(1) The pneumatic tamper, which requires air under a pressure of approximately 100 pounds, usually obtained from a portable air compressor. Because of its flexibility this type of tamper is widely used. (See fig. 82.)

(2) The electric tamper, which requires a source of electricity. The portable gasoline-engine-driven generator ordinarily is used. (See fig. 83.)

(3) The gasoline-engine-driven tamper, which is a self-contained unit.

33. Gauging Track

The standard gauge of 4 feet 8½ inches is used for tangent track and on curves up to 8°. On curves over 8°, the gauge is increased ⅛ inch for each increment of 2° to a maximum of 4 feet 9¼ inches. Increase must not exceed ¼ inch in 31 feet. Gauge is widened on the inside rail.

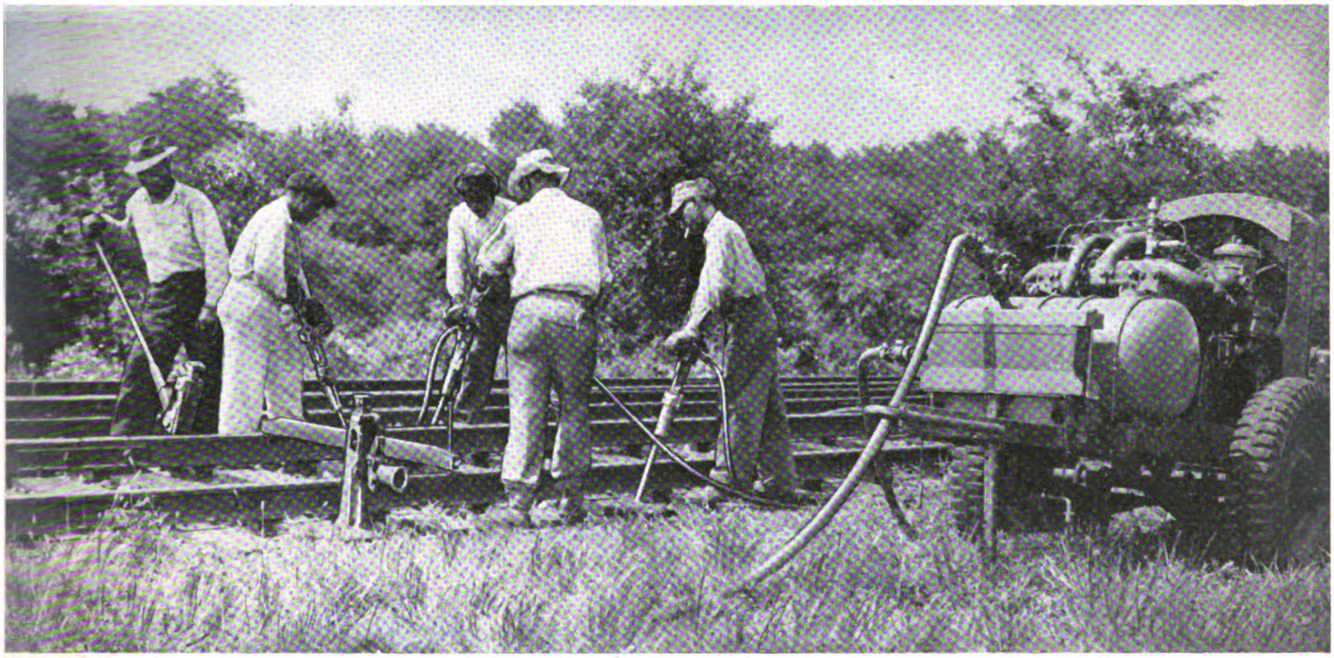


Figure 82. Use of pneumatic tie tamper.

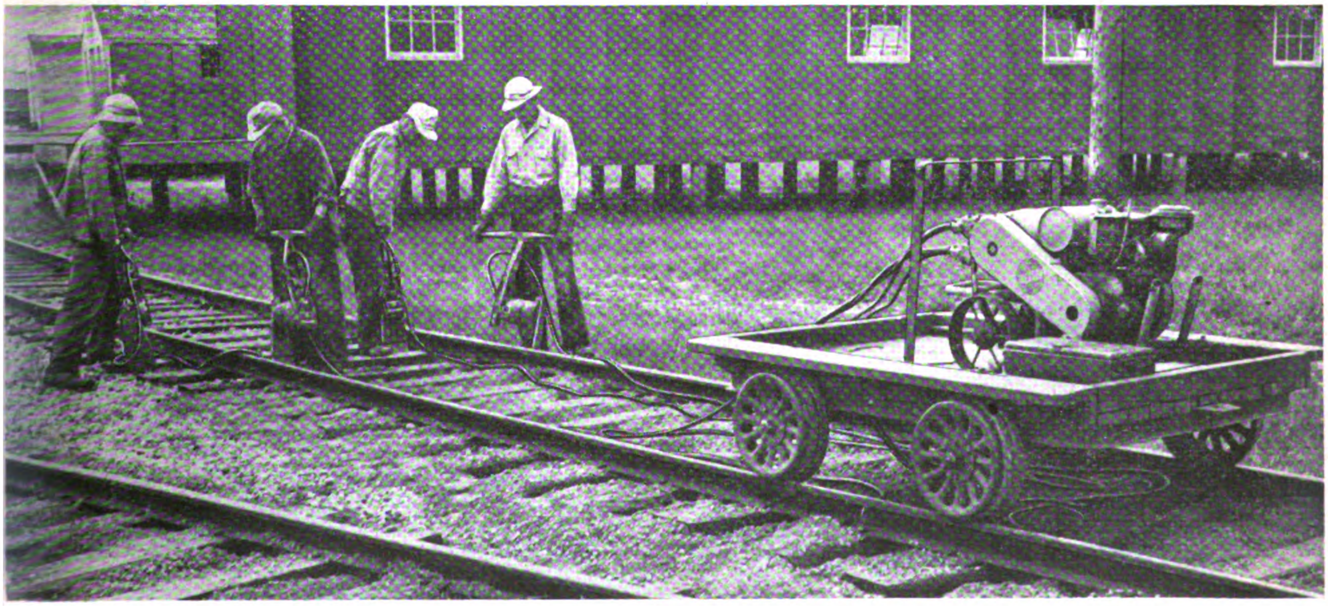


Figure 83. Use of electric tie tamper with gasoline-engine-driven generator.

a. At turn-outs and cross-overs on curved track, the gauge of the parent track is determined from the degree of curve, as described above. The gauge of the turn-out is determined by the algebraic sum of the two curves (curve of the main track plus or minus the degree of turn-out curve) and the gauge adjustment made accordingly.

b. Where gauge differs from measurements specified above, the track need not be disturbed where the difference is uniform, and the excess is not more than 3/8 inch on straight track or 1/2 inch on curves, provided rails are securely fastened to ties and correctly aligned.

c. The standard track gauge is used for correcting gauge. It should be checked frequently and replaced when it shows a variation of 1/8 inch or more. All spike pulling and driving is done on the rail opposite the line rail. The gauge is not removed until all spikes have been driven. (See fig. 84.)

Figure 84. Use of standard track gauge.

d. The gauge of guardrails at frogs must be checked frequently. Normally the distance from gauge line of frog to the flangeway face of guardrail is 4 feet 6 5/8 inches; however, if curvature through turn-out exceeds 8°, the distance must be 4 feet 6 3/4 inches *regardless of track gauge.* If gauge of track is increased, the flangeway is increased correspondingly. (See fig. 85.)

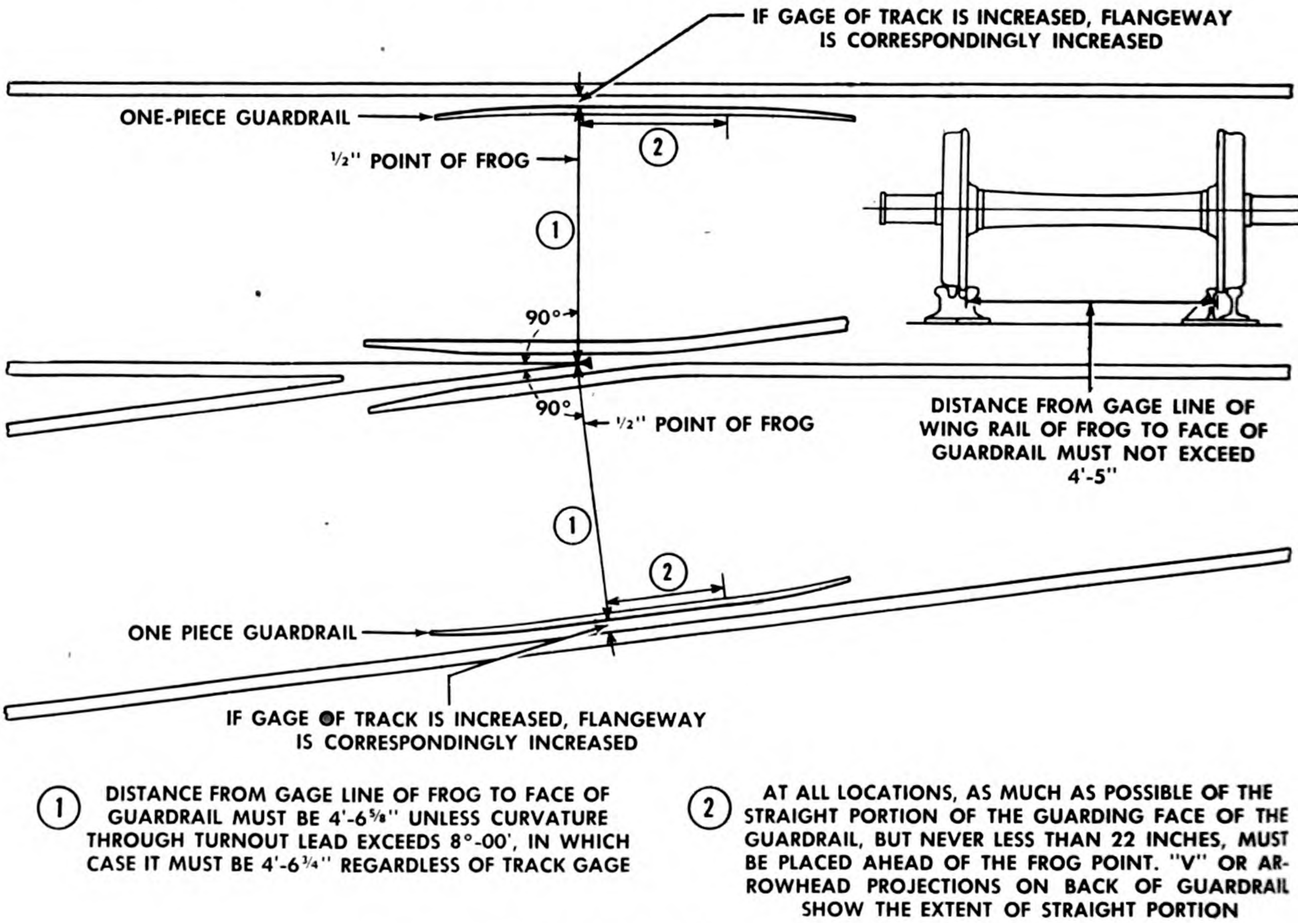


Figure 85. Gauge at guardrails.

e. Spikes are drawn with the standard claw bar. At switches, frogs, and guardrails, where the claw bar will not fit between rails, the spike puller extension is used. Tie plugs are driven in all spike holes before respiking. (See fig. 86.)

f. Corrections to gauge must not be made by striking the head of the driven spike toward the rail.

Figure 86. Driving tie plugs in spike holes.

Figure 87. Pulling spikes with claw bar.

Figure 88. Pulling spikes with spike puller extension.

Spikes must be removed and redriven and rails lined to gauge with lining bars. (See figs. 87 and 88.)

34. Spiking

Rails are spiked to ties as follows:

a. TANGENT TRACK. On tangent track, use one outside and one inside spike for each rail on each tie. Space the inside spike at least 2 inches from one face of the tie and the outside spike at least 2 inches from the opposite face.

b. CURVED TRACK. On curves 3° and over, use one additional spike on inside of each rail. Spike curves less than 3° in the same way as tangent track unless special conditions make additional spiking necessary.

c. TURN-OUTS AND CROSS-OVERS. On turn-outs and cross-overs, spike all rails fully to all switch ties. Use one outside and two inside spikes for each rail on each cross tie for a distance of 15 feet ahead of the point of switch.

d. HAZARDOUS LOCATIONS. On bridges, trestles, culverts, along retaining walls, and on approaches, use at least one outside and two inside spikes on each tie for each rail.

e. GENERAL RULES. The following general rules apply to all spiking:

(1) Use the standard spike maul. Do not drive spikes with a sledge hammer.

(2) Do not use neck-worn spikes, collect them as scrap.

(3) Start spikes upright and square, with full bearing against the base of the rail, and drive them straight. Make the last few blows of the spike maul light so the spike head will not be damaged.

(4) Draw all spikes from ties removed from track, and sort them for further use or for scrap.

(5) Use the standard track gauge whenever tracks are spiked. Do not remove the gauge until all spikes are driven.

35. Turn-Out Installation

Turn-outs, cross-overs, and their appliances are placed and maintained in accordance with standard plans and the following rules:

a. Locate point of frog and point of switch.

b. Relocate any main-track rail joints that come within the limits of switch point or guardrail.

c. Cut the lead rails, bearing in mind that the turn-out lead is longer than the main-track lead.

d. First put in headlock and gauge plate or two slide plates, and then all ties for the switch points and frog, and their slide plates, braces, heel plates, and guardrail plates. The plates and braces for the unbroken line of rail are lined and fully spiked in position while those on the turn-out side are held in place temporarily.

e. Bend a rail for the turn-out stock rail according to the following data:

Length of switch point (ft.)	*Distance of bend ahead of switch point (in.)*	*Perpendicular offset from original line at 10 feet from bend (in.)*
30	8	1⅞
18	4 13/16	3⅛
15	4 1/16	3⅞
11	3 1/16	5⅞
10	2 11/16	5⅝

f. Couple the stock rail, main-track switch point (heel block to be placed later, if used), lead rails and frog and the ends of ties on the turn-out side, doing such cutting and drilling as may be necessary to complete the main track from the point of switch to heel of frog.

g. Take out the old main-track rail, set in the stock rail and the switch point, the lead rail and frog, and make connections at the heel of the frog and at the stock rail. Spike frog to exact gauge at heel and the toe point. Place joint bars and tighten bolts before completing spiking from frog to the heel of the switch point.

h. Do not permit train movement over main track until the guardrail has been correctly placed and spiked, all switch plates on the turn-out side have been fully spiked in correct position, the switch point has been spiked against the stock rail, and the free end of the stock rail fastened to prevent movement.

i. In applying the switch plates on the turn-out side:

(1) See that gauge is correct 12 inches ahead of switch point.

(2) Put slide plates on the tie where switch point begins to taper, and adjust stock rail so that it does not bind against switch point and cause it to open. (To test this, operate switch point and see that point touches stock rail first.) Spike these slide plates, and then install and spike remaining slide plates and braces, working each way from the center.

j. When putting on slide plates, use a bar (not a pick), and do not attempt to draw the gauge with a spike.

k. Put in the remaining switch ties, and line and surface main track.

l. Couple up switch point for the turn-out lead, set lead rails, and spike turn-out lead to proper line for turn-out curve.

m. Complete the work by setting the remaining guardrail (and switch-point guardrail if staggered switch points are installed), setting and adjusting the switch-operating mechanism, checking the line, gauging, spiking, and surfacing. Figure 89 illustrates a typical turn-out installation.

36. Swimming Track

a. GENERAL. Heaving of track in winter and spring months is generally an indication of poor drainage or poor ballast conditions which must be corrected as soon as frost leaves the ground. Until the cause can be eliminated, heaving can be corrected temporarily by using shims to raise the rails on either side of the high spot, thus providing an easy grade. (See fig. 90.) The length of this temporary raise is called the run-off.

b. METHOD. The following is a detailed method of surfacing tracks at heaved spots:

(1) Raise rails only by using shims; do not bring them to new surface or grade by raising the track. Do not lower rails at high spots by adzing the ties.

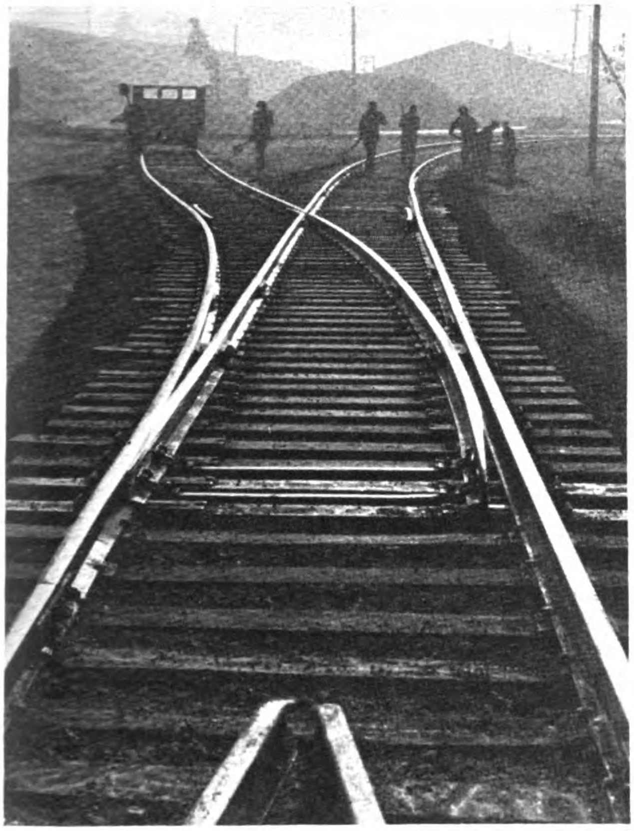


Figure 89. Typical turn-out installation.

(2) Apply wood shims of standard dimensions listed in figure 90 to track as shown. Shims are the same thickness throughout, not wedge-shaped.

(3) Place shims between tie and tie plate or between tie and rail.

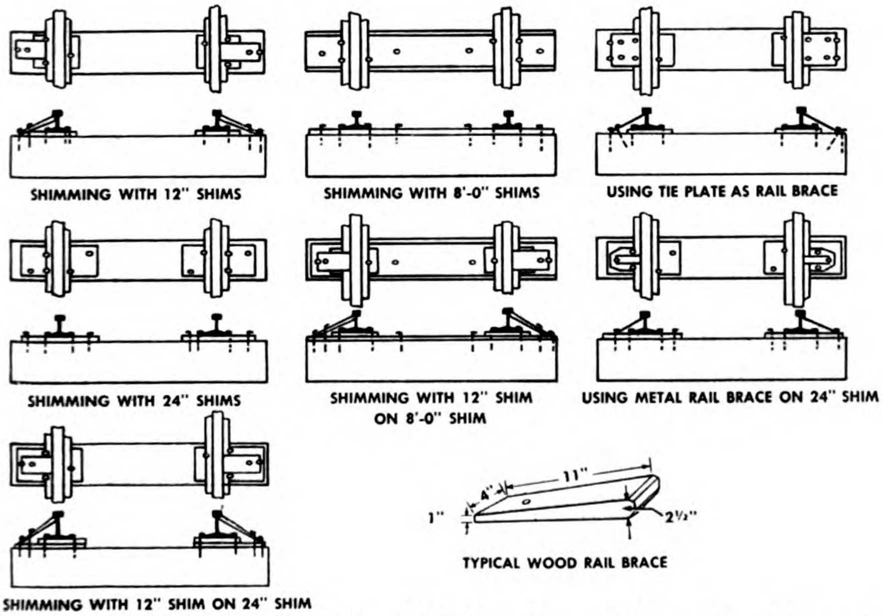
(4) When both rails are to be raised 1½ inches or more, fasten 8-foot shims securely to the tie through holes bored through the shim to receive spikes. Where the two rails have been heaved unevenly and the required raise is 1½ inches or more, use shims of required thickness and half the tie length.

(5) For shims ½ inch thick or more, use special shimming spikes.

(6) Brace all shimmed rails to prevent canting or spreading. Any of the methods shown in figure 90 may be used.

(7) Place shims to give both rails the correct gauge, line, and surface. Give shimmed track the correct superelevation on curves, using the track level and track gauge.

(8) Remove shims when the heaved track begins to settle. Shims are not removed all at once, but replaced with smaller shims until the surface of the track is gradually restored to normal.



DETAILS OF STANDARD SHIMS				OPTIONAL LENGTH
WIDTH	LENGTH	THICKNESS	NO PER BUNDLE	
7	12	¼"	50	
7	12	½"	25	
7	12	¾"	20	
7	12	1"	10	
7	12	1¼"	10	
7	24	1½"	5	8'-0"
7	24	2"	5	8'-0"
7	24	2½"	5	8'-0"
7	24	3"	5	8'-0"

Figure 90. Application of wood shims and rail braces in shimming track.

(9) Recover long shimming spikes and save them for future use.

(10) When shims are changed or removed, plug the old spike holes with tie plugs and redrive spikes in the plugged holes as long as good holding power can be secured.

(11) When all frost has left the ground and track has settled, remove all remaining shims. If the track does not return to its original surface, dig high points down to normal level. Tamp disturbed ties to provide firm support.

Caution: Watch tracks closely where heaving has occurred, since rails are frequently broken by heaving action.

37. Maintenance of Highway Crossings

a. GENERAL. Highway crossings are maintained as follows:

(1) Keep the surface of the crossing smooth. Nail down planked crossings securely; replace split or broken planking immediately.

(2) Keep underground cross drains clean.

(3) Keep planking for shoulders in place, to prevent edges of pavement from spalling or raveling.

(4) Remove or trim trees and brush to allow maximum view for vehicles or pedestrians approaching track from either direction.

(5) Immediately repair or replace damaged signs, whistle posts, signals, and other forms of protection.

(6) Plan the work on highway crossings so it will cause the least possible inconvenience to highway and railroad traffic. Take care to protect pedestrian or vehicular traffic; keep temporary footwalks or driveways in safe condition. Comply with all provisions of local and State laws.

b. MAINTENANCE OF TRACK AT CROSSINGS. (1) On tangent track and on curves up to 8°, maintain flangeways 2¼ inches wide on the gauge side of each rail through a crossing. Widen them to 2½ inches on curves over 8°. All flangeways are 2½ inches deep.

(2) Check surface, line, and gauge frequently.

(3) In track circuit territory where highway crossing bells or signals are actuated by oncoming trains, check insulating joints, bond wires and other electrical connections frequently.

(4) Do not place rail joints within limits of paved portion of highway crossings. At crossings 27 feet wide or less, use full-length rails with rail ends staggered 3 feet. Use connecting short-length rails at least 15 feet long to bring staggering of joints to standard limits.

38. Maintenance of Track Over Bridges and Trestles

Tracks on bridges, on trestles, in tunnels, and on approaches to these structures must have alignment, gauge, and surface in good condition at all times. When track is resurfaced or ballasted on bridges, trestles, approaches, in tunnels, under overhead structures, or along platforms, no change in line or general elevation can be made without special approval. If track is not in condition for usual train speed, slow orders (par. 52) must be given to train crews and appropriate warning signs or signals displayed until repairs are made.

39. Cuts and Fills

Normal maintenance of cuts and fills primarily involves stabilizing the slope surface to control run-off and minimize erosion. This can be accomplished by suitable ground cover and well-placed intercepting ditches.

a. GROUND COVER. Suitable ground cover is obtained by sodding or seeding native grasses. For methods of cultivation and control of vegetation, see TM 5-630. If local conditions make maintenance of grass impracticable, slopes are covered with a cinder blanket 2 to 4 inches thick, tamped into place. (See figs. 91 and 92.)

b. INTERCEPTING DITCHES. Intercepting ditches at the top of cut slopes intercept the surface water from adjoining areas. These ditches must be well maintained to control erosion and prevent scouring of the slope.

c. UNSTABLE SLOPES. Unstable slopes are usually the result of saturation of some portion of the subsoil, seepage of underground water, or undermining of the toe of the slope. Additional drainage is required in the first two cases. Correction of undermining at the toe of slope may involve paving the drainage ditch or building retaining walls. (See figs. 93 through 98.)

(1) *Emergency repairs.* (*a*) Keep sliding or sloughing slopes in condition to drain readily. Fill or drain irregularities in slope which may pocket water; water accumulating in these pockets further aggravates the sliding condition.

(*b*) Remove any obstructing material from ditches, drains, or drainage structures.

