SUBCOURSE TRO655

EDITION 4

RAILWAY ROLLING STOCK

AIPD

READINESS/ PROFESSIONALISM THRU GROWTH

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

CORRESPONDENCE COURSE OF THE
U. S. ARMY
TRANSPORTATION SCHOOL

RAILWAY ROLLING STOCK

LESSON EXERCISES
TRANS SUBCOURSE 655

Fort Eustis, Virginia

Supersedes Trans 655, Railway Rolling Stock, August 1969.

*** IMPORTANT NOTICE ***

THE PASSING SCORE FOR ALL ACCP MATERIAL IS NOW 70%.

PLEASE DISREGARD ALL REFERENCES TO THE 75% REQUIREMENT.

TRANS SUBCOURSE 655

RAILWAY ROLLING STOCK

INTRODUCTION

Operations in World War II and the Korean War have clearly demonstrated the value of railroads in moving supplies and troops over land with an economy of fuel and manpower. In any future conflict, it can be safely guessed that railway rolling stock would again carry a large number of troops, moving in organized groups, and a large tonnage of military freight.

You, as a member of the United States Army, may one day be serving in a rail unit. Whatever your assignment, whether it be in operations or maintenance, you should know your equipment--what it consists of, how it is constructed, and how it functions. Only by being thoroughly familiar with the major components of a piece of rolling stock can you be able to recognize promptly any malfunction and report it for correction.

This subcourse is intended to familiarize you with the types of rolling stock, distinguishable by their superstructures, and with their major components. It consists of six lessons and an examination, divided as follows:

		Credit hours
Lesson	1, Types of Rolling Stock	1
	2, Wheels and Axles	3
	3, Trucks	1
	4, Underframe, Draft Gear, and Couplers	2
	5, Brakes	1
	6, Safety Appliances	1
Examination		2
	Total	11

You are not limited as to the number of hours you may spend on the solutions of the lessons or the examination. For statistical purposes you are requested to enter on the answer sheet the number of hours spent on the solutions.

Text and materials furnished: Reference Text 655, Railway Rolling Stock, April 1974.

Upon completion of this subcourse, retain the reference text and exercise sheets. Do not return them with your answer sheet.

LESSON 1 .... Types of Rolling Stock.

CREDIT HOURS .... 1.

TEXT ASSIGNMENT .... Reference Text 655, pars. 1.1 - 1.9.

MATERIALS REQUIRED .... None.

LESSON OBJECTIVE .... To enable you to identify the categories of rolling stock: flatcar, enclosed car, gondola, hopper, tank car, passenger car, and caboose.

SUGGESTIONS .... None.

EXERCISES

Detach the consolidated answer sheet and enter your solutions in the space provided for this lesson. Retain the answer sheet to use with the remaining lessons.

<u>Weight</u> <u>True-False</u>

(On the answer sheet mark "X" under A for true or under B for false.)

Weight		
2	1.	The caboose is intended as the last car of a freight train.
2	2.	Flatcars can handle 100 percent of their load limit for concentrated loads.
2	3.	Today's passenger cars are of heavier construction than older ones.
2	4.	A heater car is equipped with a system to keep produce from freezing.

<u>Cluster True-False</u>

(Each of the following groups of questions is related to the statement that immediately precedes the group. On the answer sheet, indicate which are true and which false with respect to the statement by marking "X" under A for true or under B for false.)

Weight

		FIRST GROUP
		Specialization in a railroad's rolling stock has produced:
4	5.	Double-deck stock cars for small animals.
4	6.	Few changes in superstructures.
4	7.	Triple-deck flatcars for automobiles.
4	8.	A car with sloping floors for coal.
4	9.	No heated tank cars.
		SECOND GROUP
		If you were inspecting equipment in a railway yard, you might find:
4	10.	Tank cars loaded with propane gas, gasoline, and wine.
4	11.	The "donkey of the rails" with side doors that swing in and out.
4	12.	Hoppers with three doors on each side and one at the ends.
4	13.	Tied-down cargo containers on flatcars.
4	14.	Passenger cars of lighter construction than most freight cars.
		THIRD GROUP
		Among today's railway equipment we find:
4	15.	Flatcars constructed to give greater clearance for lading.
4	16.	No Army-owned cars to carry troops.
4	17.	No more cars requiring ice for cooling freight.
4	18.	More boxcars in use than ever before.
4	19.	Gondolas with sides of different heights.

Weight		Matching

Match the appropriate rail car from column II to each of the descriptive phrases listed in column I by marking "X" in the proper space on the answer sheet. Choices from column II may be used once, more than once, or not at all.

Weight	No.	Column I	Column II
4	20.	Designed for transporting cattle.	A. Hopper.
4	21.	Usually cleaned before being filled with another product.	B. Tank car.
			C. Caboose.
4	22.	Similar to a gondola.	D. Flatcar.
4	23.	Built for a freight train's crew.	E. Stock car.
4	24.	Well suited for piggy-backing trailers.	