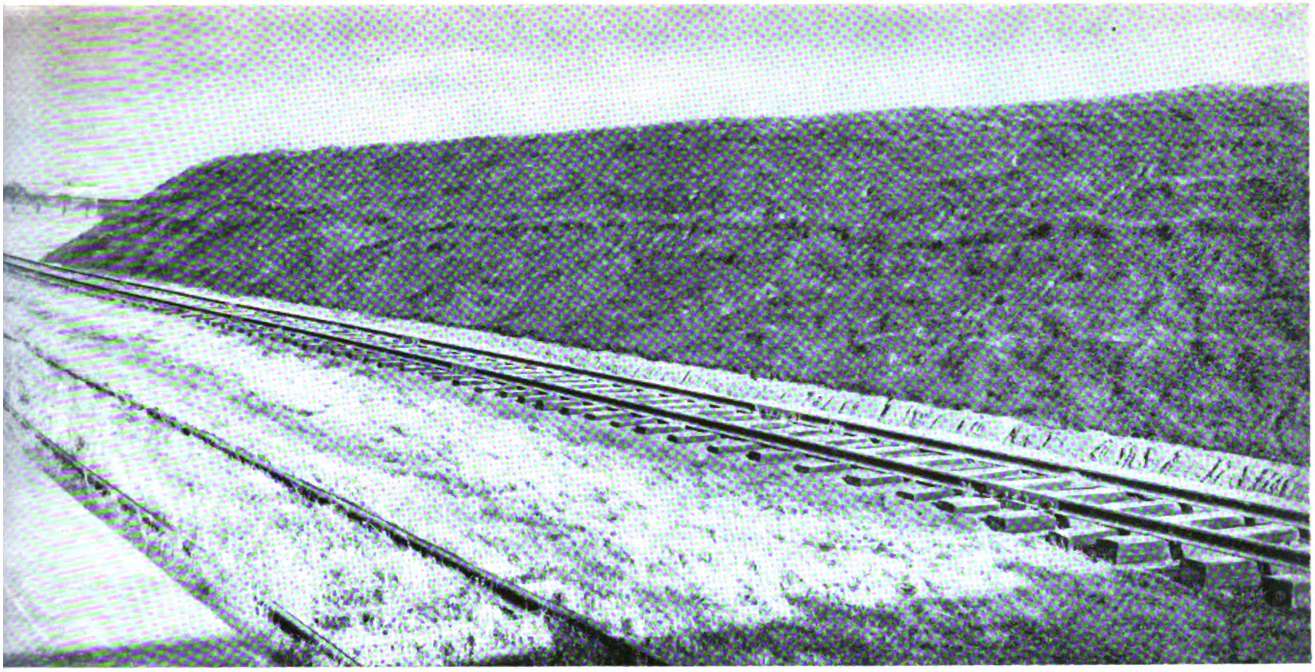


Figure 91. Grass-covered slopes.

Figure 92. Cinder-covered slopes.

(*c*) Widen narrow fill sections with cinders as a temporary measure.

(*d*) Protect traffic by establishing slow orders (par. 52) and erecting warning signs. Temporary closing of track to traffic is required in severe cases.

(2) *Permanent repairs.* Permanent repairs are undertaken as soon as the cause of sliding is determined. The assistance of qualified engineers should be obtained in planning permanent repairs to serious slides. For further details see TM 5-624 (when published).

d. Simple Erosion. Simple erosion caused by run-off is controlled and corrected as it occurs. Eroded channels are filled with compacted stable material and suitable ground cover is established. (See TM 5-630.)

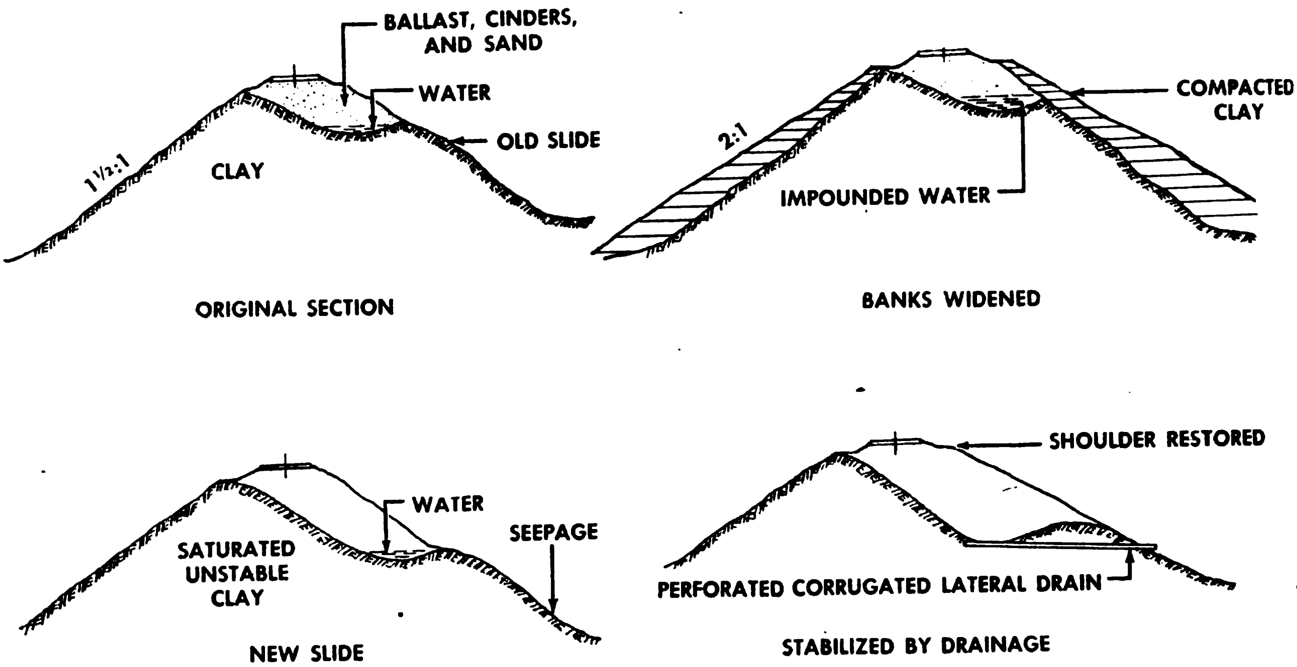


Figure 93. Effects of fill widening on unstable fill.

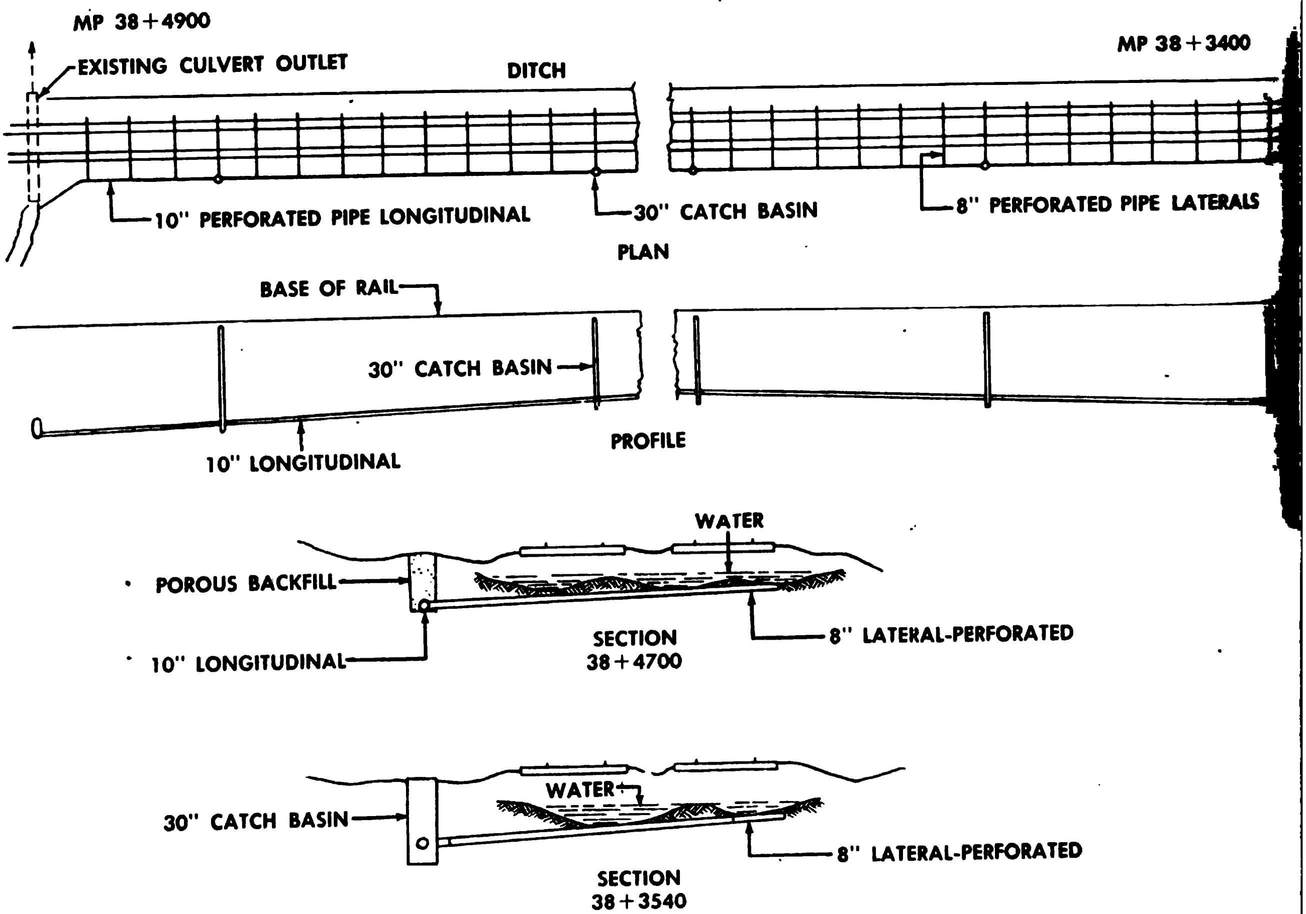


Figure 94. Typical installation of perforated pipe subdrains.

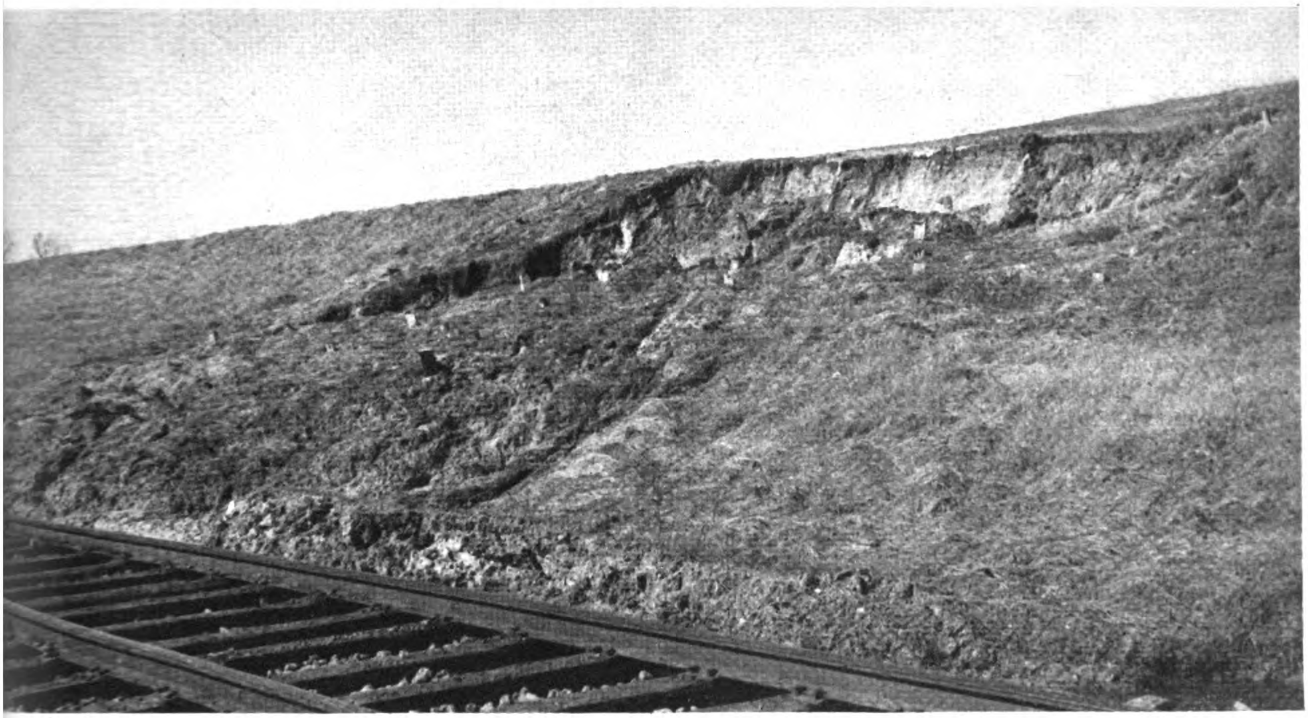


Figure 95. Slide caused by underground seepage.

Figure 96. Use of retaining walls as protection against slides.

0. Roadbed Drainage

o provide maximum support for track structure, ubgrades must be kept as dry as possible. Open itches and pipe drains must be maintained to function at maximum capacity. Inadequacies in the riginal drainage system should be corrected as they ecome evident.

a. SURFACE DRAINAGE. Drainage ditches are kept ı condition to dispose of run-off quickly. Obstructions that cause water to remain in pools are removed. Erosion of ditch sides and bottoms is controlled by lining with native grasses or by paving. (See TM 5-630.)

b. SUBSURFACE DRAINAGE. Water falling on ballast quickly reaches the subgrade, where it runs off to ditches, is dissipated by evaporation, or soaks into subgrade soil. The stability of rapidly draining soils is not particularly affected, but poorly draining soils lose supporting power if they have excess moisture. Poorly drained subgrades are usually reflected in

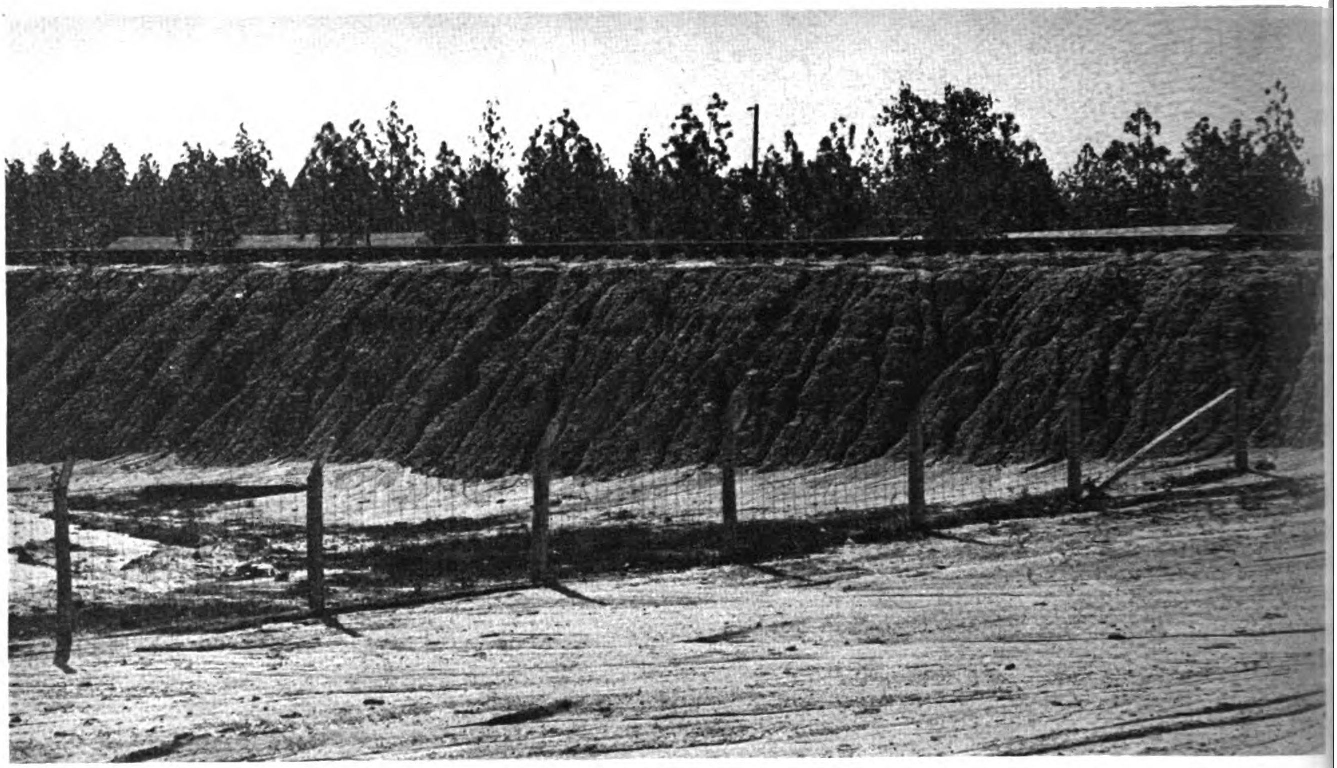


Figure 97. Eroded slope.

Figure 98. Same slope after establishment of vegetation.

poor track surface. Resurfacing or raising track instead of providing proper subdrainage is only a temporary measure.

(1) *Location of subdrains.* Borings or excavation of open pits are necessary to determine the depth and location of excess moisture in the subgrade. The entire area affected should be investigated in planning major drainage installations. To be most effective, drains should be located below the water-bearing material.

(*a*) Cross drains usually extend from the side slopes completely under the ballasted section at intervals of 50 to 100 feet along the track.

(*b*) Lateral collecting drains are required where cross drains cannot be connected to open drainage channels.

(2) *Type of subdrains.* Pipe drains are preferred or subgrade drainage installations. Perforated pipe r open-jointed clay or concrete pipe may be used. 'rench drains of heavy crushed stone are suitable nly for temporary installations. For further details f drainage installation and maintenance, see TM -624.

c. HEAVING TRACK. Heaving track results from ormation of ice lenses in poorly drained portions of ubgrades. Unequal freezing due to differences in ubgrade moisture causes high spots in the track. uch spots are corrected by installation of subgrade rainage.

d. DRAINAGE OF YARD TRACKS. Railroad yards re usually located on fairly flat terrain and require pecial drainage treatment. Since large, open ditches ı railroad yards are objectionable, pipe storm drains nd subdrains are required unless natural soils are articularly suitable for self-draining. Periodic inpections, rodding, and cleaning of installed drainage ystems are necessary if they are to function satisactorily.

1. Weed Control

'he elimination of vegetation from areas where it is ot required for erosion control is essential to eco omical maintenance of track as well as to appearance f the roadway. Weeds in track foul the ballast, terfere with drainage, and shorten the life of ties. The control of weeds along the roadway improves the view and minimizes fire hazards. (See figs. 99, 100, and 101.) Weeds are controlled by cutting, burning, or by the use of chemicals. The method of controlling weeds by burning is covered in TM 5-624. The use of chemicals to control weeds is described in TM 5-630.

42. Snow and Ice Removal

Snows heavy enough to obstruct railroad traffic or hinder train operation in yards or on running tracks can be expected in northern climates. Personnel, tools, and equipment (fig. 102) must be in readiness at all times during impending snow storms. Methods of removing snow with heavy equipment are described in TM 5-624.

a. Snow fences keep snow from drifting onto the roadbed in localities where heavy snow storms are frequent. Effective placement of snow fences can be assured by keeping records of locations where drifts have occurred during the winter season. Details of construction and erection are covered in TM 5-624.

b. Snow and ice must be removed promptly from switches, frogs, guardrails and flangeways at highway crossings. Snow-burning cans may be used to advantage. At switches where serious snow and ice conditions are expected over long periods, snow-melting pots or switch heaters are the most prac-

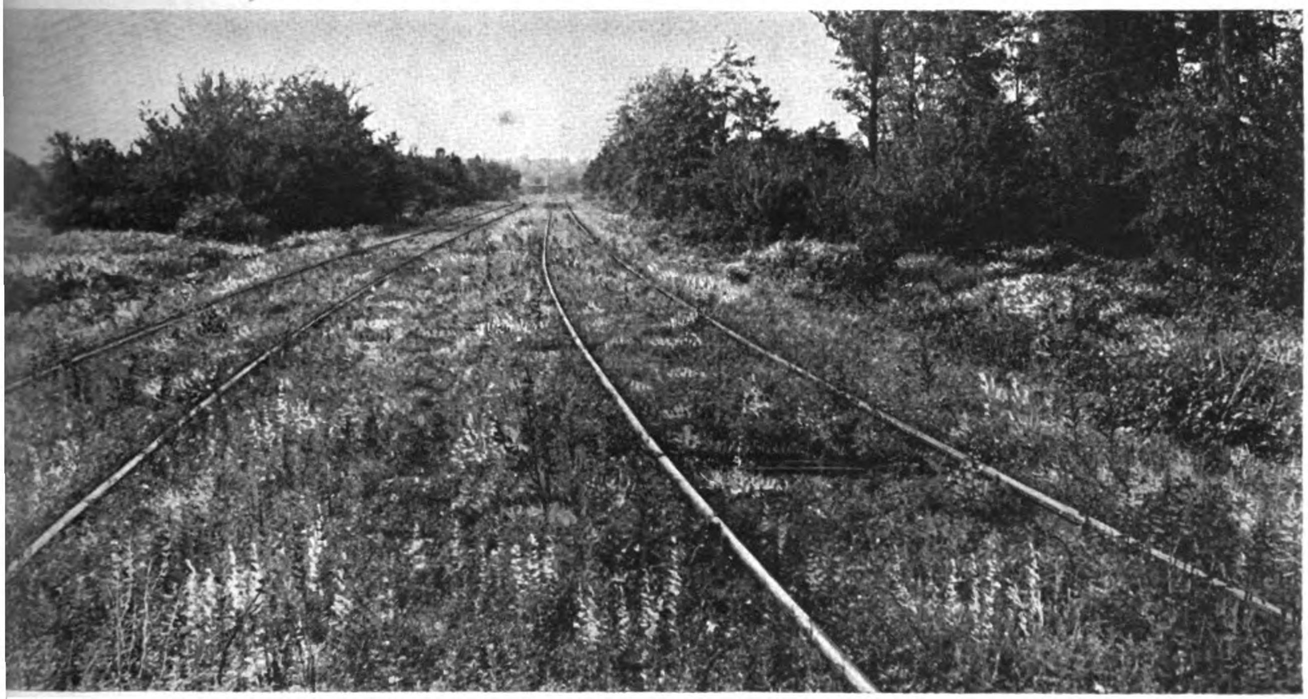


Figure 99. Excessive growth of weeds in track.

Figure 100. Effect of weeds on ties and ballast drainage.

Figure 101. Good control of weeds.

ticable method of control. Salt should not be used around switches.

c. Snow and ice must be removed promptly from loading platforms, track scales, turntables or transfer tables, and from any other places where personnel or property may be endangered.

d. During thaws, drainage channels are cut into ice or frozen ground to provide quick run-off of water. Drainage ditches are cleared if the free flow of water is hindered by ice or snow.

43. Roadway Clean-Up

During surfacing, lining, and gauging operations, all railroad signs, crossings, cattle guards, fences, etc., are given proper maintenance in the course of each working day. The ballast line is dressed to a stand-

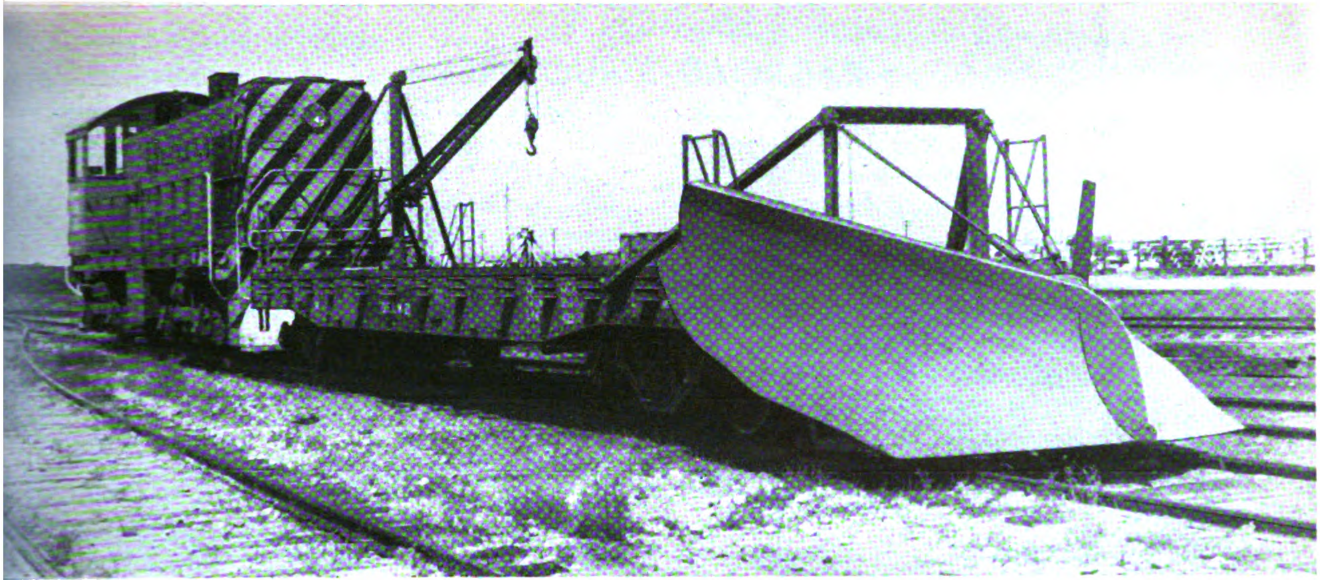


Figure 102. Snowplow.

rd and uniform section, shoulder line is clearly de-
ned, berms are cleaned or raked, and drainage
itches cleaned. All scrap metal is collected and taken to the designated storage place. Old ties unfit for further track use or for cribbing are collected and saved for firewood, or burned. (See fig. 103.)