Analytical

(Using the following key, indicate by marking "X" in the appropriate space on the answer sheet your reaction to each of the statements.)

A. The underscored statement is true, and the reason for it or result of it is true.

B. The underscored statement is true, but the reason or result is false.

C. The underscored statement is false.

3 25. <u>The caboose is the only freight car with glass-covered openings</u> so that trainmen can see out.

3 26. <u>Lumber can be carried on flatcars</u> because their high sides prevent shifting and sliding.

3 27. <u>Some enclosed cars have slatted sides</u> so that animals can breathe fresh air.

3 28. <u>All tank cars have only one dome</u> for filling the entire tank.

LESSON ASSIGNMENT SHEET

TRANS SUBCOURSE 655.......................................Railway Rolling Stock.

LESSON 2.. Wheels and Axles.

CREDIT HOURS...3.

TEXT ASSIGNMENT...Reference Text 655, pars. 2.1-2.26.

MATERIALS REQUIRED..None.

LESSON OBJECTIVE.. To enable you to identify the types of wheels, processes for manufacturing and marking them, limits of wear, and defects; to identify the kinds and types of axles, their markings, dimensions, wear limits, and defects; and to choose the procedures for mounting wheels on axles.

SUGGESTIONS... None.

EXERCISES

Enter your solutions on the consolidated answer sheet as indicated and retain it for use with succeeding lessons.

Weight — Cluster True-False

(Each of the following groups of questions is related to the statement that immediately precedes the group. On the answer sheet indicate which are true and which false with respect to the statement by marking "X" under A for true or under B for false.)

FIRST GROUP

In mounting wheels on axles, rail repairmen follow specific procedures; they:

2 1. Use a single-end press for cast-steel wheels and a double-end one for wrought-steel.

Weight

2	2.	Lubricate wheel seats and bores before mounting to prevent scratching.
2	3.	Apply pressure on the wheel, forcing it onto the stationary axle.
2	4.	Place guards over the journals before beginning the mounting itself.
2	5.	Use a higher pressure in the press than that applied for dismounting.
2	6.	Place high flange spots of mated wheels in the same place to produce a smooth roll.
2	7.	Remove axle and wheel, turn, and replace in a single-end press before mounting second wheel.
2	8.	Secure the wheels off center on the wheel seats to prevent future hotboxes.

SECOND GROUP

Axles found on freight cars today may be described as follows; they are:

2	9.	Of one set standard load capacity.
2	10.	Not designed with an end collar.
2	11.	Scrapped when wear-limit has been reached.
2	12.	All constructed with 5-x 9-inch journals.
2	13.	Constructed for use with friction or roller bearings.
2	14.	Marked with a numbered heat.
2	15.	Designated by grade: U, D, or F.

THIRD GROUP

When matching two wheels for one axle or matching wheels to axles, the following procedures should be applied:

Weight

2 16. Select one wrought-steel and one cast-steel wheel for the same axle whenever possible.

2 17. Re-turn an axle's wheel seat if one wheel bore of a pair of wheels is too small.

2 18. Mate a new wheel and a secondhand wheel on one axle.

2 19. Select two wheels of the same kind, type, and size for one axle.

2 20. Mount secondhand wheels to new axles if possible.

FOURTH GROUP

Wrought-steel wheels found on today's rolling stock have the following characteristics; the:

2 21. Furnaces producing ingots use the open-hearth process.

2 22. Identifying symbols AAR-1-W or AAR-MW appear in recessed letters on the collar of the hub.

2 23. Class U wheel is untreated and intended for general service.

2 24. Letter "R" is stamped on the multiple-wear wheel to indicate an additional heat treatment of the rim.

2 25. Multiple-wear wheel is originally made to bear the heavy weight of freight cars.

2 26. True circle of the wheel is formed in the rolling process.

2 27. Two-wear type is rapidly replacing the one-wear.

Matching

Column I lists defects of cast-steel wheels; column II lists descriptions of these defects. Match an appropriate description from column II to each defect in column I by marking an "X" in the proper space on the answer sheet. Choices from column II may be used once, more than once, or not at all.

Weight

Weight	No.	Column I	Column II
2	28.	Slid-flat.	A. Runs lengthwise around wheel's tread.
2	29.	Seam.	B. Resembles an inverted oyster shell.
2	30.	Flange worn thin.	C. Has a flange less thick than acceptable for safety.
2	31.	Vertical flange.	D. Has a flat spot caused by the wheel sliding on the rail.
2	32.	Shell-out.	E. Has the inside vertical surface of the flange worn down.

Column I lists defects of wrought-steel wheels and column II descriptions of these defects. Select an appropriate description from column E for each defect in column I by marking "X" in the proper space on the answer sheet. Choices from column H may be used once, more than once, or not at all.