Figure 103. Well-maintained roadway.

SECTION VI
RAILROAD STRUCTURES

44. Scope

Maintenance peculiar to railroad bridges, trestles, tunnels, and similar obstructions is discussed in this section. TM 5-624 covers highway bridges and trestles, and is to be used as a supplement to this material. New construction of railroads on through-truss or girder bridges, deck bridges and trestles is covered in TM 5-372, 5-373, 5-374, and 5-375, and TB 55-275-1 and 5-372-1.

45. General

The maintenance of railroad trackage over railroad structures, except ballasted deck bridges and culverts, is somewhat different from maintenance of trackage over ballasted roadbeds. Rails are held firmly to a predetermined line and grade by fastenings fixed to the deck of the structure. The deck of steel and timber bridges or trestles consists of bridge ties securely anchored to beams or floor stringers. (See fig. 104.) Rails across concrete bridges or culverts where the deck is not ballasted are anchored to the concrete deck or to sectional cross ties fastened to the deck. Inasmuch as the track is fixed to these structures, maintenance is confined to inspection, repair, or replacement of the following parts:

a. Rails. Rails are inspected and replaced immediately when they show evidence of any of the rail failures listed in paragraph 20.

b. Track Fastenings. Track fastenings inclu joint bars, track bolts, tie plates, spikes, and rail-an chor bolts. Maintenance of these items is discusse in paragraphs 17 through 28.

c. Bridge Ties. Bridge ties are inspected an replaced immediately when they show evidence o serious rotting, checks, horizontal or vertical split or other damage.

d. Anchor Bolts. Anchor bolts holding bridg ties to the structure are inspected carefully. Bol are kept tight, the threads oiled, and exposed par painted or otherwise protected against rust. All mis ing bolts are replaced immediately.

e. Bridge Guardrails. Guardrails are inspecte for clearance with running rails and condition o fastenings. Details of installation of bridge guard rails are covered in paragraph 11.

f. Bridge Members. Bridge members such a floor stringers beams, tie rods, rocker arms, expan sion shoes, etc., are inspected for condition and clean liness. All steel members are protected against rus or corrosion, and movable metal parts are well lubri cated. Concrete parts of the structure are protecte against erosion. Waterway areas are kept free o debris, and wing walls or abutments are kept we backfilled. Slopes of embankments are protecte against erosion.

Figure 104. Railroad timber trestle.

46. Ballast-Decked Bridges and Culverts

Maintenance of railroad tracks over ballast-decked structures is similar to maintenance of track over ballasted roadway. The ballast must be clean and deck drains kept in good condition to allow water to quickly drain off the track structure. Methods of maintaining track and accessory parts are covered in paragraphs 29 through 43. Rails evidencing any of the failures listed in paragraph 20 must be replaced immediately. The condition of the bridge or culvert also is inspected. Waterways are kept open and free of debris. Metal parts of the structure are protected against rust or corrosion; concrete or masonry is protected against erosion. (See figs. 105 through 108.)

47. Approaches to Structures

Track approaches to bridges, trestles, or culverts must be firmly embedded in the ballast and maintained to good line, surface, and gauge to lessen impact from moving trains as much as possible.

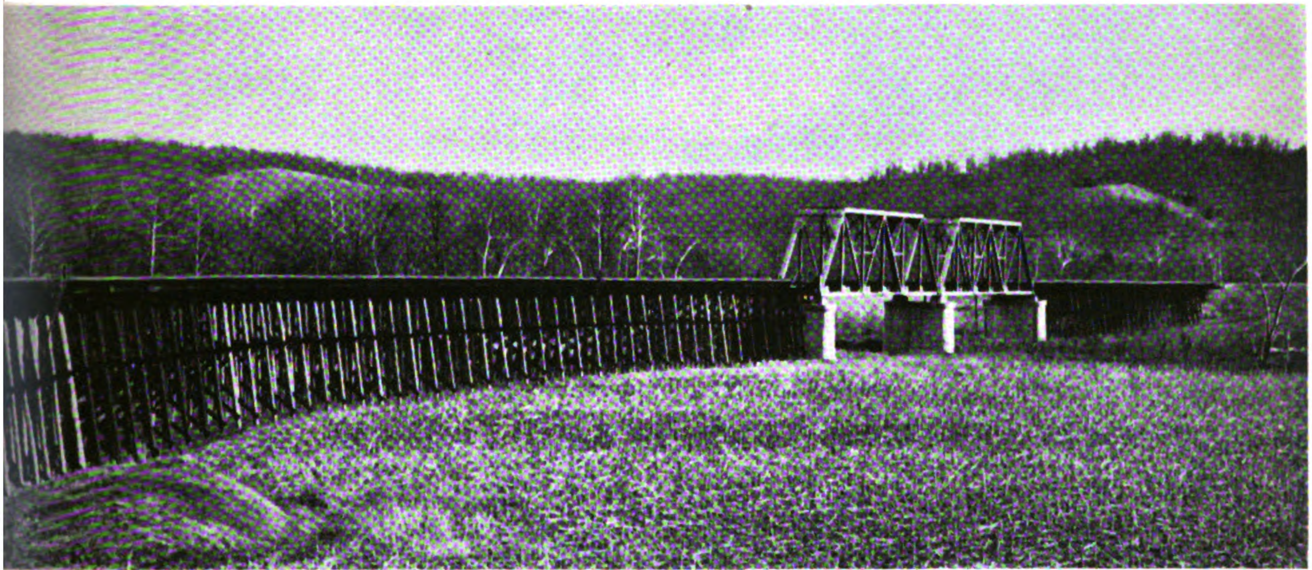


Figure 105. Timber-trestle and steel-truss bridge.

Figure 106. Open-deck bridge with concrete piers.

Figure 107. Concrete railroad culvert.

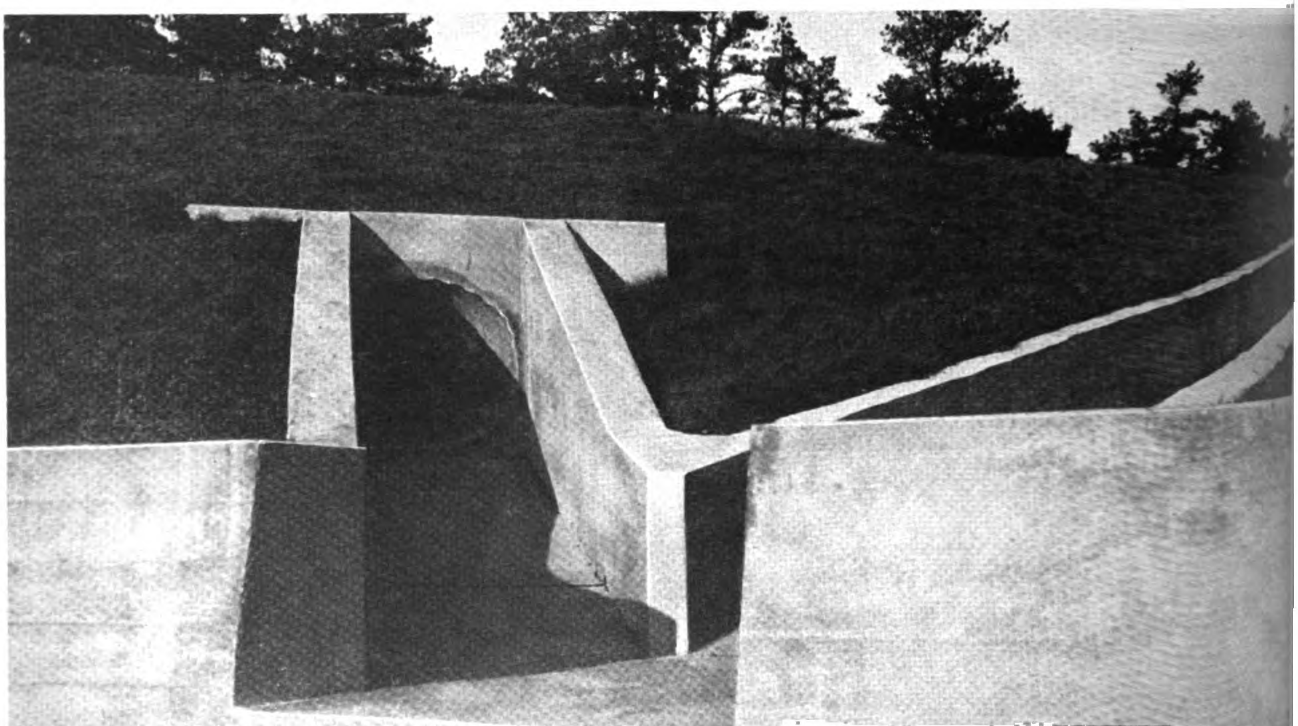


Figure 108. Railroad culvert and concrete flume.

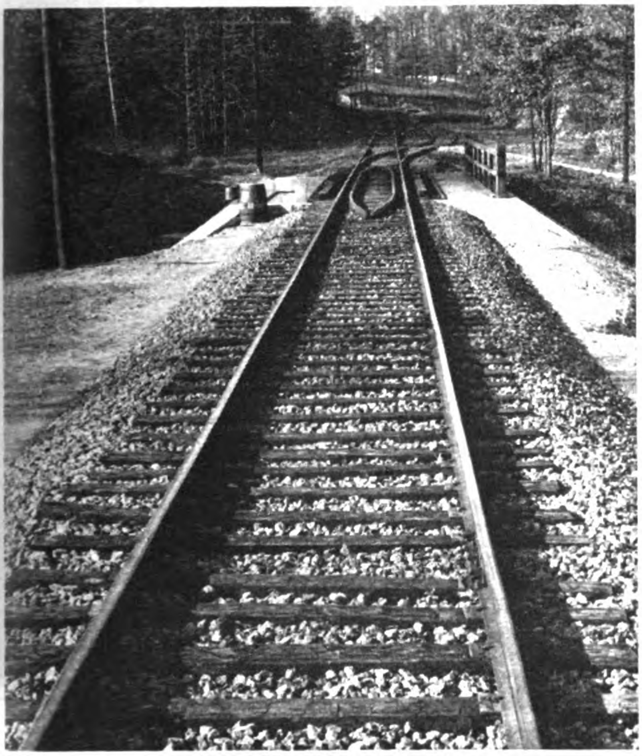


Figure 109. Well-maintained roadway on approach to structure.

48. Minimum Clearances at Structures

Minimum clearances detailed in figure 10 and specified in paragraph 7 are maintained at all times. Line or grade of track at structures cannot be changed without approval of higher authority.

49. Emergencies

When the condition of any structure is such that safe operation of trains at authorized speed is questionable, slow orders (par. 52) must be put into effect and warning signs erected far enough away in both directions to warn approaching trains of impending danger. If conditions are known to be serious, traffic must be stopped until necessary repairs can be made. The following conditions are considered to constitute emergencies requiring stoppage of traffic:

a. Rails in track structures or on their approaches show evidence of failure.

b. Bridge ties over open-deck structures unsafe to carry traffic.

c. Serious movement of track on ballast-decked structures where minimum clearance may be impaired, and on other structures where movement of track may be due to faulty anchoring of rails or bridge ties, or to movement of the structure itself.

d. Essential members of the structure badly deteriorated.

e. Abutments or approaches to the structure undermined.

f. Evidence of impending floods, high water, or ice jams upstream.

Caution: Any unusual condition or apparent failure at any and all structures must be reported to the proper authority for immediate action.

50. General

In many cases safety is the determining factor in deciding when and how track work should be done. Safety is the criterion by which to judge tools and materials, manner and extent of work to be performed, and type and usage of equipment. However, this does not mean that materials unsafe for certain operations, but usable in others, should be discarded.

51. Protection of Personnel

Work such as welding, cutting, chipping, etc., is dangerous to the operator and to nearby personnel. Such work must be done only by qualified personnel. In addition to actual skill in performance of the work, qualifications include knowledge of any impending danger, precautions to be taken, and procedures to be followed in case of accident.

52. Protection to Traffic

Whenever any track is in a condition unsafe for passage of trains at authorized speed, protection must be provided consistent with type of traffic, authorized speed, and seriousness of the condition.

a. TRACK OBSTRUCTIONS. Any track is regarded as unsafe for passage of trains at authorized speed when any of the following conditions exist:

(1) *During rail renewals.* (*a*) When spikes are withdrawn on one side of the track—

1. From more than every other tie on tangents.
2. From more than every third tie on curves up to 5°.
3. From more than every fifth tie on curves over 5°.

(*b*) If there is a space of more than 4 feet between spikes along either inside or outside line of spikes.

(*c*) When spikes are withdrawn from opposite ends of adjacent ties.

(*d*) When broken or defective rails are temporarily spliced and left in track.

(2) *During tie renewals.* (*a*) When two or more adjoining ties are removed.

(*b*) When four adjoining ties on tangents, three adjoining ties on curves up to 5°, or two adjoining ties on curves over 5° are not fully spiked and tamped on either side of any tie removed. This is based on the assumption that ties are spaced uniformly, as directed in paragraph 19.

(3) *During ballast renewal.* (*a*) When ballast has been removed or tracks have been raised, exposing more than three-fourths of the depth of the ties above the ballast for more than one rail length.

(*b*) Where newly distributed ballast extends more than 4 inches above the top of the rails.

(*c*) Where flangeways have not been provided along the gauge side of the rail.

(4) Where there is danger from slides, falling rock, or objects coming within less than the minimum clearances specified in figure 10 and paragraph 7.

(5) Where conditions at structures are considered unsafe. (See par. 48.)

b. METHODS OF PROTECTION. Depending on the seriousness of the condition, protection to traffic is as follows:

(1) *Stop signal.* Flagmen are stationed in both directions from the point of danger to stop trains at a safe distance. Flagmen display red flags during the day and red lanterns at night. If visibility is impaired by bad weather, fuses also are used. Trains proceed to the point of danger under flag protection.

Note. These instructions do not relieve the train crew of responsibility for flag protection.

(2) *Caution signal.* Until slow order can be established and proper signs erected, flagmen are stationed far enough away in both directions to warn approaching trains. Flagmen display yellow flags during the day, red lanterns at night.

(3) *Slow orders.* Whenever conditions are hazardous for the operation of trains at authorized speed, slow orders are established as follows:

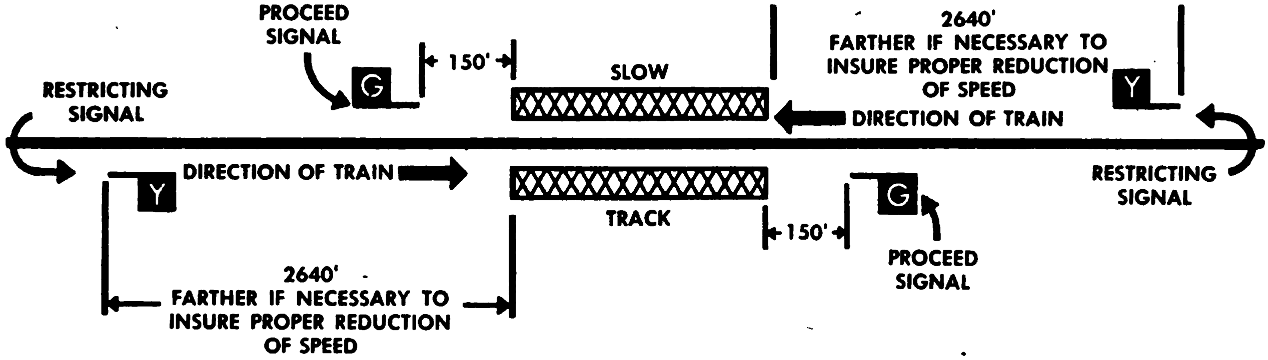
(*a*) A report giving the location and a description of the hazardous condition is made immediately to the authority responsible for train movements.

(*b*) Safe speed at the point of danger is determined and slow order signs clearly indicating the reduced speed are placed on all tracks in both directions from the danger point. (See fig. 110.)

53. Fire Protection of Structures

To provide the necessary fire protection:

a. Water barrels are placed at bridge ends of all frame structures, one barrel for the first 50 feet of



RESTRICTING SIGNAL: YELLOW SIGNAL BY DAY AND YELLOW LIGHT IN ADDITION BY NIGHT, ON THE ENGINEMAN'S SIDE OF TRACK, NOT LESS THAN 2640 FEET FROM POINT WHERE SLOW TRACK BEGINS

PROCEED SIGNAL: GREEN SIGNAL BY DAY AND A GREEN LIGHT IN ADDITION BY NIGHT 150 FEET FROM WHERE SLOW TRACK ENDS AND ON ENGINEMAN'S SIDE AS SEEN FROM A TRAIN APPROACHING TRACK TO BE PROTECTED

WHERE TWO OR MORE MAIN TRACKS ARE IN SERVICE, PROTECT EACH TRACK IN BOTH DIRECTIONS AS IF IT WERE SINGLE TRACK

Figure 110. Details for establishing slow order.

length and one additional barrel for each additional 150 feet.

b. Fire-retardant salts or fire-resistant paint is used on untreated timber on open decks. Dry sand, kept in watertight boxes, is effective in extinguishing small fires on creosote-treated bridges. Earth fills within long trestles, spaced at 400-foot intervals, act as effective fire barriers.

54. Track Charts

The use of track charts is encouraged for programming future work such as tie and rail renewals, tracks to be raised, curves and tangents to be lined and surfaced, weed burning, right-of-way clearing, etc. Track charts are also useful to the track forces for scheduling work and for indicating conditions that require more than the usual amount of maintenance.

a. Scale. Track charts are prepared to the most convenient scale to permit folding into a booklet 4 by 7 inches. If total main-track mileage is over 10 miles or 50,000 feet, the scale is either 2 inches to 1 mile or 2 inches to 5,000 feet. If total length is less than 10 miles, the scale is 4 inches to 1 mile or 1 inch to 1,000 feet.

b. Title Sheet When folded, the top sheet of the chart is the title sheet containing name and location of post, camp, or station, name of the serving railroad or railroads, scale used, and title block of the office preparing the chart.

c. Legend Sheet. The second sheet is the legend sheet. All symbols should conform to the symbols shown in figure 111.

d. Track Data Included. The remaining sheets indicate trackage and structures, including—

(1) Main lines or running tracks (indicated as reference lines).

(2) Cross-overs within main lines.

(3) Turn-outs from main lines.

(4) Sidings, spurs, ladder tracks, and yards.

(5) Buildings, bridges, trestles, culverts, and other structures.

(6) Highway and road crossings.

(7) Connections to serving railroad.

(8) Government or reservation property lines.

Note. Any important tracks leading from main or running tracks are made the basis for a separate chart, identified by name or number of the track and added as an extension to the main chart. (See dotted line between mile posts 4 and 5, fig. 111.)

e. Method of Representation. (1) In figure 111, the two main or running tracks are represented by two horizontal lines in the center of the chart. Where the double tracks change to single track, the two lines converge to a single line. The curvature of the tracks is represented by a series of arcs, and the tangents by straight lines at the bottom of the chart. The vertical lines running the full width of the sheet are the reference points, either mile posts or survey-station numbers (usually 1,000-foot stations). The number of the station or mile post is indicated in the circle at the top of the vertical line.

(2) A space 1½ inches wide is used for indicating the profile of the track. Elevation and grade are indicated as shown in figure 111.

55. String-Lining a Curve

a. Operation. The method described below consists of measuring the middle ordinate of an arc subtended by a chord of 62 feet. This measurement in inches denotes the degree of curve.

(1) Starting approximately 62 feet before the point of curve, 31-foot stations are measured along the gauge side of the high rail, marked with keel, and numbered successively; the starting point being sta 0, the first station being sta 1, the second sta 2, etc. The curve is divided in this way for its full length plus two full stations beyond the point of tangency. The numbering of these stations is marked on the rail and recorded in the first column of the field book.

(2) Beginning at sta 0, a string 62 feet in length is stretched between sta 0 and sta 2. The distance between the chord and the gauge point of the rail at sta 1 in eighths of an inch is recorded in the second column, opposite sta 1. The middle ordinate is measured and recorded in like manner at each of the 31-foot stations for the full length. The throw of the track at each station is calculated from the tabulation of the middle ordinates.

b. Calculation. The calculation of throw by the string-line method consists of rounding out the ordinate readings by borrowing from the high and lending to the low readings to provide a uniform curvature through the body of the curve and an easement or spiral from the tangent to the curve. Calculation of the final ordinates depends on a knowledge of algebra, good judgment, and experience in track-lining. Any number of combinations of throws with balanced results may be obtained. For this reason, the work should be delegated to a person with some engineering experience.

(1) The first step is to determine the points at beginning and end of the body of the curve by observation of the ordinate readings. The readings are

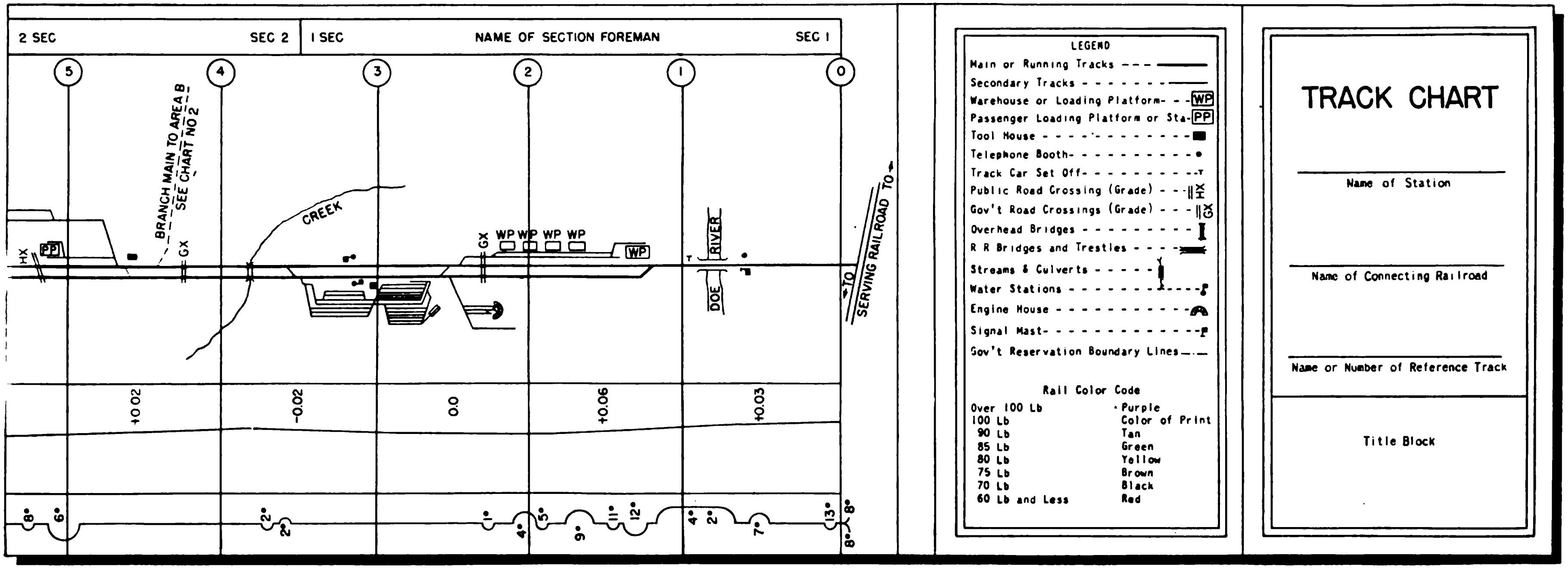
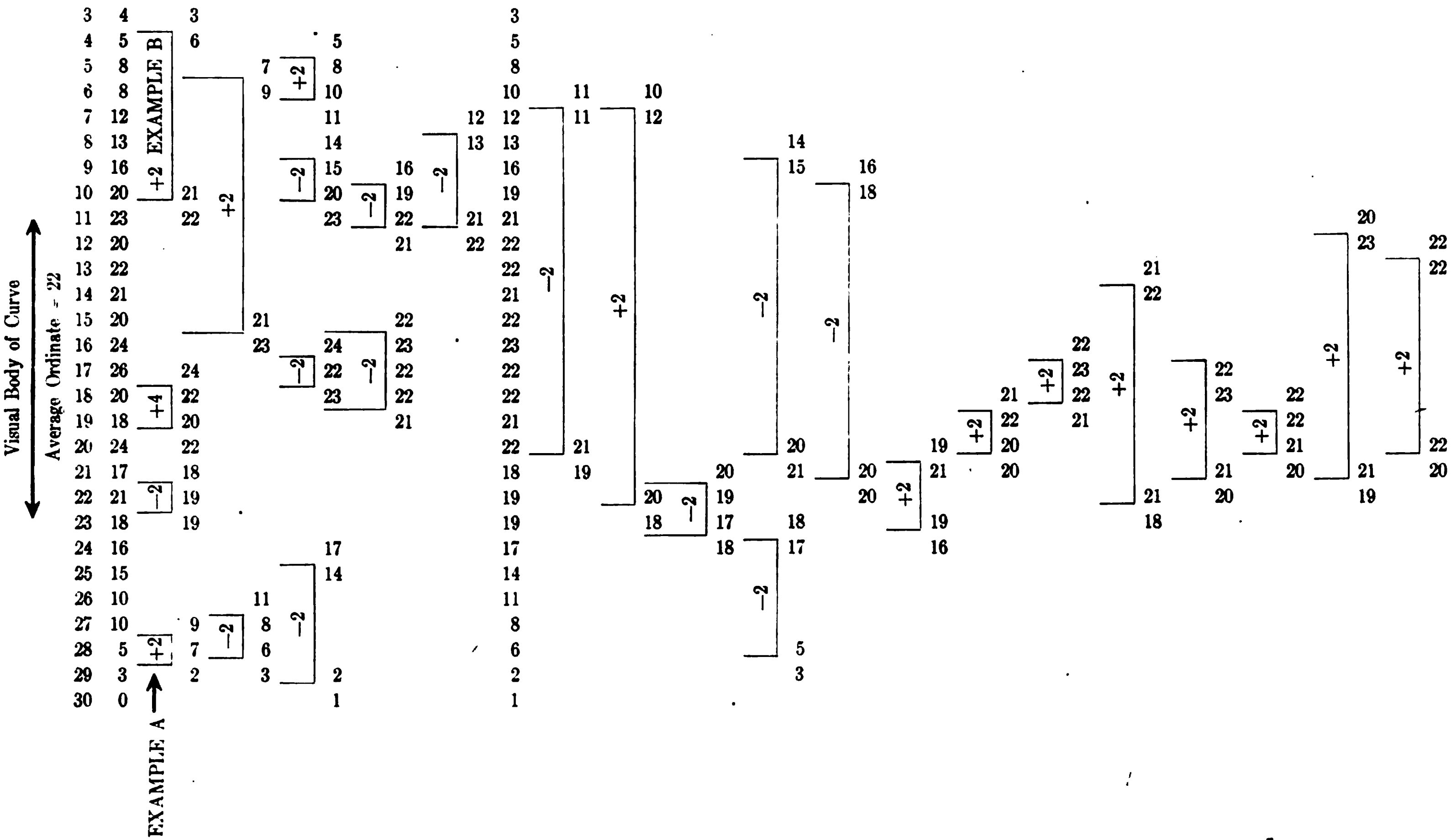


Figure 111. Track chart.

Estimated final ordinate	Station No.	Orig ⅛" ordinate	First trial reading	Final ordinates	Throw in ⅛"
0	1	0	0	0	0
2	2	1	1	1	0
4	3	4	3	3	0
6	4	5	5	5	+2
8	5	8	8	8	+4
10	6	8	10	10	+6
12	7	12	12	12	+4
14	8	13	13	14	+2
16	9	16	16	16	−2
18	10	20	19	18	−6
20	11	23	21	20	−6
22	12	20	22	22	0
	13	22	22	22	+2
	14	21	21	22	+4
	15	20	22	22	+4
	16	24	23	22	0
	17	26	22	22	0
	18	20	22	22	+8
	19	18	21	22	+12
	20	24	22	22	+8
22	21	17	18	20	+6
20	22	21	19	19	+2
18	23	18	19	18	0
16	24	16	17	16	−2
14	25	15	14	14	−4
12	26	10	11	11	−4
9	27	10	8	8	−6
6	28	5	6	5	−4
3	29	3	2	3	−2
0	30	0	1	1	0



Note. Amount of throw at each station is the algebraic sum of the plus or minus numbers under the bracket read across each station.
+ Throws indicate away from center of curve.
− Throws indicate toward center of curve.

averaged and an easement at both ends of the curve is estimated.

(2) The second step is to approximate the estimated readings of the easement and body of the curve by calculation of borrow and loan. The stations affected are included in brackets and the amount and algebraic sign of the throw indicated as shown in table VI.

(3) Where a bracket includes only one station, the full amount of the throw is given to that station; the two stations at the outside ends of the bracket are each affected by one-half the throw, opposite in sign (example A, table VI). At station 28, a throw of plus 2 is given the ordinate reading of 5, making it 7. Stations 27 and 29 are each affected by minus 1.

(4) Where a bracket includes two or more stations, the four stations at the ends of the bracket are affected. The stations at both inside and outside ends of the bracket are given half the throw. Inside stations take the same algebraic sign as the throw, outside stations take the opposite sign. (See example B, table VI.) A throw of +2 is given to stations 4 to 10, inclusive. Half the +2 throw is given to the end stations 4 and 10, increasing the ordinates by +1 each. The outside stations 3 and 11 are affected in the same amount, opposite in sign. The remaining stations in the bracket are not changed.

(5) This procedure is followed for all stations throughout the curve until final ordinates show a uniform increase to the body of the curve, uniform readings through the body of the curve, and a uniform decrease to the point of tangency.

(6) The final ordinates are then recorded and the final throw determined by taking the algebraic sum of all the throws included in the brackets across the line of each station. (See example C, table VI.) The total throw at station 10 is the sum of the following: +4, —2, —2, +2, —2, —2, +2, +2, +2, +2 = +6.

Tack is set at station 18 to give a throw of 6/8 inch.

Note. (—) throws indicate toward center of curve.
(+) throws indicate away from center of curve.

c. THROW. After the throw of track at each station has been calculated, the work is done by one of the following methods:

(1) *Method 1.* If the track to be lined is adjacent to another track for the full length of the curve, a scratch board is used. The scratch board consists of a board long enough to reach from the outside rail of the track to be lined to the nearest tie of the adjacent track. (See fig. 112.) One end of the board is notched to give variable lengths of 6 inches and make it suitable for variable track centers. The other end has a sharp metal point.

(*a*) As stations are marked off, the scratch board is used to scribe an arc on the nearest tie of the adjacent track. The number of the notch used (fig. 112) is recorded on the web of the rail.

(*b*) Surveyor's tacks are set on the marked tie according to throw calculated for that particular station. The tacks at plus throws are placed outward from the scratch; at minus throws, inward. The scratch board, set according to the notch number marked on rail and track, is thrown so point on scratch board coincides with tack previously set.

(*c*) The operation of lining the track follows as closely as possible the setting of the tacks.

(2) *Method 2.* On single track, or in multiple-track lay-outs where method 1 is not practicable, stakes are set at each of the stations. (See fig. 113.) After the amount and direction of the throw is calculated, the stakes are set between the ties and tacked so that *after* the track is thrown the inside base of the outer rail is 12 inches from the tack. The top of the driven stake should be at approximately the same level as the base of the rail. Stakes should be long enough to remain rigid while the track is being thrown.

Note. In lining track on curves, all work is done in relation to the outside rail.

56. Recommended Practices for Welding

Welding is useful in track maintenance for building up worn switch points (figs. 114 and 115), frog points and flanges (figs. 116 and 117) and for many other purposes. When using welding equipment, take the following precautions:

a. Use properly sized torch tip. If number of tip is not clear, check openings with cleaning drill.

b. Keep tips clean and free from carbon and slag.

c. Keep cleaning drills handy for use on tips.

d. Use a friction lighter to light the torch.

e. Do not use excessive pressures.

f. Close gas cylinder valves when torch is not in use.

g. Do not leave torches burning when not in use.

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

i. Use hose of correct diameter.

j. Use correct length of hose.

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

l. Check hose connections for leaks, using soap and water.

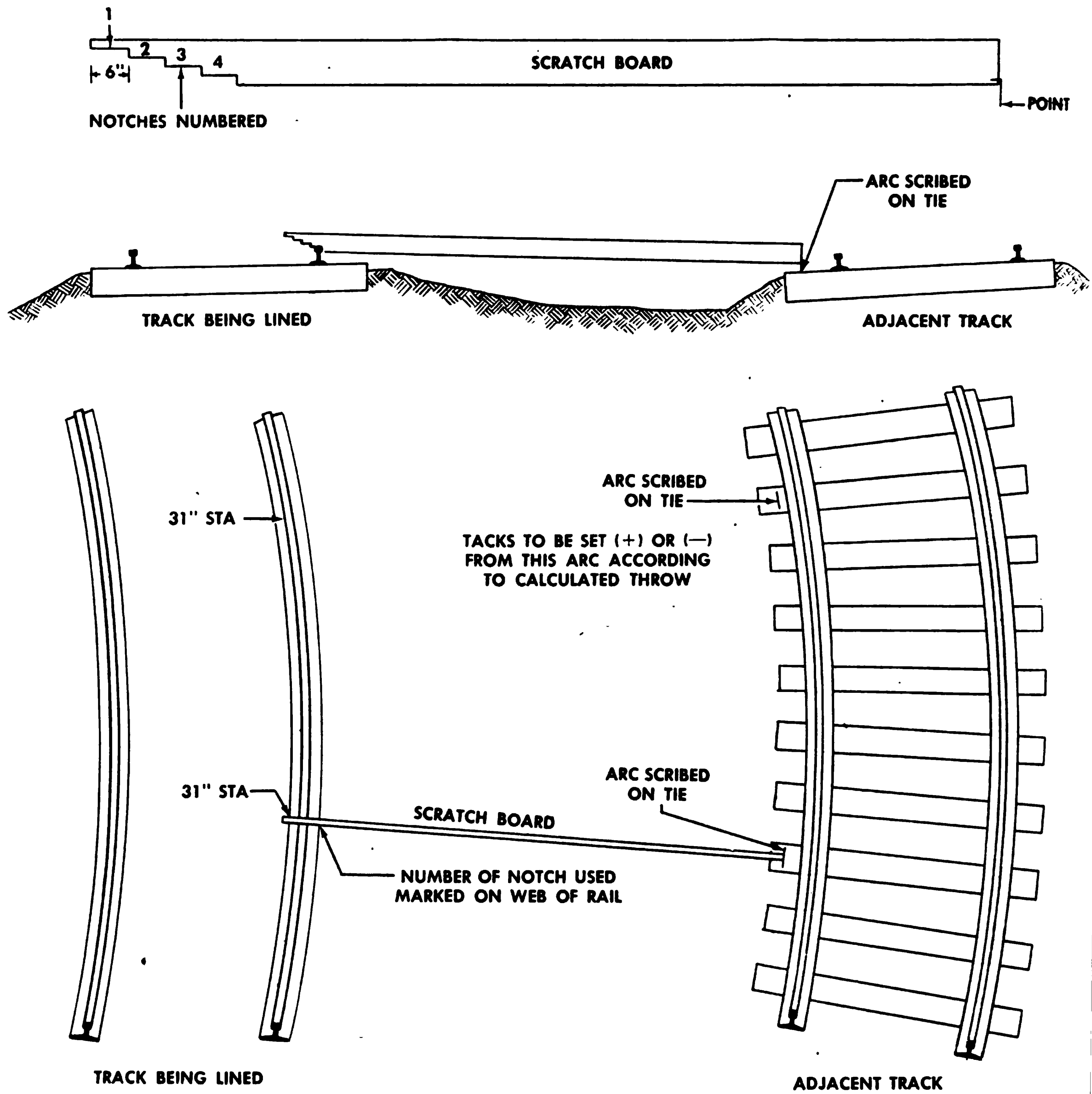


Figure 112. Use of scratch board for lining curves; multiple track.

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

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

o. See that operators wear goggles when using cutting or welding blowpipes.

p. In using portable equipment handle pressure gauges on regulators carefully to avoid damaging them.

57. Rail Expansion Allowance Formula

Use the following formula to calculate rail expansion:

$$E = 0.0000065\ DL$$

Where E = expansion in unit length (L).
L = unit length of rail.
D = difference in degrees F. from 100°.

58. Vertical Curves

Vertical curves are used for all changes in gradient. The formula for figuring vertical curves (fig. 118) is:

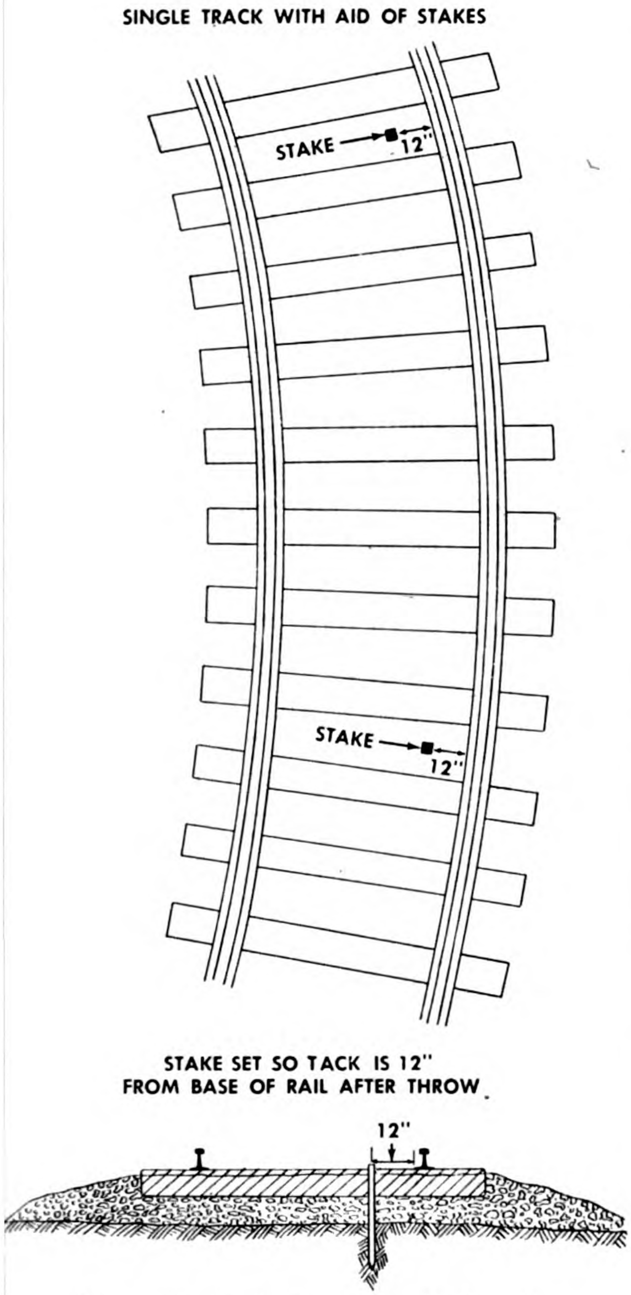


Figure 113. Setting line stakes; single track.

$$M = \frac{(\text{Elev. } B \times 2) - (\text{Elev } A + \text{Elev } C)}{4}$$

When vertical curve is concave downward.

$$M = \frac{(\text{Elev } A + \text{Elev } C) - (\text{Elev } B \times 2)}{4}$$

When vertical curve is concave upward.

L = Length of vertical curve.
R = Rate of change per station.
D = Algebraic sum of rates of grade.
M = Correction in elevation at B.
$L = \frac{D.}{R}$

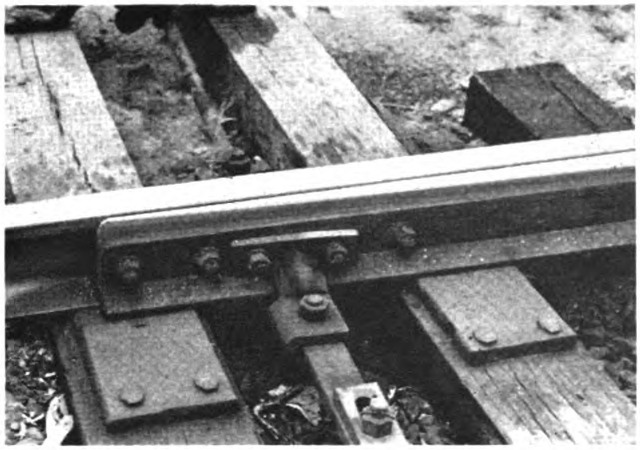


Figure 114. Badly worn switch point before welding.

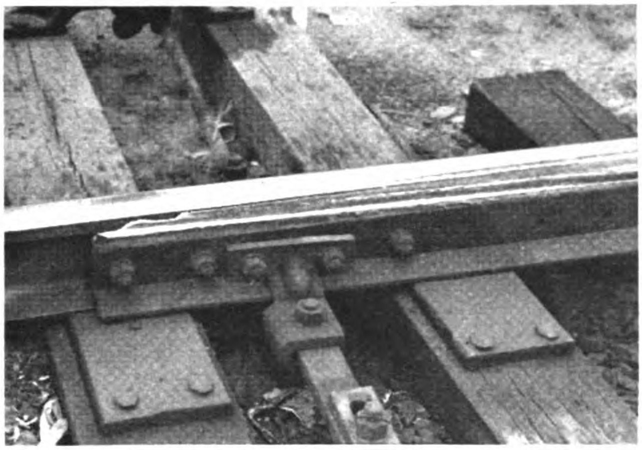


Figure 115. Switch point built up by welding.

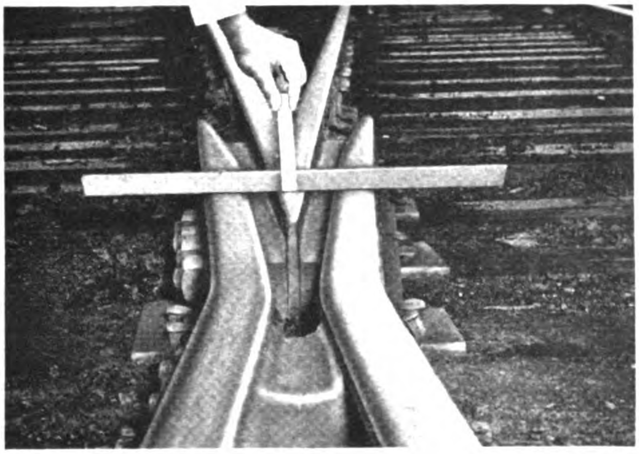


Figure 116. Frog point and flanges of badly worn frog before welding.

The correction for any other point on a vertical curve is proportional to the square of its distance from A to C or B to C.

Corrections are minus when the vertical curve is concave downward and plus when the vertical curve is concave upward.

Table VII. Turn-out and cross-over data for straight split switches

Point of switch to point intersection	Point of intersection to point opposite point of frog (1½")	Col 1 Frog number	Properties of switches: Col 2 Length of switch rail	Properties of switches: Col 3 Switch angle	Col 4 Actual lead	Closure distance: Col 5 Straight closure rail	Closure distance: Col 6 Curved closure rail	Lead curve: Col 7 Radius of center line	Lead curve: Col 8 Degree of curve	Gauge line offsets: Col 9	Gauge line offsets: Col 10	Gauge line offsets: Col 11	Gauge line offsets: Col 12	Gauge line offsets: Col 13	Gauge line offsets: Col 14	Col 15 Tangent adjacent to switch rail	Col 16 Tangent adjacent to toe of frog
			ft. in.	de mi sec	ft. in.	ft. in.	ft. in.	feet	de mi sec	ft. in.	ft. in.	ft. in.	inches	inches	ft. in.	feet	feet
		5	11 0	2 39 34	42 6½	28 0	28 4	177.80	32 39 56	18 0	25 0	32 0	11 13/16	20 5/8	2 8 7/8	0.00	0.78
		6	11 0	2 39 34	47 6	32 9	33 0	258.57	22 17 58	19 2¼	27 4½	35 6¾	12 3/8	21 5/8	2 10	0.00	1.75
		7	16 6	1 46 22	62 1	40 10½	41 1¼	365.59	15 43 16	26 2¼	35 10½	45 6¾	11 5/8	19 9/16	2 6 7/8	0.01	0.00
30-0	38-0	8	16 6	1 46 22	68 0	46 5	46 7½	487.28	11 46 44	27 7¼	38 8½	49 9¾	11 7/8	20 9/16	2 8 5/16	0.64	0.00
		9	16 6	1 46 22	72 3½	49 5	49 7¼	615.12	9 19 30	28 10¼	41 2½	53 6¾	12 5/16	21 3/8	2 9 7/16	0.00	0.17
		10	16 6	1 46 22	78 9	55 10	56 0	779.39	7 21 24	29 11¾	43 5½	56 11¼	12¼	21	2 8 5/8	2.08	0.00
		11	22 0	1 19 46	91 10¼	62 10¼	63 0	927.27	6 10 56	37 8½	53 5	69 1½	12¼	21 3/8	2 9¾	0.00	0.13
		12	22 0	1 19 46	96 8	66 10½	67 0	1,104.63	5 11 20	38 8½	55 5.	72 1½	12 7/16	21 5/8	2 9 7/8	0.00	0.50
		14	22 0	1 19 46	107 0¾	76 5¼	76 6¾	1,581.20	3 37 28	41 1¼	60 2½	79 3¾	12 7/8	22 5/16	2 10½	0.24	0.00
		15	30 0	0 58 30	126 4½	86 11½	87 0¾	1,720.77	3 19 48	51 9	73 6	95 3	12 1/8	21¼	2 9¾	1.56	0.00
		16	30 0	0 58 30	131 4	91 11	92 0	2,007.12	2 51 18	53 0	76 0	99 0	12 7/16	21 13/16	2 10 5/16	0.66	0.00
		18	30 0	0 58 30	140 11½	99 11	100 0	2,578.79	2 13 20	55 0	80 0	105 0	12¾	22 1/8	2 10 7/16	0.57	0.00
		20	30 0	0 58 30	151 11½	110 11	111 0	3,289.29	1 44 32	57 9	85 6	113 3	13 1/16	22 11/16	2 11 3/16	2 47	0.00

Col 1 Frog number	Properties of frogs: Col 17 Frog angle	Properties of frogs: Col 18 Over-all length	Properties of frogs: Col 19 Toe length	Properties of frogs: Col 20 Heel length	Properties of frogs: Col 21 Toe spread	Properties of frogs: Col 22 Heel spread	Date of cross-overs, 13' 0" track centers: Col 23 Straight track	Date of cross-overs, 13' 0" track centers: Col 24 Cross-over track	Date of cross-overs, for change of 1' 0" in track centers: Straight track	Date of cross-overs, for change of 1' 0" in track centers: Cross-over track
	de mi sec	ft. in.	ft. in.	ft. in.	inc's	inches	ft. in.	ft. in.	ft. in.	ft. in.
5	11 25 16	9 0	3 6½	5 5½	7 15/16	13 9/16	16 10 5/16	18 1 7/8	4 11 7/16	5 0 5/8
6	9 31 38	10 0	3 9	6 3	7	13	20 5½	21 6½	5 11½	6 0½
7	8 10 16	12 0	4 8½	7 3½	7 9/16	13	24 0 5/8	24 11 5/8	6 11 9/16	7 0 7/16
8	7 09 10	13 0	5 1	7 11	7 1/8	12 3/8	27 7 1/8	28 4 7/8	7 11 5/8	8 0 3/8
9	6 21 35	16 0	6 4½	9 7½	8	13 5/16	31 1 5/8	31 10 3/8	8 11 11/16	9 0 5/16
10	5 43 29	16 6	6 5	10 1	7 3/16	12 5/8	34 8 1/8	35 3 7/8	9 11 11/16	10 0 5/16
11	5 12 18	18 8½	7 0	11 8½	7 1/8	13¼	38 2½	38 9½	10 11¾	11 0¼
12	4 46 19	20 4	7 9½	12 6½	7 5/16	13 1/16	41 8¾	42 3¼	11 11¾	12 0¼
14	4 05 27	23 7	8 7½	14 11½	6 7/8	13 5/16	48 9¼	49 2 13/16	13 11 13/16	14 0¼
15	3 49 06	24 4½	9 5	14 11½	7	12 7/16	52 3 7/16	52 8 5/8	14 11 13/16	15 0 3/16
16	3 34 47	26 0	9 5	16 7	6 9/16	12 15/16	55 9 5/8	56 2½	15 11 13/16	16 0 3/16
18	3 10 56	29 3	11 0½	18 2½	6 7/8	12 5/8	62 9 7/8	63 2 3/16	17 11 13/16	18 0 3/16
20	2 51 51	30 10½	11 0½	19 10	6 1/8	12 3/8	69 10	70 2	19 11 7/8	20 0 1/8

NOTES

Recommended turn-outs and cross-overs. Data shown is computed for turn-outs out of straight standard 4-foot 8½-inch gauge track. If wheel base of equipment used requires wider gauge for switch alignment or curvature shown, maintain lead and alignment of curved closure rail and move inside stock and curved rails out the required amount. Increase gauge of straight track through switch, and bend the straight closure rail to true alignment ahead of toe of frog.