Weight	No.	Column I	Column II
2	33.	Burnt flange.	A. Raises tread higher than original contour.
2	34.	Built-up tread.	B. Is a circumferential crack extending outward toward the rim.
2	35.	Cupid's bow crack.	C. Exposes a rough granular surface.
2	36.	Shattered rim.	D. Runs at right angle to tread and flange.
2	37.	Thermal crack.	E. Exposes a smooth surface of the rim.

Weight

When axles have defects, they should be marked with a specific AAR symbol number and removed from service. Column I lists the defects; match the appropriate number from column H to each defect in column I by marking "X" in the proper space on the answer sheet. Choices in column II may be used once, more than once, or not at all.

Weight	No.	Column I	Column II
2	38.	Broken axle.	A. AAR symbol 86-A.
2	39.	Burnt journal.	B. AAR symbol 85-C.
2	40.	Wheel seat worn below limit.	C. AAR symbol 84.
			D. AAR symbol 85-B.
2	41.	Back journal fillet.	E. AAR symbol 85.
2	42.	Journal length worn to limit.	

Analytical

(Using the following key, indicate by marking "X" in the appropriate space on the answer sheet your reaction to each of the statements.)

A. The underscored statement is true, and the reason for it or result of it is true.

B. The underscored statement is true, but the reason or result is false.

C. The underscored statement is false.

2 43. Multiple -wear wheels can be put on freight cars after being used in passenger service because wear limits on freight cars are greater.

2 44. A wrought-steel wheel may be marked with the letters BE to identify it as class B, multiple-wear, entire wheel treated.

2 45. You may find the mark AR cast on the back plate of a cast-steel wheel to indicate that it is class A, rim-treated.

Weight

2 46. When in storage, journals on axles with mounted wheels should be covered with lubricant to prevent rust from forming.

2 47. Wheels stamped AAR-1-W have a minimum rim thickness of 2 1/2 inches to permit several re-turnings of the flange and tread.

2 48. The steel-wheel gage is used on cast-steel wheels to measure the length of a slid-flat spot.

2 49. Solid axles for use with friction bearings are found on many military freight cars because their life is longer than those designed for roller bearings.

2 50. The flange worn thin is a serious defect of cast-steel wheels because it may cause derailment of equipment.

LESSON ASSIGNMENT SHEET

TRANS SUBCOURSE 655....................................Railway Rolling Stock.

LESSON 3.. Trucks.

CREDIT HOURS...1.

TEXT ASSIGNMENT...Reference Text 655, pars. 3.1-3.8.

MATERIALS REQUIRED.......................................None.

LESSON OBJECTIVE... To enable you to identify the parts of a typical truck and to explain the function of each.

SUGGESTIONS.. None.

EXERCISES

Enter your solutions on the consolidated answer sheet as indicated and retain it for use with succeeding lessons.

Weight		True-False
		(On the answer sheet mark "X" under A for true or under B for false.)
2	1.	Truck bolsters have coil springs at each end.
		Cluster True-False
		(Each of the following groups of questions is related to the statement that immediately precedes the group. On the answer sheet, indicate which are true and which false with respect to the statement by marking "X" under A for true or under B for false.)
		FIRST GROUP
		A six-wheel truck differs from a four-wheel in that it is:
4	2.	Equipped with coil springs instead of elliptical springs.

Weight		
4	3.	Rigged with one brakeshoe per wheel instead of two on inner wheels.
4	4.	Often constructed with the brake cylinder on the truck's side.
4	5.	Constructed with heavier side frames.
4	6.	Built to give a smoother ride at higher speeds.
		SECOND GROUP
		What happens when a piece of rolling stock moves over the rails? The trucks:
4	7.	Absorb much of the vibration.
4	8.	Receive the weight of the car.
4	9.	Furnish the power to move the car.
4	10.	Carry all of the braking equipment.
4	11.	May have two or three wheels.
		THIRD GROUP
		Each part of a truck serves a distinct function. The:
3	12.	Journal box lid prevents the lubricant from seeping out.
3	13.	Side bearing limits the side-to-side rocking.
3	14.	Bolster end interlocks the bolster itself with the truck side frame.
3	15.	Pin through the two center plates permits the swiveling of a truck under a car.
3	16.	Side frame contains the journal box.
3	17.	Journal bearing transfers a car's weight to the journal wedge.

Weight

FOURTH GROUP

What is characteristic of a truck's journal box, with friction bearing, that houses the axle journal? It:

Weight	No.	
4	18.	Has a dust guard to keep out dirt and moisture.
4	19.	Dissipates heat, from the wedge into the atmosphere.
4	20.	Holds lubricant to prevent the axle journal from overheating.
4	21.	Requires a bearing cast to the shape of the axle journal.
4	22.	Contains a permanently sealed-in journal bearing.

Matching

Match a truck part from column II to each phrase in column I that describes it by marking an "'X" in the appropriate space on the answer sheet. Choices from column H may be used once, more than once, or not at all.

Weight	No.	Column I	Column II
4	23.	Is parallel with the axles.	A. Journal box.
4	24.	Has two connecting columns.	B. Side frame.
4	25.	Provides continuous lubrication of the journal.	C. Live truck lever.
			D. Truck bolster.
4	26.	Steadies the car.	E. Side bearing.
4	27.	Applies brakes when moved.	

LESSON ASSIGNMENT SHEET

TRANS SUBCOURSE 655..Railway Rolling Stock.

LESSON 4...Underframe, Draft Gear, and Couplers.

CREDIT HOURS...2.

TEXT ASSIGNMENT..Reference Text 655, pars. 4.1-5.9.

MATERIALS REQUIRED...None.

LESSON OBJECTIVE...To enable you to identify the parts of the underframe, and the draft gear and couplers used in the United States and those found in foreign countries.

SUGGESTIONS...None.

EXERCISES

Enter your solutions on the consolidated answer sheet as indicated and retain it for use with succeeding lessons.

Weight — Cluster True-False

(Each of the following groups of questions is related to the statement that immediately precedes the group. On the answer sheet, Indicate which are true and which false with respect to the statement by marking "X" under A for true or under B for false.)

FIRST GROUP

How do the hook-and-link couplers found in foreign countries differ from couplers used in the United States? They:

Weight	No.	
3	1.	Operate with rubber draft gear instead of friction.
3	2.	Have a transition device to bypass the buffers.
3	3.	Have buffer assemblies mounted on end sills.
3	4.	Are safer to connect, one to another.

Weight

3	5.	Must be connected manually.
		SECOND GROUP
		What is characteristic of a rail car's underframe? It:
3	6.	Includes strengthening longitudinal parts called floor stringers.
3	7.	Includes five different sills: center, side, cross, floor, and end.
3	8.	Has crossbearers running parallel to the end sills.
3	9.	Is cast as one piece.
3	10.	Has two cross structural members called body bolsters.
		THIRD GROUP
		When cars in a train are coupled:
3	11.	Some slack is left in the couplers.
3	12.	Shocks as cars come together are cushioned by the draft gear.
3	13.	The connection of one car with the next is made.
3	14.	All cars start a the same time.
3	15.	Cars are usually moving about 10 miles per hour.
		FOURTH GROUP
		How are rail cars constructed?
3	16.	Draft gear is seated in the center sill pocket.
3	17.	Trucks are connected to the superstructure.
3	18.	Two transverse body bolsters are connected to the center sill, one near each end.

Weight

3 19. Longitudinal floor stringers strengthen the underframe.

3 20. Two side sills are fastened on each side of the center sill.

FIFTH GROUP

Friction draft gears work on the following principles:

3 21. Wedges and plates prevent the coil springs from recoiling rapidly.

3 22. Rubber plates absorb shocks during coupling.

3 23. Placed between coupler and underframe, they cushion the shock in coupling.

3 24. The friction unit aids the coil springs in recoiling rapidly.

3 25. Compression pressure is slowed down by the friction unit.

SIXTH GROUP

In the E coupler, used on most freight cars in the United States, you find the following:

3 26. The knuckle and the guard arm must remain in contact.

3 27. A knuckle lock prevents uncoupling.

3 28. Both coupling and uncoupling are entirely automatic.

3 29. A rotating hook throws the knuckle open.

3 30. Height from the top of the rail can be adjusted by adjusting height of car.

Matching

Match a part of the underframe from column II to its description in column I by marking "X" in the proper space on the answer sheet. Choices from column II may be used once, more than once, or not at all.

Weight		Column I	Column II
2	31.	Can be called the backbone of the underframe.	A. Striker plate.
2	32.	Has pockets for housing the draft gear.	B. End sill.
2	33.	Protects draft gear.	C. Body bolster.
2	34.	Extends from the side sill to the near side of the center sill.	D. Crosstie.
2	35.	Has a counterpart on the truck.	E. Center sill.

LESSON ASSIGNMENT SHEET

TRANS SUBCOURSE 655....................................Railway Rolling Stock.

LESSON 5.. Brakes.

CREDIT HOURS...1.

TEXT ASSIGNMENT...Reference Text 655, pars. 6.1-6.11.

MATERIALS REQUIRED.....................................None.

LESSON OBJECTIVE.. To enable you to identify the parts of the KC and AB airbrake systems and of handbrakes; and to explain their operating principles.

SUGGESTIONS.. None.

EXERCISES

Enter your solutions on the consolidated answer sheet as indicated and retain it for use with lesson 6.

Weight | Cluster True-False

(Each of the following groups of questions is related to the statement that immediately precedes the group. On the answer sheet, indicate which are true and which false with respect to the statement by marking "X" under A for true or under B for false.)

FIRST GROUP

Both the AB and KC airbrake systems have the following parts:

3 1. Dirt collectors combined with release valves.

3 2. Branch-pipe tees.

3 3. Five pipe connections to the valve.

3 4. Triple-compartment air reservoirs.

3 5. Train lines.