Frog designs. For short spring-rail type frogs, lengthen the straight closure to conform; for solid manganese frogs, lengthen the straight and curved closures.

For diagram of straight split switch keyed to columns of table, see figure 121.

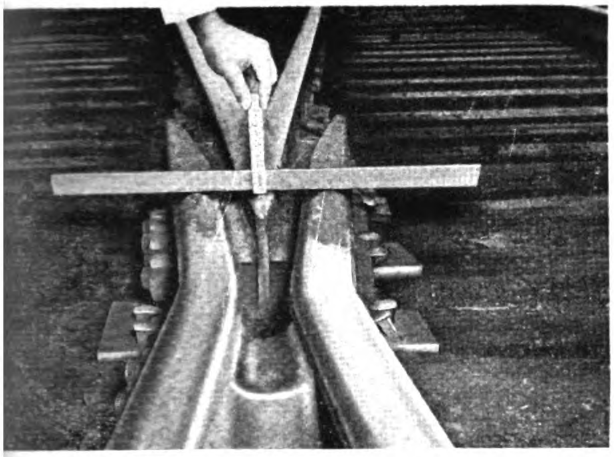


Figure 117. Frog point and flanges built up by welding.

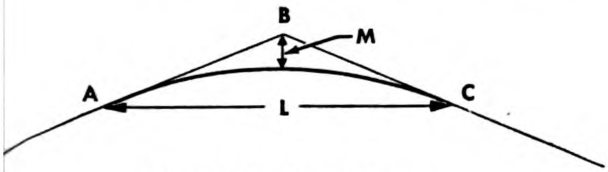


Figure 118. Vertical curve.

59. Miscellaneous Data

The figures and tables in this paragraph (figs. 119 through 129 and tables VII through XX) give miscellaneous data useful in track maintenance.

Table VIII. Track accessories required for installing one No. 8 turn-out

Joint bars	14 pair
Track bolts	64 each
Lock washers	64 each
Spikes	280 each
Tie plates	100 each
Lead rails (8 lengths)	264 linear feet

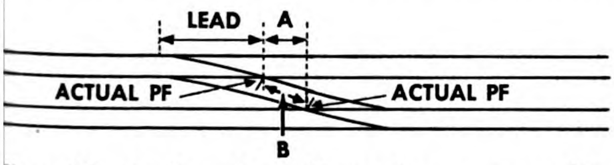


Figure 122. Leads and coordinates for crossovers (See table XI for dimensions.)

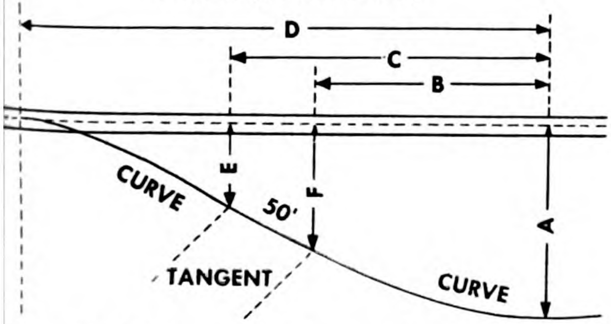
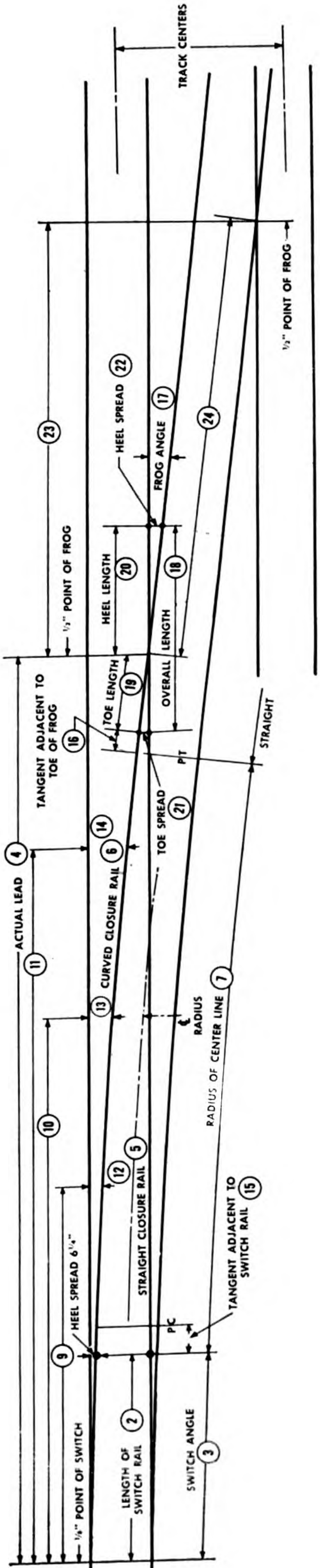


Figure 123. Diagram for laying temporary tracks around wrecks and wash-outs. (See table XII for dimensions.)



NO 8 CROSSOVERS	
TRACK CENTERS	LENGTH
13'	163.69
14'	171.56
15'	179.53
40' (12° REVERSE CURVE)	294.25
65' (12° REVERSE CURVE)	371.01
65' (10° REVERSE CURVE)	382.00

Figure 121. Straight split switch. (See table VII for dimensions.)

Table IX. Rail accessories for 1,000 feet of track

Weight of rail		Ties (No.)		Joint[1] bars		Bolts (sq nuts) 4 per joint		Lock washers		Spikes[2] (4 per tie)				Ballast 15% shrinkage allowed 6" deep	Tie[3] plates
										16 ties per 33' rail		18 ties per 33' rail			
Wt per yd lb)	Wt (long tons)	16 per 33' rail	18 per 33' rail	No. of pairs	Wt (net tons)	Kegs	Wt (net tons)	No.	Wt (net tons)	Kegs	Wt (net tons)	Kegs	Wt (net tons)	Cu yd	Wt (net tons)
75	22.32	484.85	545.45	60.61	1.303	1.636	.1636	242.42	.0202	5.877	.5877	6.612	.6612	391.10	.4735
80	23:81	484.85	545.45	60.61	1 303	1.746	.1746	242.42	.0202	5.877	.5877	6.612	.6612	391.10	.4735
85	25.30	484.85	545.45	60.61	1.636	1.746	.1746	242.42	.0202	5.877	.5877	6.612	.6612	391.10	.4735
90	26.79	484.85	545.45	60.61	1.636	2.089	.2089[4]	242.42	.0219	5.877	.5877	6.612	.6612	391.10	.7064
100	29.76	484.85	545.45	60.61	1.939	2.089	.2089[4]	242.42	.0219	5.877	.5877	6.612	.6612	391.10	.7860

[1]No allowance made for shorts.
[2]Additional spikes needed on curves (2 per tie).
[3]Tie plates estimated for use only on 12 percent of track.
[4]Hexagonal nuts.

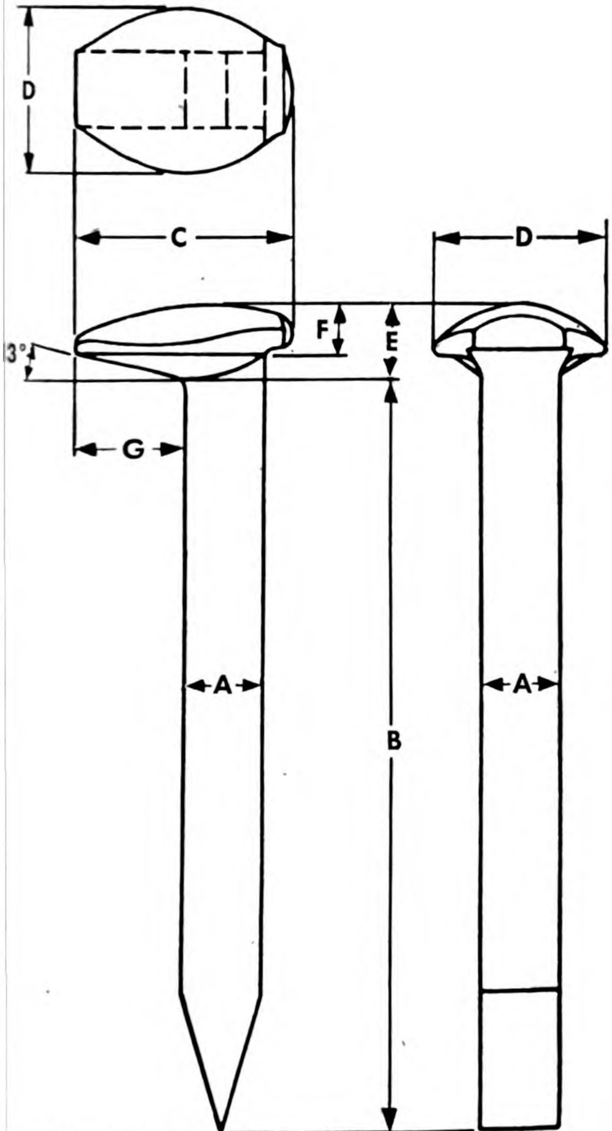
Corrections in track materials to be made for each turn-out

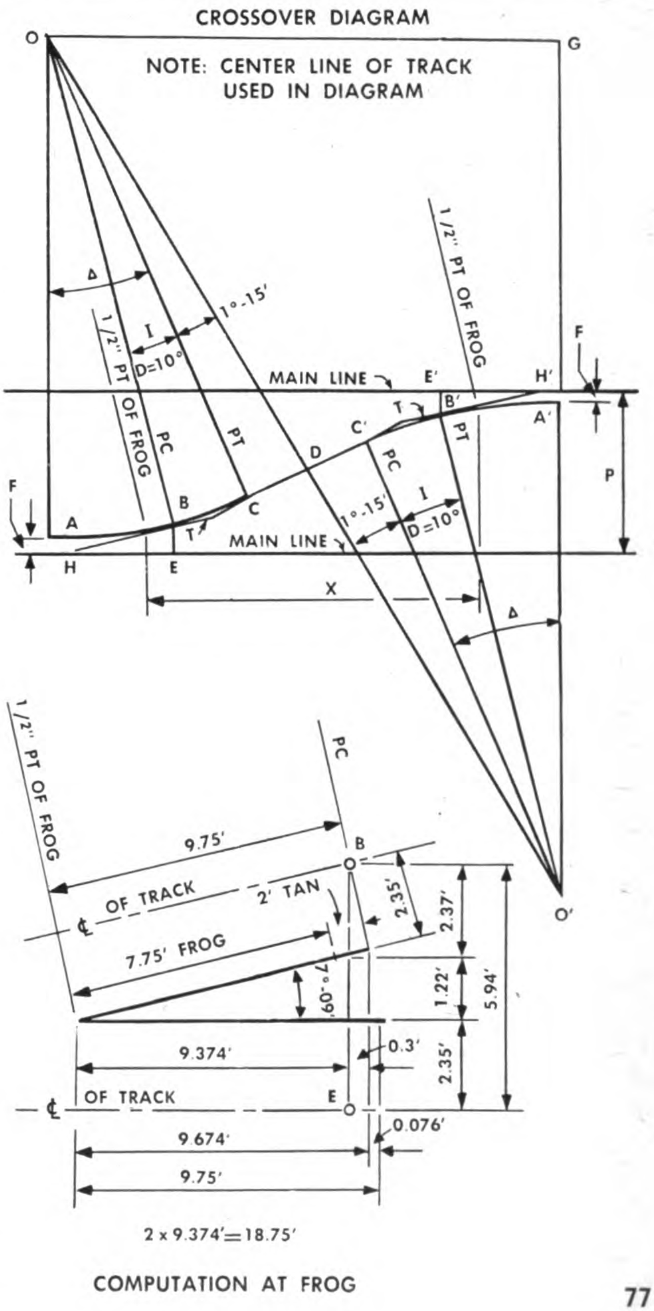
1. Measure track to switch point.
2. On standard turn-out, add 59 feet of track or 118 feet of rail.
3. Deduct 95 cross.
4. Add 7 pairs of joint bars.
5. Add 28 track bolts.
6. Add 28 lock washers.
7. Add 1/3 keg of spikes.
8. Standard turn-out plan shows D-bars for joints in turn-outs. When angle bars can be used, it is preferable to use them.
9. Add 136 tie plates.
10. Measurement of standard track begins at end of switch ties (87 feet from PS).

Table X. Size and weight of rail accessories

Weight of rail (lb)	Joint bars		Bolts (square nuts)			Lock washers ½" wide ¼" thick		Spikes
	Length (4 hole) (in.)	Weight per pair (lb)	Size (in.)	Average No. in 200-lb keg	Weight each (lb)	Size (in.)	Weight each (lb)	Sizes 9/16" x 5 1/2"
75	24	43	⅞ x 4	148	1.35	1 I.D.[2] 2 O.D.[3]	0.16705	Weight each 0.5882 lb.
80	24	43	⅞ x 4½	139	1.44	1 I.D.[2] 2 O.D.[3]	0.16705	
85	24	54	⅞ x 4½	139	1.44	1 I.D.[2] 2 O.D.[3]	0.16705	Average number per 200-lb. keg=340
90	24	54	1 x 4¾	116	1.724[1]	1⅛ I.D.[2] 2⅛ O.D.[3]	0.18097	
100	24	64	1 x 4¾	116	1.724[1]	1⅛ I.D.[2] 2⅛ O.D.[3]	0.18097	

[1]Hexagonal nuts.
[2]I.D.—Inside dimension.
[3]O.D.—Outside dimension.





igure 125. Standard railroad spikes. (See table XIV for dimensions.)

gure 124. Curve details for standard No. 8 cross-over. (See table XIII for dimensions.) ⟶

Table XI. Table of leads and coordinates for cross-overs

Frog No.	Leads	Frog angles	Distance between track centers 12′ A	12′ B	13′ A	13′ B	14′ A	14′ B	15′ A	15′ B	18′ A	18′ B	20′ A	20′ B
5	42′ 6″	11° 25′	11′ 10¾″	13′ 1¼″	16′ 10¼″	18′ 1¾″	21′ 9¾″	23′ 2½″	26′ 9″	28′ 3″	41′ 7¼″	43′ 5″	51′ 6″	53′ 6″
6	47′ 6″	9° 32′	14′ 6″	15′ 6″	20′ 5½″	21′ 6½″	26′ 5″	27′ 7″	32′ 4½″	33′ 7½″	50′ 3″	51′ 9″	62′ 2″	63′ 10″
7	62′ 1″	8° 10′	17′ 1″	17′ 11″	24′ 0½″	24′ 11¾″	31′ 0″	32′ 0″	37′ 11¾″	39′ 0½″	58′ 10¼″	60′ 2″	72′ 9½″	74′ 2¾″
8	68′ 0″	7° 09′	19′ 7½″	20′ 4½″	27′ 7″	28′ 5″	35′ 6¾″	36′ 5¼″	43′ 6½″	44′ 5¾″	67′ 5¼″	68′ 6¾″	83′ 4½″	84′ 7½″
9	72′ 3″	6° 22′	22′ 2″	22′ 10″	31′ 1¾″	31′ 10½″	40′ 1½″	40′ 10¾″	49′ 1″	49′ 11″	76′ 0″	77′ 0″	93′ 11½″	95′ 0½″
10	78′ 9″	5° 43′	24′ 8¼″	25′ 3¾″	34′ 8″	35′ 4″	44′ 8″	45′ 4¼″	54′ 7½″	55′ 4½″	84′ 6½″	85′ 5½″	104′ 6¼″	105′ 6″
12	96′ 8″	4° 46′	29′ 9″	30′ 3″	41′ 8¾″	42′ 3¼″	53′ 8½″	54′ 3½″	65′ 8¼″	66′ 3¾″	101′ 7½″	102′ 4½″	125′ 7″	126′ 5″
14	107′ 1″	4° 05′	34′ 9½″	35′ 2½″	48′ 9¼″	49′ 2¾″	62′ 9″	63′ 3″	76′ 9″	77′ 3¼″	118′ 8¼″	119′ 4″	146′ 8″	147′ 4½″
15	126′ 4″	3° 49′	37′ 3¼″	37′ 8½″	52′ 3½″	52′ 8½″	67′ 3¼″	67′ 8¾″	82′ 3″	82′ 9″	127′ 2½″	127′ 9¾″	157′ 2″	157′ 10″
16	131′ 4″	3° 35′	39′ 9½″	40′ 2¼″	55′ 9¾″	56′ 2½″	71′ 9½″	72′ 2¾″	87′ 9¼″	88′ 3″	135′ 8¾″	136′ 3½″	167′ 8¼″	168′ 3¾″
18	140′ 11″	3° 11′	44′ 10″	45′ 2″	62′ 10″	63′ 2¼″	80′ 9¾″	81′ 2½″	98′ 9½″	99′ 2½″	152′ 9″	153′ 3″	188′ 8½″	189′ 3½″
20	151′ 11″	2° 52′	49′ 10″	50′ 1¾″	69′ 10″	70′ 2″	89′ 10″	90′ 2″	109′ 9¾″	110′ 2¼″	169′ 9½″	170′ 2¾″	209′ 9″	210′ 3″

Note: See figure 122 for sketch and key.

Table XII. Tables for laying temporary tracks arou wrecks and wash-outs

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

All dimensions in feet.

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

All dimensions in feet.

Note. See figure 123 for sketch and key.

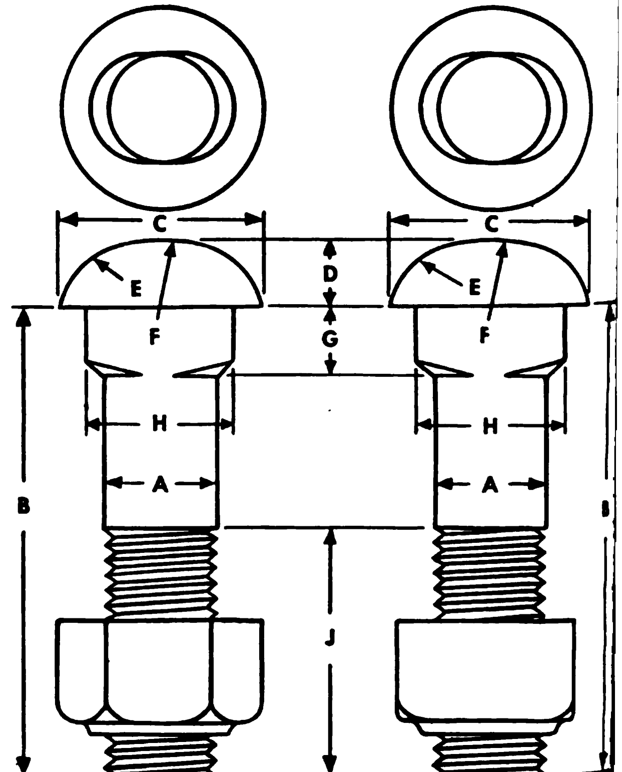


Figure 126. Standard track bolts. (See table XV for dimensions.)

Table XIII. Dimensions of standard No. 8 cross-over

Dimensions are between parallel tracks, at P distance apart, using 10° curves and 25′ tangent between frogs. (See fig. 124.)

$R = 573.69$; Frog angle $= 7°\ 09'$; CC' (tangent) $= 25.00$;

$OD = O'D = \sqrt{R^2 + 125^2} = 573.83$

Continue curve I to tangent parallel to main track.

Then $F = BE - 573.69$ versine $7°\ 09' = 1.48'$.

$O'G = 2R - P + 2F = 1{,}150.34 - P$

$\Delta = \cos^{-1} \dfrac{1150.34 - P}{1147.66} - 1°15'$

$I = \Delta - 7°09'$ $\quad T = R \tan \frac{1}{2} I$

X = Distance between actual points of frogs = $(2T + 25) \cos \Delta + 2T \cos 7°\ 09' + 18.75$.

P	X	I	P	X	I
30	124.75	4° 07′	51	205.35	8° 17′
31	129.21	4° 21′	52	208.67	8° 27′
32	133.60	4° 35′	53	211.95	8° 38′
33	137.90	4° 48′	54	215.20	8° 48′
34	142.12	5° 01′	55	218.42	8° 58′
35	146.28	5° 14′	56	221.60	9° 08′
36	150.37	5° 26′	57	224.74	9° 18′
37	154.40	5° 39′	58	227.87	9° 28′
38	158.37	5° 51′	59	230.96	9° 37′
39	162.28	6° 03′	60	234.01	9° 47′
40	166.13	6° 15′	61	237.04	9° 56′
41	169.93	6° 27′	62	240.04	10° 06′
42	173.68	6° 38′	63	243.02	10° 15′
43	177.37	6° 50′	64	245.97	10° 25′
44	181.03	7° 01′	65	248.89	10° 34′
45	184.62	7° 12′	66	251.78	10° 43′
46	188.18	7° 23′	67	254.66	10° 52′
47	191.70	7° 34′	68	257.51	11° 01′
48	195.17	7° 45′	69	260.33	11° 10′
49	198.60	7° 56′	70	263.13	11° 19′
50	201.99	8° 06′			

Table XIV. Weights and dimensions of standard railroad spikes

Size of spike	Length	Head					Length of taper of point	Approx. No. per 200-lb keg	Kegs per mile of single track	Rails used, weight per yard
		Length	Width	Thickness	Thickness of heel	Length of hook				
A	B	C	D	E	F	G				
Inch	Inch	Inch	Inch	Inch	Inch	Inch	Inch		No.	Lb.
5/16	2	13/16	3/4	5/16	7/32	7/16	1/2	2,480	4.2	12 to 16
5/16	2 1/2	13/16	3/4	5/16	7/32	7/16	1/2	2,117	4.5	12 to 16
3/8	2 1/2	1 1/16	7/8	3/8	1/4	9/16	5/8	1,420	7.1	12 to 16
3/8	3	1 1/16	7/8	3/8	1/4	9/16	5/8	1,267	7.9	12 to 16
3/8	3 1/2	1 1/16	7/8	3/8	1/4	9/16	5/8	1,012	10.2	12 to 16
7/16	3 1/2	1 3/16	1	7/16	5/16	5/8	3/4	860	12.1	16 to 20
7/16	4	1 3/16	1	7/16	5/16	5/8	3/4	704	15.2	16 to 20
7/16	4 1/2	1 3/16	1	7/16	5/16	5/8	3/4	653	15.6	20 to 30
1/2	3 1/2	1 5/16	1 1/8	1/2	5/16	11/16	7/8	624	17.9	20 to 30
1/2	4	1 5/16	1 1/8	1/2	5/16	11/16	7/8	550	18.0	20 to 30
1/2	4 1/2	1 5/16	1 1/8	1/2	5/16	11/16	7/8	504	20.0	30 to 40
1/2	5	1 5/16	1 1/8	1/2	5/16	11/16	7/8	472	21.6	30 to 40
9/16	4 1/2	1 1/2	1 1/4	9/16	5/32	3/4	1 1/8	408	25.8	40 to 50
9/16	5	1 1/2	1 1/4	9/16	5/32	3/4	1 1/8	365	32.6	50 to 60
9/16	5 1/2	1 1/2	1 1/4	9/16	5/32	3/4	1 1/8	330	37.1	60 to 100
5/8	5	1 9/16	1 5/16	21/32	7/32	3/4	1 1/4	288	38.4	85 to 100
5/8	5 1/2	1 9/16	1 5/16	21/32	7/32	3/4	1 1/4	272	42.7	85 to 130
5/8	6	1 9/16	1 5/16	21/32	7/32	3/4	1 1/4	242	47.6	85 to 130

Number of spikes in this table based on tie spacing of 24 inches for rails up to and including 45 pounds and 22 inches for rails 50 pounds and heavier

Note. See figure 125 for sketch and key.