Weight		
3	6.	Triple valves.
3	7.	Release valve.
		SECOND GROUP
		On a moving train, 36 coupled cars using the KC or AB brakes can be safely braked:
4	8.	Even if five cars have inoperative airbrakes.
4	9.	By exhausting air from the system.
4	10.	From the locomotive.
4	11.	By closing the cut-out cocks.
4	12.	To a full stop very quickly.
		THIRD GROUP
		All railway cars have handbrakes that:
4	13.	Can be used by trainmen to stop cars when switching in yards.
4	14.	Use handwheels placed at right angles to the sides of the cars.
4	15.	Operate in similar ways by handwheels or hand levers.
4	16.	Work in connection with the airbrake system.
4	17.	Have chains that wind around vertical shafts.
4	18.	Have helical gears meshing with other gears.
		FOURTH GROUP
		The KC airbrake system differs from the straight airbrake in that it has:
4	19.	A triple valve with three pipe connections.

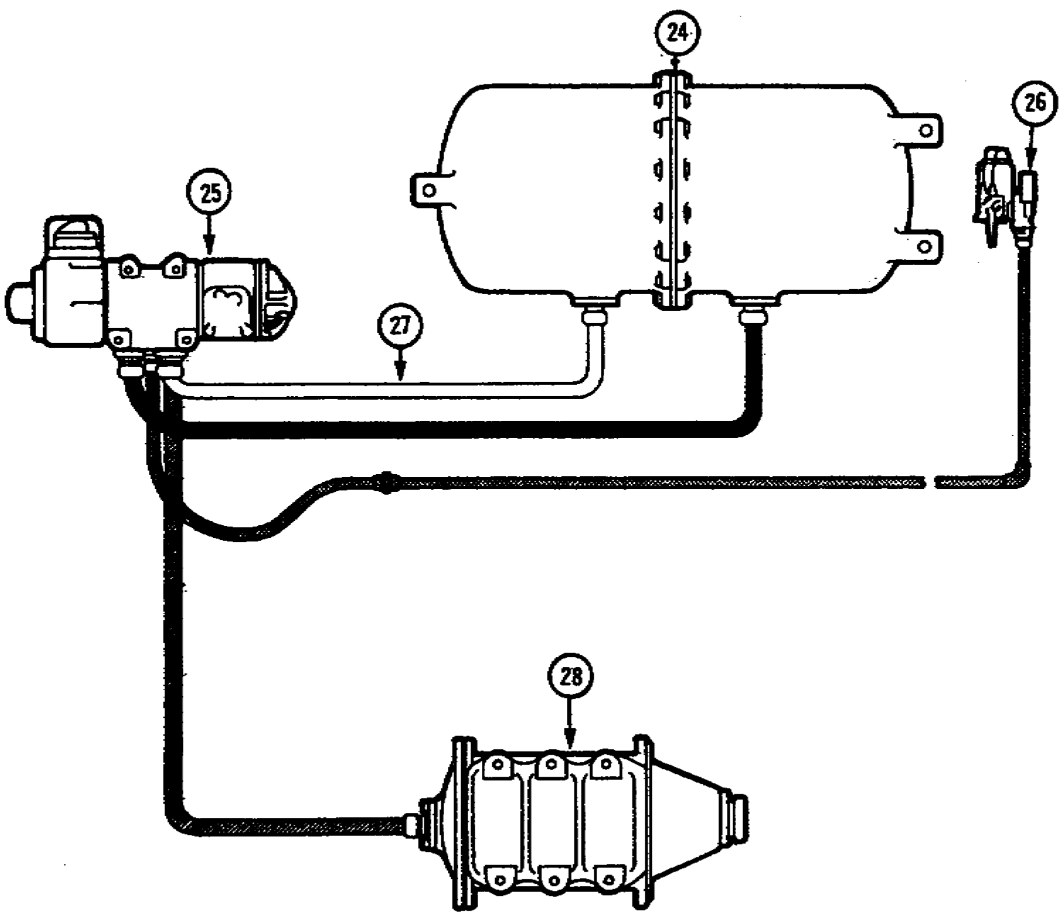
Weight

4	20.	An airbrake cylinder attached directly to an auxiliary reservoir.
4	21.	An air compressor on the locomotive for recharging the reservoir.
4	22.	Fewer parts and simpler construction.
4	23.	Direct piping from the supply reservoir in the locomotive to each car.

Matching

In questions 24 through 28, match a named part from column II to each numbered part in the diagram of the braking system shown in column I to identify it. A weight of 3 credit points is given for each choice. Mark "'X" in the proper space on the answer sheet.

Column I



Weight

Column II

A. AB valve.

B. Release control retainer.

C. Two-compartment reservoir.

D. Brake cylinder.

E. Emergency reservoir pipe.

LESSON ASSIGNMENT SHEET

TRANS SUBCOURSE 655....................................Railway Rolling Stock.

LESSON 6.. Safety Appliances.

CREDIT HOURS..1.