Table XV. *Weights and dimensions of standard track bolts*

For rails 12 to 100 pounds per yard

Dimensions (in.): Diameter	Length	Head				Shoulder		Length thread	Nuts		With square nuts			With hexagon nuts			Rail used on
A	B	C	D	E	F	G	H	J	Thickness	Short diameter of square and hexagon	Weight, pounds per 100	Number in 200-lb keg	Number of kegs per mile of track	Weight, pounds per 100	Number in 200-lb keg	Number of kegs per mile of track	Weight pounds per yard
1/2	1 3/4	15/16	5/16	9/32	15/16	5/16	11/16	1 1/8	1/2	7/8	22.0	909	1.6	20.3	986	1.5	12 to 20
1/2	2	15/16	5/16	9/32	15/16	5/16	11/16	1 1/8	1/2	7/8	22.7	881	1.7	21.7	923	1.6	12 to 20
1/2	2 1/4	15/16	5/16	9/32	15/16	5/16	11/16	1 1/8	1/2	7/8	24.0	834	1.8	22.9	874	1.7	12 to 20
5/8	2 3/4	1 1/8	13/32	3/8	1 1/8	3/8	7/8	1 1/4	5/8	1 1/16	44.5	448	3.2	43.0	466	3.1	25 to 35
5/8	3	1 1/8	13/32	3/8	1 1/8	3/8	7/8	1 1/4	5/8	1 1/16	47.3	439	3.3	45.5	440	3.3	25 to 35
3/4	3	1 3/8	17/32	1/2	1 3/8	1/2	1	1 3/4	3/4	1 1/4	73.5	273	5.3	70.0	286	5.0	40 to 45
3/4	3 1/4	1 3/8	17/32	1/2	1 3/8	1/2	1	1 3/4	3/4	1 1/4	76.0	264	5.0	72.3	277	4.8	50 to 75
3/4	3 1/2	1 3/8	17/32	1/2	1 3/8	1/2	1	1 3/4	3/4	1 1/4	80.3	249	5.3	76.0	264	5.0	50 to 75
3/4	3 3/4	1 3/8	17/32	1/2	1 3/8	1/2	1	1 3/4	3/4	1 1/4	83.7	239	5.5	79.1	252	5.2	50 to 75
3/4	4	1 3/8	17/32	1/2	1 3/8	1/2	1	1 3/4	3/4	1 1/4	86.9	231	5.7	81.9	245	5.4	50 to 75
7/8	4	1 9/16	19/32	9/16	1 9/16	9/16	1 3/16	2	7/8	1 7/16	124.1	162	8.0	118.5	169	7.7	75 to 85
7/8	4 1/4	1 9/16	19/32	9/16	1 9/16	9/16	1 3/16	2	7/8	1 7/16	129.4	155	8.4	122.2	164	8.0	75 to 85
1	4 1/2	1 23/32	5/8	19/32	1 23/32	5/8	1 5/16	2 1/4	1	1 5/8	175.0	115	11.3	166.3	121	10.8	90 to 100
1	4 3/4	1 23/32	5/8	19/32	1 23/32	5/8	1 5/16	2 1/4	1	1 5/8	182.5	109	12.0	174.4	115	11.3	90 to 100

Note: See figure 126 for sketch and key.

Table XVI. Spiral lengths on curves for various elevations and train speeds

Elevation (in.)	Spiral length (ft) for train speeds (mph)													Elevation (in.)
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1		18	23	29	35	41	47	53	59	64	70	76	82	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

Table XVII. Middle ordinates for curving rails

Degree of curve	Length of rails in feet		
	30	33	39
	(in.)	(in.)	(in.)
6°	1⅜	1¾	2⅜
7°	1⅝	2	2¾
8°	1⅞	2¼	3⅛
9°	2⅛	2½	3⅝
10°	2⅜	2⅞	4
11°	2⅝	3⅛	4⅜
12°	2⅞	3⅜	4¾
13°	3	3¾	5⅛
14°	3¼	4	5½
15°	3½	4¼	6

Note. Curve rails as above, which gives middle ordinate of a curved rail. Stretch a line from end of rail on inside of curvature. Distance from edge of rail to line at exact center of rail is middle ordinate. Ordinates at quarters are three-fourths of middle ordinate.

Table XVIII. Drainage table for waterway areas

Square miles area drained	Acres	Waterway area required (sq ft)	Square miles area drained	Acres	Waterway area required (sq ft)	Square miles area drained	Waterway area required (sq ft)
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	1,180
.04	25.6	7.5	.70	448	81	40	1,350
.05	32.0	9	.75	480	85	50	1,510
.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		

Table XIX. 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″

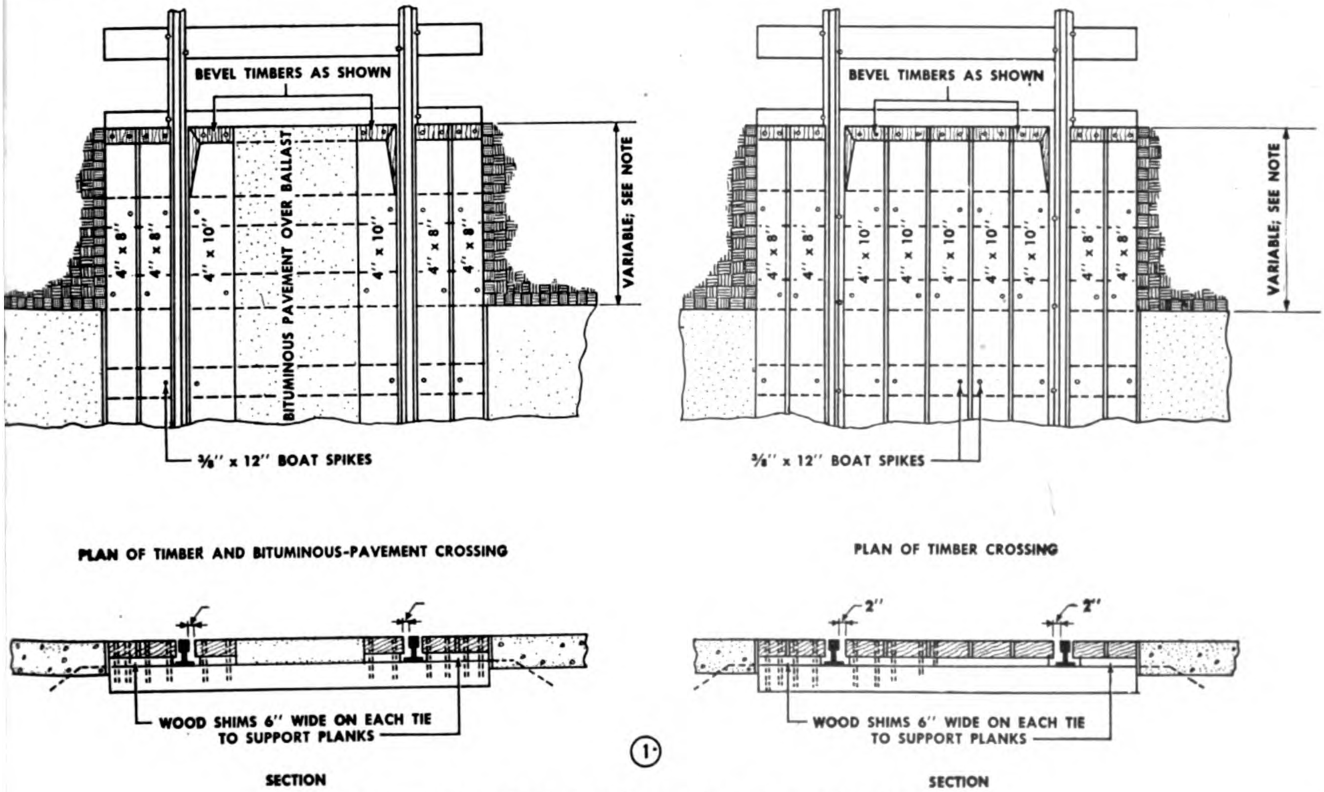


Figure 128. Typical grade-crossing construction details.

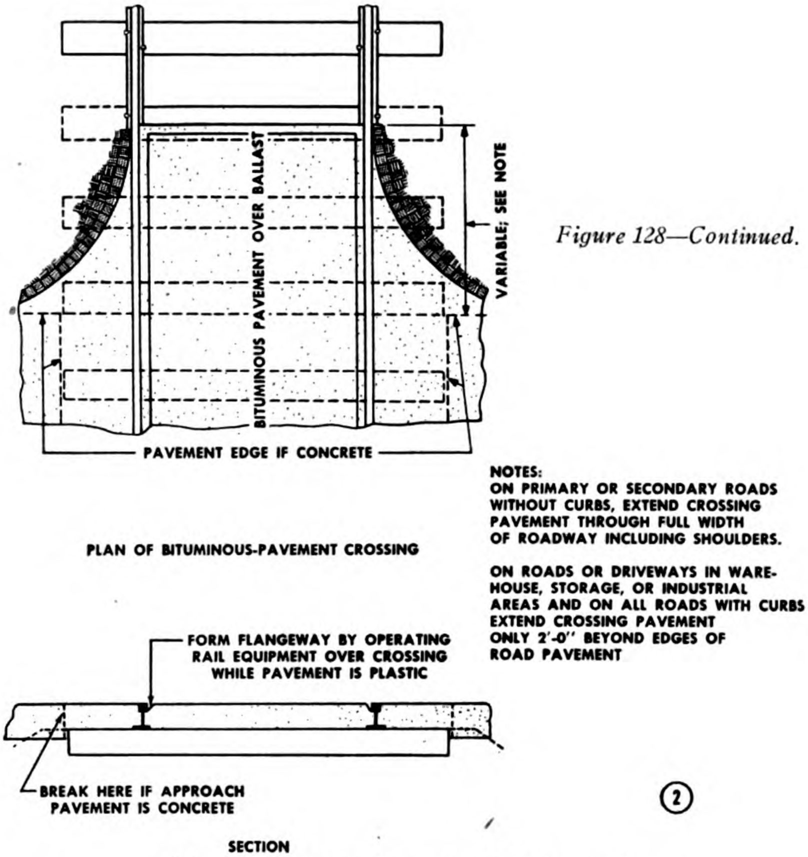
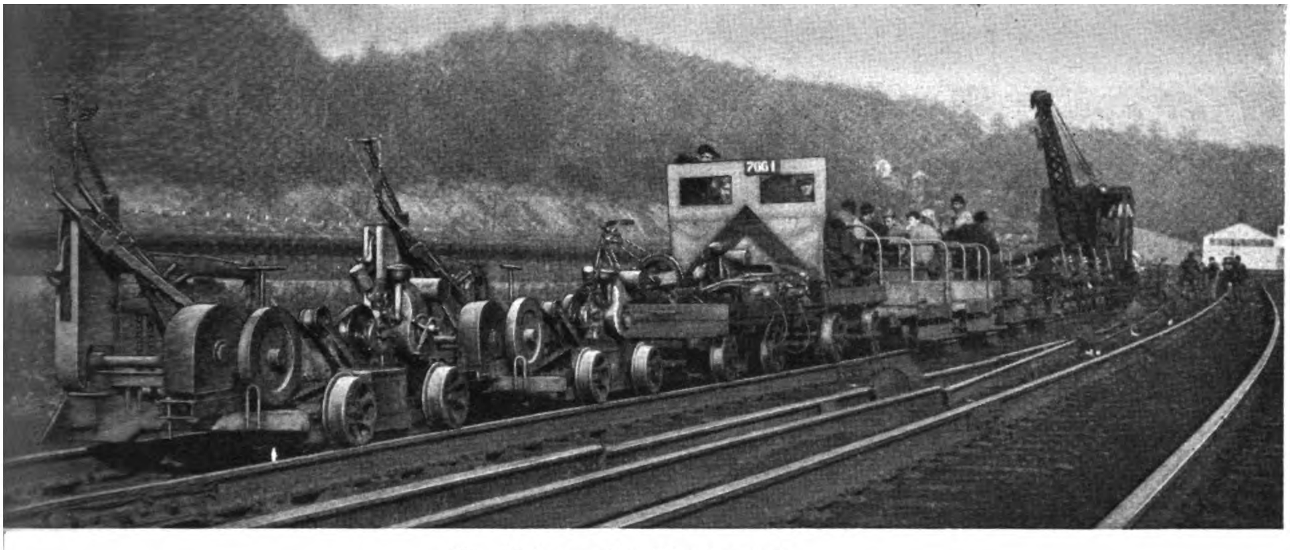


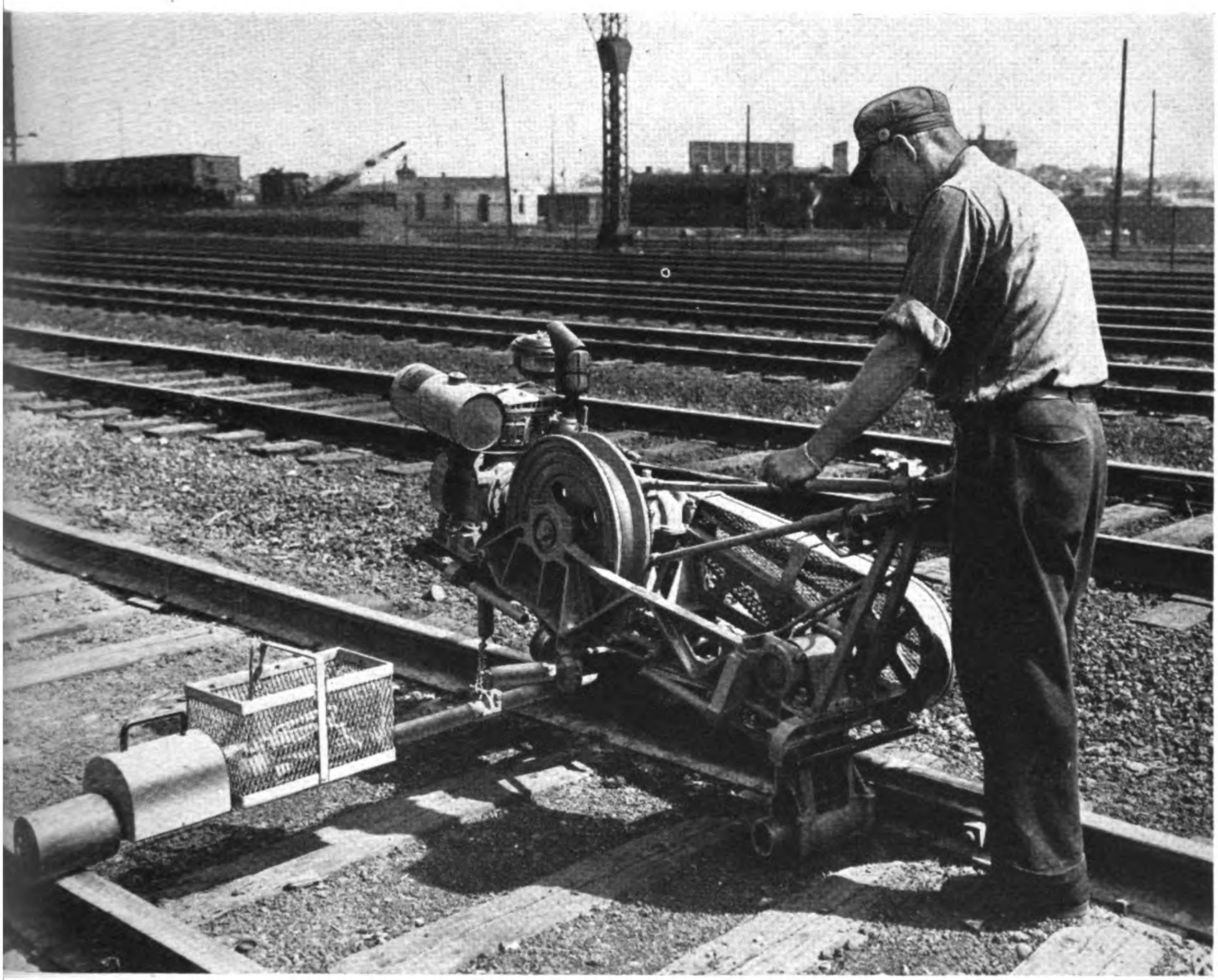
Figure 128—Continued.

Table XX. Operations of rail-laying train

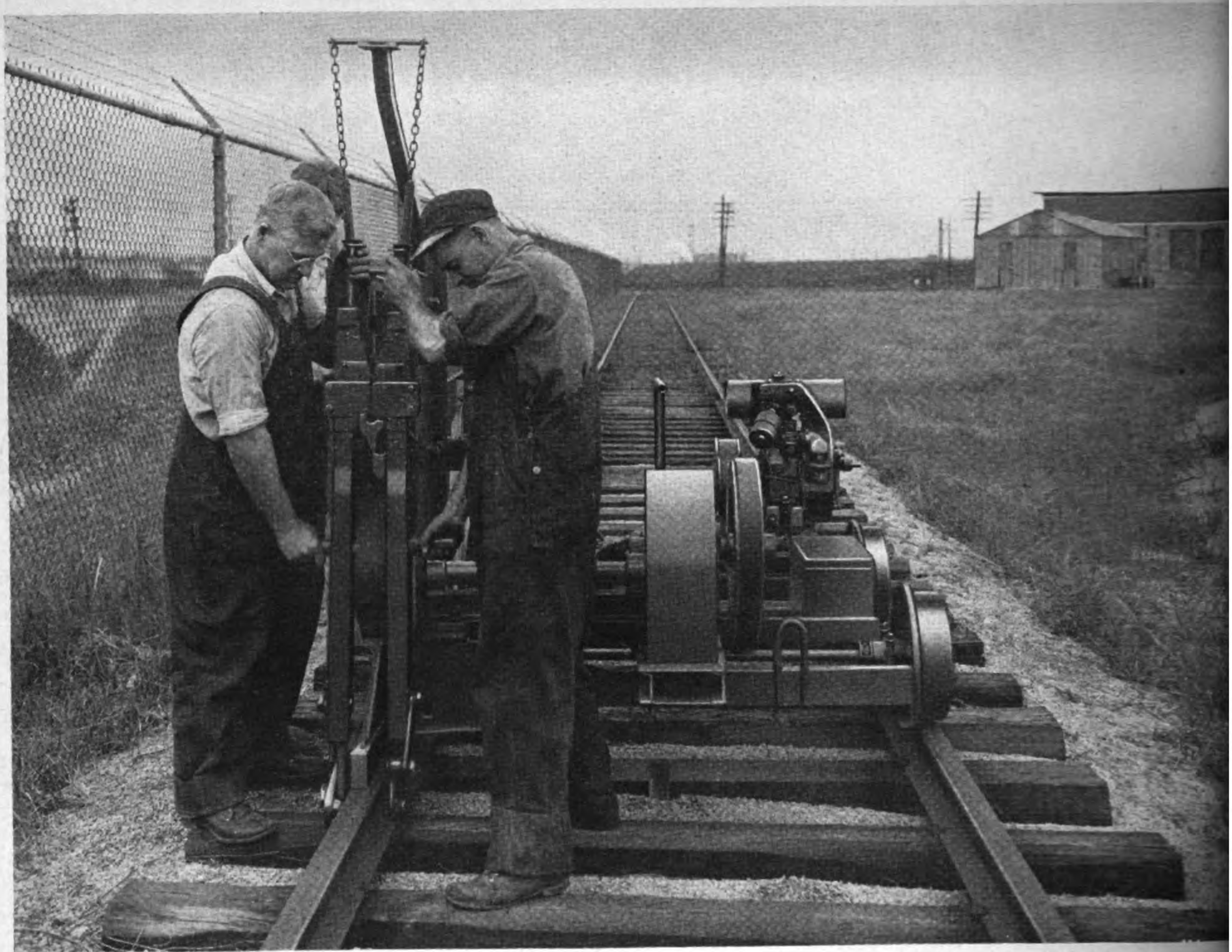
Operation	Type of operation	Equipment	No. of men
Flagman	Manual	1 flag, 1 trackman's whistle	1
Removing bolts	Mechanical	2 power track wrenches	2
Removing spikes	Mechanical	3 spike pulling machines	9
Burning bolts not removed by power wrench.	Manual	1 acetylene burner	1
Distributing miscellaneous material.	Mechanical	1 motor track car, 4 trailers	3
Removing joint bars	Manual	1 sledge	1
Removing spikes at joint bars.	Manual	2 claw bars	2
Rolling out old rail	Manual	1 rail fork	1
Removing tie plates	Manual		1
Cleaning cribs below top of tie	Manual	3 hand rakes, shovels, or ballast forks	3 - 8
Sweeping off top of ties.	Manual	1 hand broom	1
Setting and driving tie plugs	Manual	2 hand tamping bars	3
Driving broken spike stubs	Manual	2 sledges, 2 counterpunches	4
Adzing ties	Mechanical	4 tie-adzing machines	4
Sharpening cutter heads	Mechanical	1 power-operated bench grinder	1
Spot-creosoting ties	Manual		1
Setting tie plates	Manual		1 - 2
Relief operator (tie adzing)			1
Setting rail	Mechanical and manual	1 rail-laying crane	4
Applying joint bars	Manual	1 joint-bar clamp	5 - 7
Gauging rail	Manual	2 track gauges, 4 spike mauls	6 - 9
Setting spikes	Manual	8 spike mauls	8 - 12
Mechanical adjustments	Manual		1
Driving spikes	Mechanical	1 air compressor—5 pneumatic spike drivers	6
Tightening bolts	Mechanical	1 power track wrench	1
Rear flagman	Manual	1 flag, 1 trackman's whistle	1
			72 - 78 Totals



① *Make-up of rail-laying train.*
Figure 129. Operations of rail-laying train.



② *Removing track bolts with power wrench.*
Figure 129—Continued.



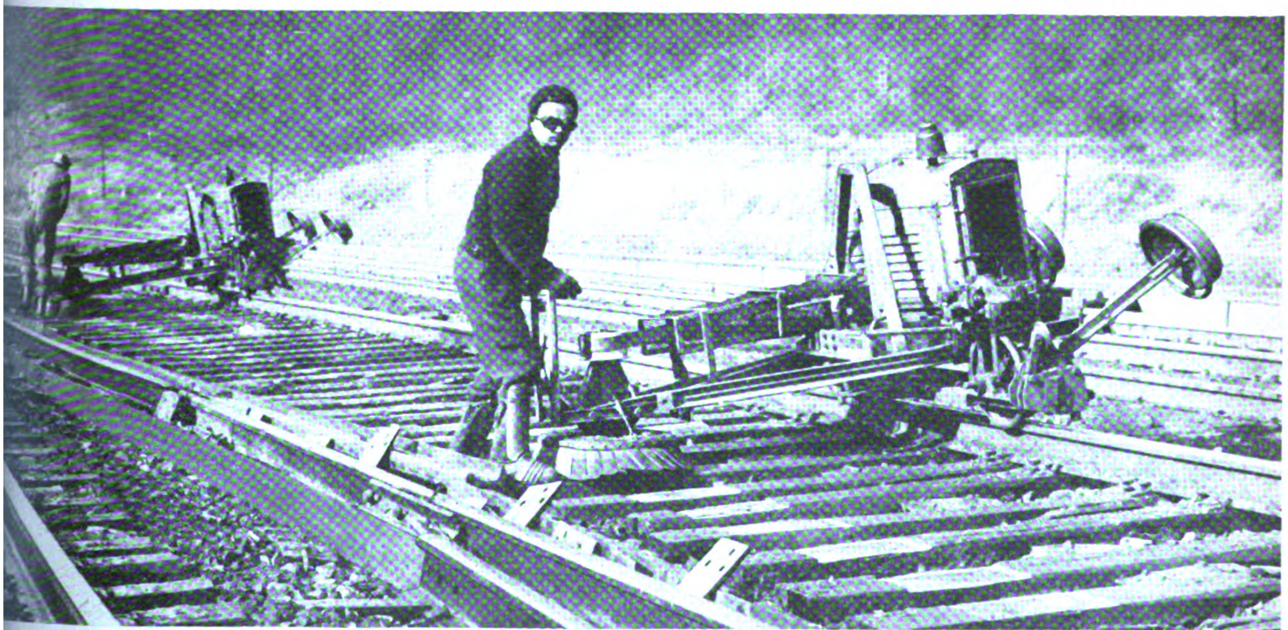
③ *Pulling spikes with mechanical spike puller.*
Figure 129—Continued.