TEXT ASSIGNMENT..Reference Text 655, pars. 7.1-7.9.

MATERIALS REQUIRED..None.

LESSON OBJECTIVE.. To enable you to identify the various ladders, handholds, and other attachments placed on cars for the safety of trainmen.

SUGGESTIONS... None.

EXERCISES

Enter your solutions on the consolidated answer sheet as indicated and mail in the addressed envelope provided.

Weight — Cluster True-False

(Each of the following groups of questions is related to the statement that immediately precedes the group. On the answer sheet, indicate which are true and which false with respect to the statement by marking "X" under A for true or under B for false.)

FIRST GROUP

What safety attachments does a caboose have for the protection of the train crew? It:

Weight	No.	
4	1.	Has vertical handholds on each side of side doors.
4	2.	Has sill steps leading to its platform
4	3.	Needs no roof running board when it has a cupola.
4	4.	Has handholds around the top of a cupola.

Weight		
4	5.	Must have platforms, one at each end.

SECOND GROUP

Certain parts of a piece of rolling stock, such as the handbrake and uncoupling lever, have definite requirements for the safety of trainmen. Also, specific dimensions have been laid down for the safety appliances required on railway cars. They are as follows:

3	6.	Running board on sides of tank car-a minimum width of 6 inches.
3	7.	Handbrake shaft on flatcar-on left side at least 40 inches from end of car.
3	8.	Handhold on top of caboose cupola-3 inches above cupola's roof.
3	9.	Longitudinal running board on roof of boxcar-at least 24 inches wide.
3	10.	Uncoupling lever on boxcars-12 inches from top of rail when unlocked.
3	11.	Roof handholds on refrigerator car-8 inches or less from edge of roof.
3	12.	Sill steps on boxcars-clearance between tread and car not more than 21 inches.

THIRD GROUP

What safety appliances does a tank car have that are not found on enclosed cars and flatcars ?

4	13.	A 4-inch-wide end running board when it has no end sills.
4	14.	Handholds on or near each dome.
4	15.	A continuous running board all around when there are no end sills.
4	16.	A safety railing at least on the sides of the tank.

Weight		
4	17.	Sill steps at least 32 inches above the rails, close to the running board.
		FOURTH GROUP
		What appliances does a typical boxcar have?
4	18.	A brake step at least 28 inches long.
4	19.	Only two ladders, on one side and one end.
4	20.	Handholds on the roof above ladders.
4	21.	Horizontal handholds on the ends.
4	22.	Handbrake wheels at both A and B ends.
4	23.	A running board all around it.
		FIFTH GROUP
		The ends and sides of railway cars are specifically designated to distinguish one from the other. All cars have:
3	24.	Their brake-cylinder piston rod pointing to the B end.
3	25.	The handbrake wheel on the B end.
3	26.	C and D sides.
3	27.	Stenciled letters, A and B, on their ends.
3	28.	Right and left sides.

REFERENCE TEXT
655

RAILWAY ROLLING STOCK

The information contained herein is provided for instructional purposes only. It reflects the current thought of this school and conforms to printed Department of the Army doctrine as closely as possible. Development and progress render such doctrine continuously subject to change.

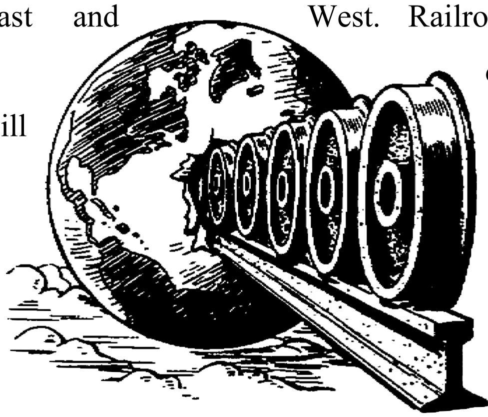
U. S. ARMY TRANSPORTATION SCHOOL
Fort Eustis, Virginia

Supersedes Reference Text 655, Railway Rolling Stock, August 1969.

CONTENTS

INTRODUCTION

American railroads have been called the backbone of the Nation's transportation system ever since the day in May, 1869, when the last spike was driven in the track at Promontory, Utah, connecting the rail lines from the East and West. Railroads are still one of the best ways of hauling heavy freight over long distances; the U.S. Army has always used them and probably always will use them to support its military missions. Although today's commercial railroads offer a fantastic array of special freight cars, military railway equipment includes the more standard, basic rail cars, especially in the fleet of equipment designed for foreign service.



This text offers a general introduction to the various types of cars commonly used in military railway operations. It also explains the basic major components in terms of their parts, construction, location, and function. No attempt has been made to describe or even enumerate the many variations and refinements that have been made on commercial rail car components and cars themselves to tailor them for specific transportation jobs. When you have finished your study of Railway Rolling Stock, you will not be an expert on rail equipment, but you will know something about what it is, what parts are found in each rail car, what they are used for, and what can go wrong with them.

In this text, after a brief description of their superstructures, railway cars are approached from the wheels up. Discussions include those on the types of freight cars, wheels and axles, trucks; underframes, draft gear and couplers, braking systems, and safety appliances; a chapter is devoted to each of these subjects.

Chapter 1

TYPES OF ROLLING STOCK

1.1. GENERAL

Since the first steam-powered train operated in South Carolina in late 1830, technological advances and industrial expansion have continuously created new requirements for the railroads of this Nation. Part of the railroad's answer to these problems has been the development of special rolling stock. The scope of this text is not great enough to include the many variations in the superstructures of rail cars that specialization has brought about; however, most rolling stock can be classified as either freight or passenger and placed into seven broad categories: flatcar, enclosed car, gondola, hopper, tank car, caboose, and passenger car. Each of these categories is discussed in the order mentioned.

1.2. FLATCAR

Supplies and equipment that need no protection from weather are often moved on flatcars. These cars, similar to the one shown at the top of figure 1. 1, are constructed with either welded or riveted steel underframes and covered with wood floors. Stake pockets are added on the sides and ends for fastening tiedowns that keep loads from shifting. The Army uses flatcars to transport such things as assault boats, vehicles, cranes, lumber, large crated loads, and cargo containers. Flatcars can handle 75 percent of their load limit for concentrated loads and 100 percent for uniformly distributed loads.

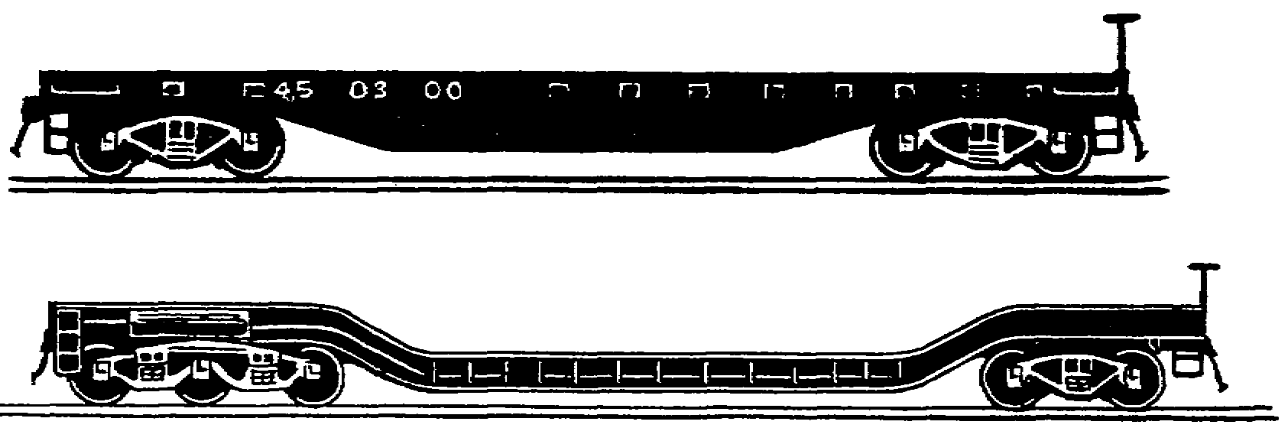


Figure 1.1. Flatcars.

Several variations of the flatcar have been developed; two are most useful: the depressed-center and the well-hole. Both of these have the principal advantage of providing additional overhead clearance for freight or equipment that cannot be carried on the standard flatcar. The depressed-center flatcar has a portion of the floor between the trucks depressed, as shown at the bottom of figure 1.1. Well-hole flatcars also have a portion of the floor depressed, but the depressed portion has enclosed sides.

1.3. ENCLOSED CAR

Cars that completely, or nearly, enclose the freight they are carrying have many variations in their superstructures. They all, however, have roofs, sides, ends, and doors, and protect their contents from the weather. Of the different types of enclosed cars, the boxcar, the refrigerator and heater car, and the stock car are the most common.

a. Boxcar. Until recently, the boxcar was the most widely used of all freight equipment; however, it is becoming secondary in usefulness to the flatcar. For example, automobiles were formerly transported in boxcars; now the current trend is to use flatcars with double- and triple-deck superstructures to transport them. More and more commodities are being shipped in prepackaged, weatherproof containers that are well suited for the flatcar or for trailers that are carried piggyback on flatcars. As a result, the boxcar is losing some of its popularity. Although the dimensions of boxcars vary, most of those used in the United States have interior lengths ranging from 40 feet 6 inches to 53 feet 6 inches. Side doors on these cars are at least 10 feet wide. A typical boxcar is shown in figure 1.2.