④ *Setting tie plugs in ties.*
Figure 129—Continued.

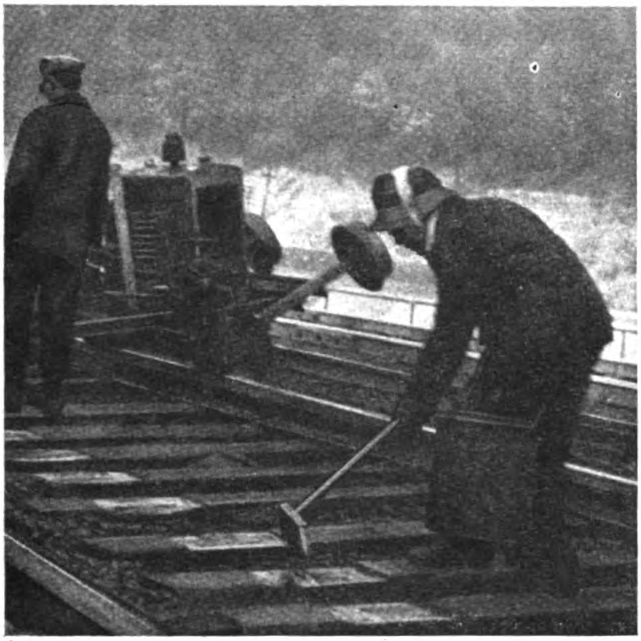
⑤ *Driving tie plugs with stamping bars.*
Figure 129—Continued.

⑥ *Clearing ballast below top of ties.*
Figure 129—Continued.

⑦ *Driving stubs of broken spikes.*
Figure 129—Continued.



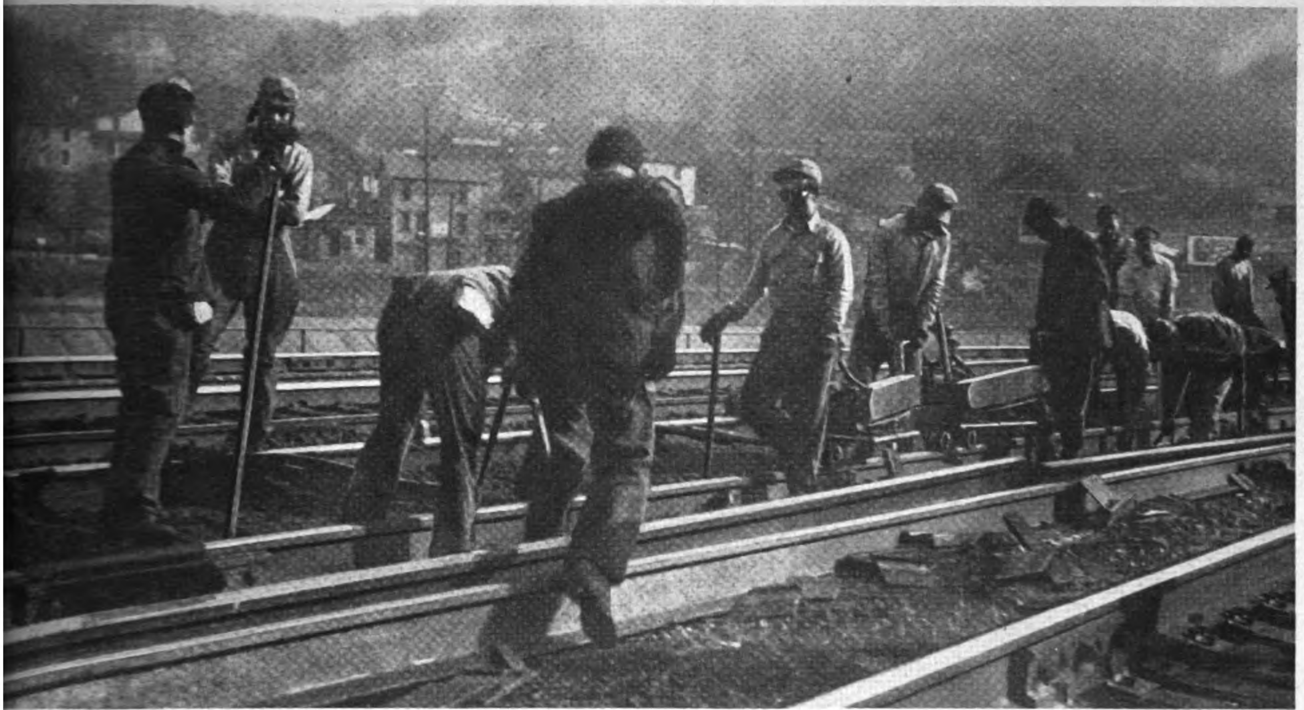
⑧ *Adzing tie with mechanical tie-adzing machines.*
Figure 129—Continued.



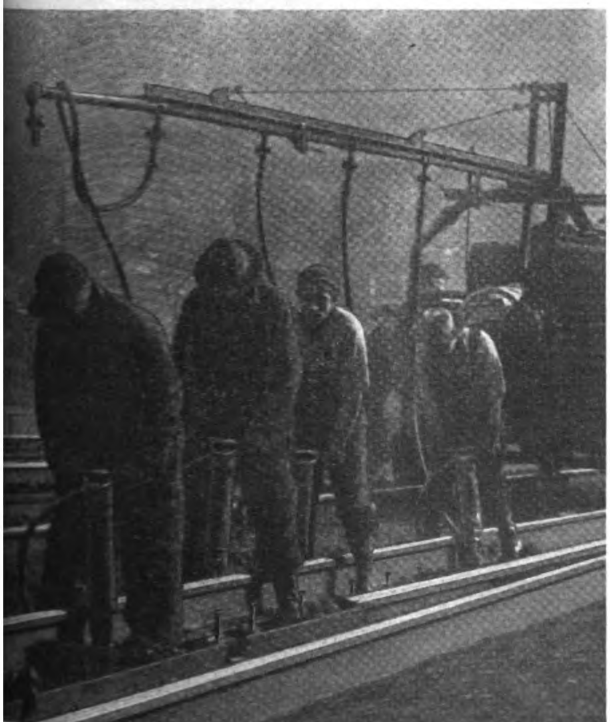
⑨ *Spot-creosoting of adzed surface of ties.*
Figure 129—Continued.

⑪ *Applying joint bars and bolts.*
Figure 129—Continued.

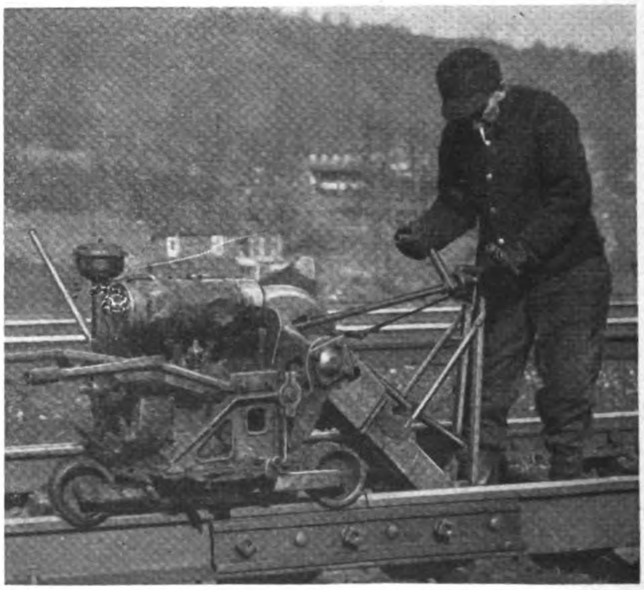
⑩ *Placing rail with rail-laying crane*
Note. Tie plates are set before rail is placed.
Figure 129—Continued.



⑫ *Gauging track and preboring ties with mechanical tie drill.*
Figure 129—Continued.



⑬ *Driving spikes with pneumatic spike drivers.*
Figure 129—Continued.



⑭ *Tightening bolts with power wrench.*
Figure 129—Continued.

APPENDIX I.
GLOSSARY OF RAILROAD TERMS

Adzing machine. A portable power-operated machine designed to adze the rail seat on ties to provide proper bearing for rail or tie plates.

Anti-checking iron. A piece of flat iron sharpened on one edge driven into the end of a tie to prevent checking and splitting. It is bent to special designs or to the shape of C, S, or Z, and called C-iron, S-iron, or Z-iron.

Anticreeper. A device attached to a rail to keep it from moving longitudinally under traffic.

Apron (fence). A flared panel of fence set parallel with the track and along the outside edge of a stock guard.

Asphaltum (asphalt). A compact bituminous material practically indestructible by air and impervious to water, commonly used for roofing and paving.

Automatic block signaling. See Signaling.

Ballast. Selected material placed on the roadbed to hold track in line and surface. Ballast preferably consists of hard particles easily handled in tamping, which distribute the load, drain well, and resist plant growth.

Ballast, cinder. The residue from coal used in locomotive and other furnaces. Its availability, good drainage, and ease of application make it desirable for ballast in branch lines, sidings, and yards, although it is used also in main lines and for subballast on wet roadbeds.

Ballast cleaner. Any screening device by which dirt or other foreign matter is removed from broken stone or hard slag ballast.

Ballast disker. A device consisting of a set of disks attached on either or both sides of a motor car, each set containing one or more disks designed to remove plant growth, promote drainage, and improve the contour of the ballast section.

Ballast, disintegrated granite. A natural deposit which breaks into particles of size suitable for ballast on removal from its bed. Disintegrated granite makes satisfactory ballast, packing, draining, and holding the track well.

Ballast, gravel.

Pit-run. Worn fragments of rock and sand occurring in natural deposits. There are three kinds; river or stream gravel; hill gravel, not cementing; and hill gravel, cementing.

Screened. Worn fragments of rock occurring natural deposits, of a size that will pass throu a 2½-inch ring and be retained on a No. screen.

Washed. Gravel from which foreign matter h been washed. Washed gravel ranks second o to stone in its effectiveness as ballast.

Ballast, sand. Any hard, granular, comminuted ro which passes through a No. 10 screen and is tained on a No. 50 screen. It erodes easily, b can be tamped and worked readily when dam It is dusty when dry and fine, and is used ballast only if more suitable material is not ava able.

Ballast shoulder. The portion of ballast between t end of the tie and the toe of the ballast slo It distributes the traffic load over a greater wid of roadway and helps hold the track in alignme

Ballast, slag. The waste product, in a more or le vitrified form, of ore-reduction furnaces; usual the product of a blast furnace.

Ballast, stone. Stone broken artificially into sm fragments of specified sizes. Stone ballast is t most effective of all types of ballast. It is usual traprock, limestone, or sandstone.

Ballast, sub-. Any material of a superior charact which is spread on the finished subgrade of t roadbed and below the top ballast to provide bett drainage, prevent upheaval by frost, and distribu the load over the roadbed more evenly. Lar sizes of broken stone are used frequently, and ci ders also are effective.

Ballast tamper. A portable machine actuated b compressed air or electricity, for compacting ba last under ties of railway track.

Ballast tamping. Compacting of particles to solidif ballast under the track, to maintain the trac surface.

Ballast, top. Any material of a superior characte spread over a sub-ballast to support the trac structure, distribute the load to the sub-ballas and provide good initial drainage.

Batter. Deformation of the surface of the railhea close to the end of the rail.

Bent. The members forming a single vertical suppo of a trestle; called a *pile bent* if the principal mem bers are piles and a *framed bent* if principal members are framed timbers.

rm. Space left between the top or toe of a slope and the excavation made for intercepting ditches or borrow pits. Also, an approximately horizontal space introduced in a slope.

eeding. The exudation of preservative from treated timber.

ock. A length of track of defined limits, the use of which is governed by block signals.

ock section. A section of track of defined length, the use of which is regulated by a fixed signal at the entering end on double track, and at each end on single track.

ocks, toe, point, middle, and flare. The metal blocks at the respective points named, which provide rigidity in the assembly of a frog, crossing, tongue switch, or mate, or in the installation of a guardrail, serving in some cases also as foot guards. They are usually made of grey cast iron.

ock station. A place from which block signals are operated.

ock system, manual. A series of consecutive blocks, governed by block signals operated manually.

ocking. One of a number of wood or metal separators used between parts of frogs and switches, or between a running rail and a guardrail to keep the parts in their correct relative positions and sometimes to act also as foot guards.

ard, spot. A sighting board laid across the rails in advance of a track-raising gang to indicate the required amount of lift.

lted rail crossing. A crossing in which all running surfaces are of rolled rail and parts are held together with bolts.

nd plug. A piece of metal resembling a tapered rivet, used to fasten a bond wire to a rail.

nd, rail. An electrical conductor for bridging joints between rails.

nd wire. Wire used in signaling, forming part of a rail bond.

ace, rail. A device used at switches, movable-point frogs, etc., in combination with switch, tie, or gauge plates for holding the rail in place. Also used on rails to preserve the gauge and prevent overturning of the rail.

ace, track. An auxiliary fastening designed to function both as a rail brace and a gauge rod.

idge, ballast-floored. A bridge with a solid floor in which ballast and track structure are placed in order to reproduce as nearly as possible the track conditions on an earth roadbed.

Bridge, girder. A steel bridge in which the track is supported on the tops of or between two or more girders, generally used in lengths from 30 to 120 feet.

Bridge, I-beam. A type of bridge consisting of a number of steel I-beams used as stringers, laid parallel to one another; used in spans up to a maximum of about 30 feet.

Bridge pier. One of the intermediate supports of a bridge, usually a columnar structure of masonry, rectangular in section, which transmits loads from the superstructure to the foundation.

Bridge, skew. A bridge which crosses a passageway at other than a right angle.

Bridge tie. A transverse timber resting on stringers and supporting the rails.

Bridge, trestle. A bridge composed of relatively short spans of simple horizontal members or beams, supported on caps resting on upright members placed at right angles to the axis of the structure and forming bents or trestles.

Burrs. Rough edges remaining on a sawed rail; also formed by the drill in making bolt holes.

Cant hook. A tool for holding and rolling logs or heavy timbers.

Canting of rail. Inward inclination of the rail, effected by inclined tie plates or by adzing the ties.

Cap. A horizontal member secured to the tops of piles or posts of a trestle bent to support longitudinal members and their loads.

Car, ballast. A car specially designed for loading, transporting, and unloading ballast into the track space.

Catch basin. A small cistern or chamber in which storm water or other drainage is collected.

Chamfer cut. The vertical beveling of the gauge side of a switch point or movable center point to produce a practical point, which may be $\frac{1}{8}$ or $\frac{1}{16}$ inch thick in the former, and $\frac{1}{4}$ or $\frac{3}{8}$ inch thick in the latter. It is run out in an established distance between 9 and 24 inches.

Check. A lengthwise separation of the wood of a cross tie, usually occurring across rings of annual growth.

Chisel, track. A tool used principally for cutting rail by holding the cutting edge on the rail while the top is struck a succession of blows by a sledge. Also called a rail cutter.

Circuit, track. An electric circuit of which the rails of a track form a part.

Classification gauge. See Gauge, classification.

Classification yard. See Yard, classification.

Clip, side-jaw. A U-shaped fixture which fits over and under a switch rod to secure the rod and switch points together.

Clip, switch. The device by which the switch rod is joined to the switch rail. It is usually united with the switch by a bolt, but may be connected to the switch rail by bolts or rivets. It sometimes has staggered bolt holes in the horizontal leg for making detailed adjustments in positions of the switch rails.

Clip, transit (switch). A switch-rod clip drilled with several holes in a line diagonal to the axis of the switch rod, for effecting adjustments in the throw of the switch.

Coping. The cap or covering member of a wall or parapet, usually having a sloping top surface and drip on the under edge to provide protection against weather; commonly made of concrete, cut stone, or terra cotta.

Crane. A weight-moving machine designed for direct lifting. Different types include stationary, locomotive traveling, and gantry cranes.

Crane, crawler. A revolving self-propelled machine having functions similar to those of the locomotive crane, but equipped with crawler treads in place of wheels so it can travel on the ground or over the floor of cars.

Crane, gantry. A stilted traveling crane supported on a bridge or trestle. Trestle bents are constructed on car wheels so the whole structure travels on a track laid on the ground or floor.

Crane, locomotive. A revolving, self-propelled, long-boomed, general-utility crane, designed to handle a grab bucket, lifting hooks, or magnet; to move coal for locomotive use, to handle track materials, cinders or scrap metals, to erect bridges, excavate foundations, etc.

Crane, track. (Also called maintenance crane.) A power-operated locomotive crane of small capacity used principally for setting rails in track renewal, but having many similar uses in maintenance work.

Crank, adjustable (switch stand). A switch-operating device by which the position of the mechanism at the base of the spindle can be altered to adjust throw of the switch.

Crank, breakable (switch stand). A short crank casting of soft metal, designed to break when the switch is run through and so prevent injury to switch-point rails.

Creosote. A distillate of coal tar produced by high-temperature carbonization of bituminous coal; it consists principally of liquid and solid aromatic hydrocarbons and contains appreciable quan of tar acids and tar bases.

Crib. That portion of ballast between two adjac ties.

Cross grain. Wood in which cells or fibers do n run parallel with the axis, or sides, of a piece. may be classified as spiral, diagonal, wavy, di curly, and interlocked grain.

Cross tie. See Tie.

Crossing, butt-rail. A bolted rail crossing at a 3 angle or greater, in which ends of the main ra are mitered to form intersections.

Crossing protection. An arrangement of signali devices, designed to prevent accidents at railwa grade crossings.

Crossing, track. A device used where two trac intersect at grade to permit traffic on either tra to run across the other. It comprises four co nected frogs, one for each rail intersection.

Cross-over. Two turnouts with a track betwe their frogs, arranged to form a continuous passa between two nearby and generally parallel track The two frogs are usually of the same numb although those of different numbers may be com bined.

Cross-over, double. A combination of two cros overs in opposite directions which intersect be tween parallel tracks, used where space is no available for placing two cross-overs in tanden

Curve, compound. A continuous change in direc tion of alignment by means of two or more con tiguous simple curves of different degrees havin a common direction at their junction points. I abrupt, juncture is commonly modified by a trans tion curve.

Curve, degree of. Angle subtended at the cente of a simple curve by a 100-foot chord. It may con veniently be considered as equivalent in inches t the middle ordinate of a 62-foot chord.

Curve, easement. A curve whose degree varies eithe uniformly or in some definitely determined manne to give a gradual transition between a tangent an a simple curve which it connects, or between tw simple curves.

Curve, reverse. Two contiguous simple curves in opposite directions.

Curve, simple. A curved track forming an arc of a circle of a single radius, usually defined by its degree.

Curve, vertical. A vertical bend in the track to con nect intersecting grade lines. It provides for smoother, safer, and less abrupt passage of equipment.

urved lead (turn-out). The length measured on the outside gauge line of the turn-out from point of switch to point of frog.

eadman. A buried timber, log, or beam designed as an anchorage to which a guy wire or cable is fastened to support a structure, as a wood or steel column, derrick, or mast.

epth (ballast). The distance from the bottom of the tie to top of the subgrade, embracing top ballast and sub-ballast. On single track, depth is measured at the center line and on double track or multiple track at a point midway between the center and outside rail of outside tracks.

erail. A track safety device designed to guide railway rolling stock off the rails at a selected spot as a means of protection against collisions or other accidents; commonly used on spurs or sidings to prevent cars from fouling the main line or the parent track.

imension lumber. The term commonly applied to framing lumber and rough lumber which has been cut to standard dimensions for commercial use. Standard dimensions of 2 x 4's are 1⅝ by 3⅝ inches; of 2 x 6's 1⅝ by 5⅝ inches; of 2 x 8's 1⅝ by 7⅝ inches, etc.

isk weeder. A device for removing weeds from ballast and roadbed shoulders, consisting of a set of disks attached on either side of a motor car, each set containing several disks which cut the plant growth and also improve the contour of the ballast section.

itch, intercepting. An open artificial waterway for preventing surface water from flowing over slopes of a cut or against the foot of an embankment. It protects slopes from erosion and tracks from washing out or being covered by a deposit of material carried in suspension.

olly, timber. A device consisting of a single wide roller mounted in a frame, used as a platform and as a truck for moving long heavy timbers; when inverted, as a stationary roller.

oty tie. A tie affected with a fungus disease.

rill, track. A machine tool designed to operate horizontally to drill holes through webs of track rails, especially for track bolts. It may be a one-man ratchet drill or a geared drill machine with a frame, rail clamps, feed screw, high-speed steel bit and chuck, and alternating crank handles turned by two men.

Dry rot. A term used to indicate a form of decay in timber caused by fungi.

Drain, french. An underground passageway for water through the spaces between stones placed loosely in a trench.

Easement curve. See Curve, easement.

Elevation of curve. Vertical distance that the outer rail is raised above the inner rail, called super-elevation. Elevation is required to resist the centrifugal force of a moving train and is a function of the degree of curve and the square of the authorized speed.

End chipping. Loosening of metal on the top or gauge side of the rail end.

End overflow. Projection of metal into the joint gap at the top of the gauge side of the railhead, brought about by impact of wheels under traffic.

Excavation, or cutting. Cutting down of natural ground surface. Also, material taken from cuttings, borrow pits, or foundation pits, and the space formed by removing material.

Expansion opening (rail). Space left between contiguous rails to allow for expansion under increasing temperature. Openings are specified by the AREA for 0° to 100° F. by 25° increments and for 33- and 39-foot rails.

Expansion shim (rail). Spacer inserted between ends of abutting rails while track is being laid to provide allowance for expansion of steel when temperature changes.

Fastener, tie-plate. A special tie plate long enough to support the bases of a guardrail and the adjacent running rail, and with a rail brace riveted to it for supporting the guardrail.

Fastenings, auxiliary track. Nutlocks, spring washers, tie plates, rail braces, and anticreeping devices.

Fastenings, track. A term commonly applied to splice bars, bolts, and spikes.

Fishing space. Space between head and base of a rail occupied by a splice bar.

Flange. A projecting edge, rib, or rim on any object such as the base of a rail or the top and bottom horizontal parts of a beam or girder.

Flange frog. See Frog, self-guarded.

Flanger. A form of plow for clearing ice and snow from the inside of rails to provide a clear passage for wheel flanges. Sometimes placed under a special car called a flanger car, but usually carried under a snowplow. Also frequently attached to locomotives, either on or just behind the pilot wheels.

Flangeway. Space between running rail and guardrail which provides clearance for passage of wheel flanges. Standard flangeway width on straight track is 2¼ inches; minimum depth is 2½ inches.

Flangeway guard. A structure designed to fit against the paving of a crossing, walk, or platform at grade on one side, and against and under the head of the track rail on the other side, to provide a continuous flangeway which is easily kept clean; it facilitates maintenance, and prevents the feet of persons or stock from catching.

Flangeway width. Distance between the gauge line of running track rail and the guarding face of the adjacent guardrail. Standard flangeway width on straight track is 2¼ inches.

Flare opening. Horizontal distance between the gauge line of running rail and the side of the head of guardrail or frog wing rail at point of maximum opening. Width should not be less than 3½ inches in frogs and is preferably 4 or 4¼ inches in guardrails.

Flow of metal (rail). Rolling out of steel on the crown of a rail toward sides of the head. More common on the low side of a curve where less than established speed is used frequently.

Fracture detail. A progressive transverse fracture originating at the surface of a railhead. It should not be confused with a transverse fissure.

Frog. A device used where two running rails intersect, providing flangeways to permit wheels and wheel flanges on either rail to cross the other.

Frog angle. Angle formed by intersecting gauge lines of a frog, or by tangents to the gauge lines at their point of intersection when the frog is curved.

Frog, rigid bolted. A frog built entirely of rolled rails, with fillers between rails, and rigidly held together with bolts.

Frog number. One-half the cotangent of one-half the frog angle, or the number of units of centerline length in which the spread is one unit.

Frog point. The part of a frog lying between the gauge lines, extending from their intersection to the heel end.

Frog, actual point of. Point at which the spread between gauge lines is sufficient to allow for a practical width of manufactured point. Standard width is ½ inch in all frogs except solid manganese-steel frogs, in which the actual point is ⅝ inch thick; but in such cases the ½-inch point is marked on the casting, since all measurements are made from it.

Frog, point of (half-inch point). Point at which t spread between gauge lines is ½ inch, and t point from which shop measurements are mad It is located at a distance from the theoreti point toward the heel equal in inches to one-ha the frog number.

Frog, self-guarded (flange frog). A frog with guard member for guiding the flange of a whe past the point of frog by engaging the tread ri of the wheel in a horizontal plane above the t of the running surface of the frog.

Frog, theoretical point of. Point of intersection gauge lines of the frog.

Frog, throat of. Point at which the convergi wings of a frog are closest together.

Fungus. A plant, some forms of which grow on in wood and destroy it by causing decay.

Fusee. A signaling device which is lighted a dropped from the rear of trains. It burns with red light, warning following trains of dange Fusees also are carried by track watchmen to ind cate temporarily a dangerous condition of trac or structures.

Gauge, classification. A template made of tool ste which may be applied to rail for measuring i wear.

Gauge line. A line ⅝ inch below the running surfac of a rail on the side of the head nearest the trac center; the line from which measurements of gaug are made.

Gauge, narrow. A gauge narrower than standar gauge. A gauge of 24 inches or less is commonl employed for industrial railways.

Gauge of track. Distance between heads of rail measured at a point ⅝ inch below the top of rail Standard gauge is 4 feet 8½ inches.

Gauge rod. A device for holding track to correc gauge, generally consisting of a 1¼ inch rod with a forged jaw on one end and a malleable jaw o the other end, adjustable through a locknut. Sometimes consists of a rod made in two parts with a solid jaw on each, united by a turnbuckle. Als called a tie rod.

Gauge tool. A tool by which the gauge of track is determined. It is made of wood and steel, or all steel, and sometimes has a guardrail gauge attached. It may be combined with a track level.

Gauging (of track). Bringing two rails into their correct relative positions as regards gauge.

Girder-type crossing. A manganese-steel crossing in which the body is constructed of a deeper section than the rails with which it is to connect.

rade. Ratio of rise or fall of the grade line to its length, computed in length of constructed stations. Also, to prepare the ground for reception of ballast and track.

rade line. The line on the profile representing tops of embankments and bottoms of cuttings ready to receive ballast; the intersection of the plane of the roadbed with a vertical plane through the center line.

adient. Rate of inclination of the grade line from the horizontal.

uard, cattle. See Stock guard.

uardrail. A rail laid parallel to running rails of a track to prevent wheels from being derailed, or to hold wheels in proper alignment with the track to prevent their flanges from striking the points of switches or the points of frogs in turn-outs or crossings. A rail laid parallel to the running rails of a track to keep derailed wheels on the ties. Two lines of guard rails are commonly employed on bridges; a single line may be sufficient at other places.

uardrail (crossing). The rail placed parallel to the running rail with the required flangeway between them.

uardrail, one-piece. A guardrail cast as one piece. All required tie plates, braces, foot guards, and other supporting and protecting features are made integral with the structure.

uardrail (turn-out). A rail or other device laid parallel to the running rail opposite a frog to form a flangeway with the rail and hold wheels of equipment to proper alignment when passing through the frog.

uardrail brace. Metal shaped to fit the contour of the side of the guardrail, extending over the ties and fastened to them to prevent moving or tilting of the guardrail.

uardrail, bridge. A line of special rails, generally used T-rails, laid parallel to and between running rails of a track over a bridge and its aproaches to keep derailed wheels close to running rails.

uardrail clamp. A device consisting of a yoke and fastening devices engaging the running rail and guardrail.

alf-inch point. See Frog, point of.

ead block (switch). A tie or ties of a set used to support the switch-point operating mechanism. Modern switch stands require the use of two head-block ties.

ead rod. The switch rod nearest the point of a switch, usually placed between the two head-block ties.

Heartwood. Inner portion of a tree in which wood cells are dead and perform no vital function; usually darker in color than sapwood.

Heater, switch. A device for melting snow at switches by means of steam, an electric current, gas jets or oil.

Heaving. Lifting of the ground surface by action of frost on the soil.

Heel block (switch). A block which spans joints and fills the space between adjacent rails at the heel of a switch, joined with outside splice bars by continuous bolts to form a unit joint. Also serves as a foot guard.

Heel length. Distance between the heel end and half-inch point of a frog, measured along gauge lines.

Heel of switch. End of a switch rail farthest from the point of switch.

Heel spread (frog). Distance between gauge lines at the heel end of a frog.

Highway-crossing protection. An arrangement of one or more highway-crossing signals to protect highway traffic.

Jack, track. A compound ratchet-lever jack which trips its load by a single operation, as distinguished from an automatic lowering jack which lets the load drop by successive stages. There are two kinds: single-acting, in which the load is raised on the down stroke of the lever; and double-acting, in which the load is raised on both up and down strokes. Track jacks now usually have 15-ton capacity.

Joint bar. A steel angle bar used to fasten together the ends of contiguous rails; sometimes called a splice bar. Joint bars are used in pairs, one on each side of the rail, and are designed to fit the space between head and base (fishing space) closely. They are held in place by track bolts and suitable accessory equipment.

Joint-bar drilling. Provision of suitable holes at the ends of a rail, switch, frog, or other track member to receive joint-bar bolts. In specifying joint-bar drilling, give the distance from rail end to center of the first hole, successive distances between centers of holes, vertical locations of holes, and their diameter.

Joint, compromise. A special rail joint, sometimes also called a step joint, for uniting rails of different sections; made so it brings gauge sides and joined rail heads into line, so continuous smooth surfaces are presented to treads and flanges of passing wheels.

Joint, rail. A fastening designed to unite abutting ends of contiguous rails. The term commonly includes all joint fastenings which contribute to connection and support of rail ends.

Joints, supported and suspended. A supported rail joint is one in which rail ends are over a single tie; a suspended joint is one in which ends of the rail joint are carried by two consecutive ties.

Joint tie. A tie used under a rail joint.

Keeper, switch-stand. See Latch, switch-stand.

Kink, stock-rail. See Stock-rail bend.

Latch, switch-stand. A device for catching and holding the lever of a switch stand in position; also called a switch keeper. Two latches are used at each switch stand.

Lead, actual. The length between actual point of switch and half-inch point of frog, measured on the line of the parent track. It varies according to toe length of the frog and length and other details of the switch used.

Lead curve. The curve in a turn-out interposed between heel of switch and toe of frog.

Lead track. An extended track connecting either end of a yard with the main track.

Lens, switch-lamp. A lens set in a switch lamp. A wide-angle lens, which provides a light of low intensity over a wide area, is most commonly used with yard switches.

Line. The condition of track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

Lining track. Shifting the track laterally to conform to established alignment. *Maintenance lining* is ordinarily done during repairs; *general lining* is done to make the track conform throughout to established alignment.

Locknut. See Spring washer.

Marker, snow flanger. A post or sign indicating the proximity of an obstruction which makes it necessary to raise snow flangers or close snowplow wings.

Mate. A structure somewhat similar to a frog point, placed opposite a tongue switch to guide wheels and carry them throughout the extent of the switch. It is frequently used in industrial tracks laid in paved streets.

Middle ordinate. The distance measured from gauge line of rail on a curve to the middle of a string drawn taut and held to contact with gauge line of rail at its ends. The middle ordinate forms a co venient means of measuring detailed curvature a is used in the adjustment of curves and the inves gation of accidents. It is also a factor in bendi rails to a desired curvature.

Nail, dating. A galvanized or copper nail with large head in which the last two numerals of t year are stamped; used when a tie is laid or treat to indicate its service life.

Number, turn-out. The number corresponding the number of frog used in a turn-out.

Parapet. A wall or barrier on the edge of an elevat structure for protection or ornament.

Penetration (timber treatment). The depth to whi perservative enters wood, usually determined b boring with an increment borer or common auge the test hole later being refilled with a treated wo plug.

Pier (masonry). An intermediate support for arch and other spans, usually built of stone or concret although timber posts, framed-timber bents, an pile bents are sometimes used.

Pile. A long, slender timber or reinforced-concre member usually driven or jetted into the groun deriving its support from underlying strata an friction of ground on its surface. *Bearing pil* are used to carry a superimposed load or to com pact the surrounding ground. *Sheet piling* is use to form a wall to exclude water and soft materia or to resist lateral pressure of adjacent ground.

Plate, bearing. A steel plate resting on masonry walls carrying the end of a beam or girder.

Plate, end. A rectangular metal plate usually place on the masonry footing of a steel bridge suppo to distribute imposed loads and protect masonr from crushing.

Platform, high. A station platform at approximat car-floor height.

Platform, low. A station platform at approximat top-of-rail height.

Pneumatic tool. A tool driven by compressed air extensively used for tamping ballast, riveting, an other purposes.

Post, bumping. A braced post, block, or other ca stopper placed at the end of a stub track to preven rolling stock from going off the ends of the rails

Profile. A longitudinal section through a track whic shows elevation and depression. Also, a drawin showing grade line of a railroad, usually obtaine from levels taken on top of the rail.

Rail anchor. See Anticreeper.

'ail bearing. The portion of tie or other support which is beneath the base of the rail and which sustains pressure from it, either directly or through a tie plate.

ail bender. A tool or shop machine for bending rails to fit curves in tracks, turn-outs, or turntable circles; to introduce bend in stock rails; and for a variety of allied operations. Two common types are the Samson and the Jim Crow, the latter sometimes modified by addition of a roller for continuous bending of rails.

ail brace. A metal casting made to fit against the side of a rail or guardrail and to be spiked to the tie on the outside of a track or the inside of a guardrail to prevent the rail from inclining backward with the thrust of wheels. Made in plain and adjustable types.

ail brace, adjustable. A rail brace moving on a tie plate to hold stock rail of the switch or the guardrail rigidly in place and to change their positions for detailed adjustments.

ail brand. An identification mark, including manufacturer's name or initials, month and year the rail was rolled, weight a lineal yard, initials of section, number of the heat, portion of the ingot, and process of manufacture.

'ail creeping. Intermittent, longitudinal sliding movement of rails in track under traffic or because of temperature changes. The effect of rail creeping is resisted by anticreepers or similar devices.

ail failure. A break or any other defect which necessitates removing a rail from main track.

'ail fastenings. Splice bars (also called joint bars), bolts, and spikes. Splice bars, joined together by bolts and bolt-securing devices, are the main parts of the rail joint, although other features are sometimes present.

'ail, girder. A deeper section of rail, principally for use in city streets or other places where paving is required.

'ail, high. The outer or elevated rail of a curved track.

'ail joint. A fastening designed to unite ends of contiguous rails of a railway track. The rail joint includes bolts, bolt-securing devices (the latter being classed as rail-joint accessories), base plates, wood filler blocks, and insulation.

'ail joint bar. A steel member with beam strength and stiffness because of its shape and material. Used in pairs to splice rail ends together, and to hold them firmly in position with reference to surface and gauge-side alignment.

Rail joint base plate. A horizontal plate designed as a bed for the base of both rails at a joint to prevent vertical movement and to add strength to the rail joint.

Rail joint, insulated. A rail joint which arrests the flow of electric current from rail to rail, as at the end of a track circuit, by means of nonconductors separating rail ends and other metal parts.

Rail joint, pumping. A rail joint so poorly supported that mud is churned by passage of wheels and pumped up through ballast.

Rail layer. A small crane, manually or power-operated, to set new rail in place with the use of few men.

Rail, low. The inner rail of a curve which is maintained at grade while the opposite or outer rail is elevated.

Rail, relayer. Worn rails suitable for use in track. Relayer rail is divided into main-track relayer rails, side-track relayer rails, and resawed main-track relayer rails.

Rail rest. A support for one or more emergency-repair rails consisting of two or more shelved upright posts or slabs of timber, iron, or concrete.

Rail saw, portable. A tool or machine for sawing steel rails, commonly a hacksaw or a circular steel saw, set in a vertical frame.

Rail section. The pattern or dimensional details of rail, such as width of base, height of rail, thickness of web, width and thickness of head, angle of head, and angle of base. Each particular pattern is identified by a brand name or symbol such as ASCE, AREA, ARA, PRR, and others.

Rail (track). A rolled-steel shape, commonly a T-section, designed to be laid end to end in two parallel lines on ties to form a track for railway rolling stock.

Rails, closure (lead rails). Rails connecting the heel of switch with the toe end of frog.

Rails, point. Movable rails in a split switch, as distinguished from immovable stock rails; more properly called switch rails.

Reamer. A steel tool designed to true or enlarge holes in wood or steel, to facilitate passage of bolts or rivets.

Retaining wall. A wall for sustaining the pressure of earth or filling deposited behind it, used at railroad fills or cuts.

Right of way. Land or water rights necessary for the roadbed and its accessories.

Riprap. Rough stone of various sizes, placed compactly or irregularly to prevent scouring by water.

Roadbed. The finished surface of roadway upon which track and ballast rest.

Roadbed shoulder. The portion of subgrade lying between the ballast-covered portion and the ditch in cuts, and the top of slope on embankments. A roadbed shoulder not less than 18 inches wide should be maintained outside the toe of the ballast slope.

Roadway. The part of a railway prepared to receive track. During construction the roadway is often referred to as the grade.

Rod, front. A rod fastened to the point of a switch, derail, or movable-point frog to which the lock rod is attached.

Rod, operating. The rod with which motion is transmitted to apparatus.

Rod, switch-operating. A rod attached to a switch, derail, or similar device for moving it from one position to another.

Rod, throw. The rod attached to the head rod of a switch, connecting the switch to a switch stand.

Rotary snowplow. A car with a bladed wheel on the front end set at right angles to track and driven by an engine on the car. It cuts the snow and discharges it to one side of track.

Running rail. The rail or surface on which the wheel bears, as distinguished from a wing rail or guardrail.

Run-off (curve). The inclined profile through which the full elevation of a curve is brought to the level of the tangent, or through which different elevations on a compound curve are connected.

Run-off (surface). The inclined grade through which the raised portion of a track is connected with the old grade. It generally includes the two rails and is made at a long easy slope, for both comfort and safety.

Sap tie. A tie with sapwood wider than one-fourth the width of tie, 20 to 40 inches from the middle of the tie.

Scale, track. A scale with a weighbridge supporting a section of running track, used to find weight of rolling stock, usually cars and carloads of freight.

Section tool house. A small building used for storing the section motor car or hand car, maintenance-of-way tools, and other equipment of a section gang.

Separator, adjustable. A metal block of two or more parts, acting as a filler between running rail and guardrail, and providing a means of maintaining the proper width of flangeway.

Serving railroad. A common carrier connecting its tracks to Government-owned tracks for delivery receipt of freight.

Settlement (grading). The reduction in elevation an embankment because of shrinkage or su sidence.

Shake (timber). A cylindrical separation of woo following in general the annual layers (rings).

Shim (track.) A bearing piece, usually of woo placed between rail and tie or between tie pla and tie, to raise rail to a desired elevation.

Shoulder, ballast. See Ballast shoulder.

Side planing. Cuts made on sides of the head of t switch rail to form a taper from the full width head to the point.

Signal, wigwag. A highway-crossing signal, a ho zontally swinging disk with or without a red lig attached.

Signaling, automatic block. An electric, pneumati or other system in which signals are operated aut matically by a train or by a broken rail, an op switch, a car standing on a turn-out foul of th main track, etc. Devices at a railroad crossin which operate automatically upon the approach a train.

Slppe wall. A wall to protect the slope of an embank ment or cut.

Slot spiking. Driving track spikes so they engag with slots or notches at edges of splice bars an thus interpose resistance against creeping of rail

Snow fence. A structure erected to form artifici eddies on the windward side of a cut far enoug to cause snow to deposit between fence and cu A portable or permanent wood fence, a hedge, o a stone fence is usually employed.

Snow melter. A contrivance designed to preve accumulation of snow and ice in tracks; sometime a blowtorch held close to the snow, or a steam electric, oil, or gas heater attached to the rail through the switch leads at interlockers or rail road crossings; sometimes a chemical poured o strewn along the tracks.

Snow shed. A roofed structure built over tracks t protect traffic against snow blockades. Restricted to locations where snow encroaches seriously and cannot be handled with plows, usually in sidehil cuts on mountain slopes where snow slides amount ing to avalanches frequently bury the tracks.

Spike puller. A steel rod approximately 1 inch in diameter and 5 feet long, with a claw end which fits under the head of a spike. The nose of the claw end provides a fulcrum for drawing spikes.

ke Puller Extension. A tool with a claw end and wo or three pairs of knobs on a straight bar. A pike puller is engaged with the knobs after the law is slipped under the spike head. It is used to rithdraw spikes from flangeways and other places n which a spike puller alone cannot operate.

ral. When used with respect to track, a form of asement curve in which the change of degree of urve is uniform throughout its length.

ice bar. See Joint bar.

ice drilling. The spacing of holes in the ends of ails or other track structures to receive bolts for astening splice bars.

it. Lengthwise separation of wood, due to the earing apart of the wood cells.

ing washer. A washer designed to prevent backward movement of a nut and looseness in bolted nembers due to wear, rust, or other deterioration. Spring washers are of two general classes, helical nd elliptical.

p. car. A device for stopping motion of a car by ngaging the wheels, as distinguished from a umper which arrests motion upon contact with he draw head of a car or the front bumper beam f a locomotive.

ck guard. A barrier of wood, metal, or other material placed between and alongside track rails to revent passage of livestock on or along railroad racks. Also frequently called cattle guard.

ck rail. A running rail against which the switch ail operates.

ck-rail bend. The bend or set which must be given he stock rail at the vertex of a switch to allow it o follow the gauge line of the turn-out.

drain. A covered drain below roadbed or ground urface, receiving water along its length by absorption or through its joints.

grade. The finished surface of a road bed before pplication of ballast.

sidence (grading). The portion of an embankment which has settled below the original ground urface.

structure, bridge. Abutments and piers and their upporting bases.

erstructure, bridge. The portion of a bridge which is supported on piers and abutments including beams girders or trusses, floor system, and racing.

face. When used with respect to track, condition the track as to vertical evenness or smoothness er short distances.

Surface, running (tread). The top part of track structures on which treads of wheels bear.

Surfacing, out-of-face. Raising the entire track to a new grade.

Switch angle. The angle included between gauge lines of switch rail and stock rail.

Switch heater. A device for melting snow with heat generated by an electric current, or by gas or oil; used for movable parts of switches, etc.

Switch lock. A fastener, usually a spring padlock, used to secure the switch or derail stand in place and thus maintain correct position of these members. The AREA has standardized parts of the switch lock other than the internal mechanism.

Switch plate. A special metal tie plate for use on switch ties, each plate being long enough to extend not only under the stock rail and its supporting braces, but also under the switch rail in open position. Switch plates are furnished in sets to correspond with switch length. There are two plates to each tie; however, at point of switch, the two may be replaced by a gauge plate which embraces both switch rails.

Switch, actual point of. The point where the spread between gauge lines of stock rail and switch rail is sufficient to allow for a practical width of switch point. The standard width of switch point is ¼ inch.

Switch, theoretical point of. The point where the gauge line of the switch rail, if produced, would intersect the gauge line of the stock rail. Also called the vertex.

Switch-point lug. The lug attached to a switch point, to which the front rod is connected.

Switch-point protector. A reversible protector plate, having a contour at top and bottom similar to the switch point, attached several inches ahead of the actual point to receive the impact of the wheels and deflect them, to avoid wear of the switch point and provide increased safety.

Switch rail or point rail. The tapered rail of a split switch.

Switch rod, adjustable. A switch rod with an attachment for altering its length to keep the switch rails in their proper positions. Adjustment is usually effected through staggering holes in the clips which connect switch rod and switch rail.

Switch stand. A device by which a switch is thrown, locked, and its position indicated. It consists essentially of a base, spindle, lever, and connecting rod, and is usually furnished with a lamp and a banner signal.

Switch stand, low. A switch stand with a spindle higher than 1 foot but less than 2 feet.

Switch target. A visual day signal fixed on the spindle of a switch stand, or the circular flaring collar fitted around the switch-lamp lens, and painted a distinctive color to indicate the position of the switch.

Switch tie. A tie of a set used to support a turn-out, crossover, or track crossing.

Switch. A pair of movable track rails, with their fastenings and operating rods, providing means for making a path over which to move an engine, car, or train from one track to another.

Switch, insulated. A switch in which the fixtures, principally gauge plates and switch rods, connecting one rail to the opposite rail are insulated so the electric track circuit will not be shunted.

Switch, split. Two tapered movable rails with necessary connections, designed to divert rolling stock from one track to another.

Switch, staggered-point. A switch in which one point is placed in advance of the other, as in a turn-out from inside a curve.

Switch, throw of. The distance, measured along the center line of the rod nearest the point connecting the two switch rails, through which switch points are moved sidewise to bring either point against the stock rail; standardized at 4¾ inches.

Switch, tongue. A structure used in tracks in paved streets to divert rolling stock from one track to another. The straight connected tongue switch, also called the doubletongue switch, is generally preferred for main tracks, while the tongue switch and mate are more common in industrial tracks.

Tamper, air. An air-driven tool for compacting ballast under ties. Commonly used in sets of 4, 8, or 12 tools in connection with a portable air compressor.

Tamper, electric. An electrically driven tool used for compacting ballast under ties. Commonly used in sets of 4, 8, or 12 tools in connection with a portable generator set. (Electric tampers are of three general classes: vibratory, magnetic impulse, and mechanical impulse.)

Tamper, mechanical. A power-driven machine for compacting ballast under ties.

Team track. A track on which freight is transferred directly between cars and highway vehicles.

Tie. A transverse support to which rails are fastened to keep them to line, gauge, and grade.

Tie plate. A metal plate at least 6 inches wide and long enough to provide a safe bearing area on the tie, with a shoulder to restrain outward movem of the rail.

Tie plate, twin. A tie plate in two parts which n to form a combined width equal to that of standard tie plate, for use back of the heel switch to the point where standard tie plates r be applied without their ends infringing.

Tie plug. A wooden pin driven in to fill an unu spike hole in a tie, to exclude moisture, prev decay, and provide solid wood for redriving spike. Usually supplied in the form of sticks c taining several plugs; frequently of treated wc

Tie rod. See Gauge rod.

Tie spacer. A device for aligning and spacing in track with minimum disturbance of ballast. may be a device which grips the rail to provid fulcrum for a bar, or a shoe to be attached to track jack for forcing ties ahead, etc.

Tie spacing. The distances between ties in a railw track or switch connection.

Tie tamper. See Ballast tamper.

Tie tongs. An implement designed to engage a with a lever grip; with handles by which ties be carried or drawn into or out of the track renewals.

Toe end of frog. The end of a frog in front of point and toward the switch.

Toe spread. The distance between gauge lines at toe end of the frog.

Tolerance. An allowance made for a small variat from dimensions specified.

Track, body. Each of the parallel tracks of a ya on which cars are switched or stored.

Track, house. A track alongside of or entering freight house; used for cars receiving or deliv ing freight at the house.

Track, ladder. A track connecting successively body tracks of a yard.

Track, parent. A track from which a turn-out constructed.

Track fastenings, auxiliary. The term commonly a plied to spring washers, tie plates, rail brac anticreepers, and gauge rods.

Track fastenings. The term commonly applied rail joints, bolts, and spikes.

Track-laying machine. A machine designed to mi imize the manual labor of placing rails, fastening ties and other materials.

Track liner. A device designed to minimize manu labor in lining track. It consists generally of base resting securely on the roadbed to act as fulcrum for some form of lever arm.

Track shim. A hardwood or fiber plate, generally as wide as the bearing of a standard tie plate but of a varying thickness; used to restore the running surface of track heaved by frost or otherwise distorted.

Track, storage. One of the body tracks in a storage yard, or a track used for storage purposes.

Track, spur. A stub track diverging from a main or other track.

Trailing point. A switch in which points face away from the normal direction of traffic.

Treatment (wood preservation). The amount of preservative specified to be injected into timber, usually expressed in pounds a cubic foot. Treatment is economically limited to the amount which will preserve timber from decay until it is worn out in service.

Treatment refusal (wood preservation). Treatment of timber by pressure until absorption of preservatives practically ceases. The pressure is usually continued for approximately 1 hour after the refusal point is reached when it is desired to give timber the heaviest possible treatment.

Trestle, ballast-floor. A trestle having a tight wooden floor on which ballast and track are supported.

Trestle, pile. A structure in which piles are the upright members or supports forming the bents.

Turn-out. An arrangement of a switch and a frog with closure rails, by which rolling stock can be diverted from one track to another.

Wall, bearing. A wall which supports a portion of a floor or roof load.

Water pocket. A depression in a roadbed, filled with ballast or other porous material, in which water collects.

Yard. A system of tracks within defined limits provided for making up trains, storing cars, and other purposes.

Yard, classification. A yard in which cars are classified or grouped in accordance with requirements.

Yard, receiving. A system of tracks within defined limits, used for temporary storage of cars.

APPENDIX II.
REFERENCES

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TM 5-601, Property Repairs and Utilities.

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2. Office, Chief of Engineers Publications

CE 40, OCE Specification Guide for Railro Construction.

3. General Publications

American Railway Engineers Association Manu American Railway Engineers Association, Chica Illinois.

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