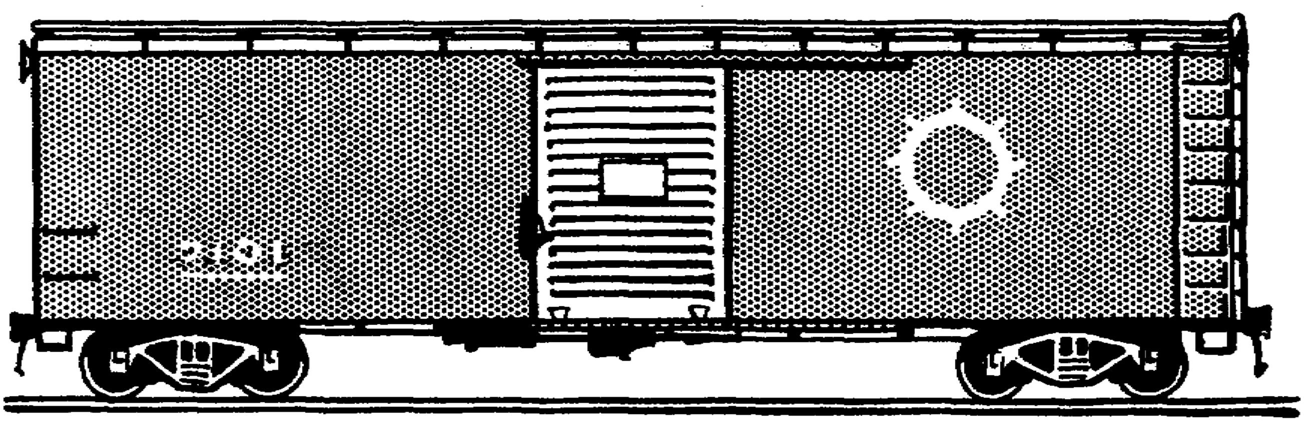


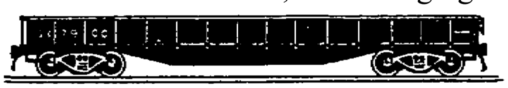
Figure 1.2. Typical Boxcar.

b. Refrigerator and heater cars. Two special types of enclosed cars used to transport perishables are refrigerator and heater cars. Refrigerator cars are usually equipped with one of three basic cooling systems: chunk ice, brine made of crushed ice and salt, or mechanical cooling systems. Heater cars have either temporary or permanent heating systems using charcoal, alcohol, coal, or propane gas for fuel.

c. Stock car. The principal difference between the construction of stock cars and boxcars is that the sides of stock cars are slatted with air space between to permit a free circulation of air for livestock. These cars are of either the single- or the double-deck variety depending upon the size of the animals to be hauled. Stock cars are often used to ship produce, such as lettuce and cabbage; they are also used to ship lumber, brick, and tile that need no protection from the weather.

1.4. GONDOLA

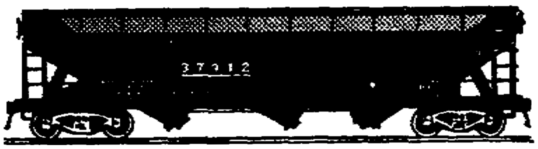
Because of the wide variety of freight hauled in gondolas, their designs vary greatly. Often referred to as "the donkey of the rails," gondolas may have high and low sides, end and side doors, drop doors in the floors or at the ends of the car, and swinging side doors. Depending on their construction, they are referred to as solid-bottom, drop-bottom, hopper-bottom, side-dump, and well-hole. Gondolas are used to transport such things as steel products, lumber, brick, coal, ore, machinery, and large cargo containers.



One rail line in the United States has recently put into operation a fleet of gondolas with all-white interiors as an aid to loaders working at night. It seems that crane operators, loading steel pipe for example, have always had trouble estimating how far their loads were from the bottom of the gondolas. Black interiors against the night darkness offered no contrast; operations were slowed down and loads were frequently damaged when they were slammed down too hard. Now, with interiors painted white with a special light-reflecting paint, loadings at night are faster and gentler on the lading.

1.5. HOPPER

Designed primarily to haul coal, the hopper is similar to the gondola except that instead of level floors it has floors that slope from the ends and sides to hopper doors through which the load can



be discharged by gravity. The capacity of these cars ranges from 50 to 80 tons with the number of hopper doors ranging from 2 to 4.

1.6. TANK CAR

Liquids, petroleum products, and compressed gases are transported in tank cars, similar to the one shown in figure 1.3. The large steel tank is mounted on either a steel underframe or cradles resting on the truck bolsters. On top of the tank, one or more domes are constructed; the number depends upon the number of compartments with usually one dome for each compartment. Inside the dome are openings through which the tank is filled; discharge of the contents is usually through pipes or hoses fitted at the bottom of the tank. Cars designed to transport semifluids, such as molasses and asphalt, are usually equipped with heating pipes. Tank cars have capacities ranging from 8 to 20 thousand gallons, with a variation of interior linings designed for the products they are intended to contain. Plastic, glass, lead, and copper are a few of the materials that line the interiors. Tank cars usually require a thorough cleaning before they are filled with a different product.

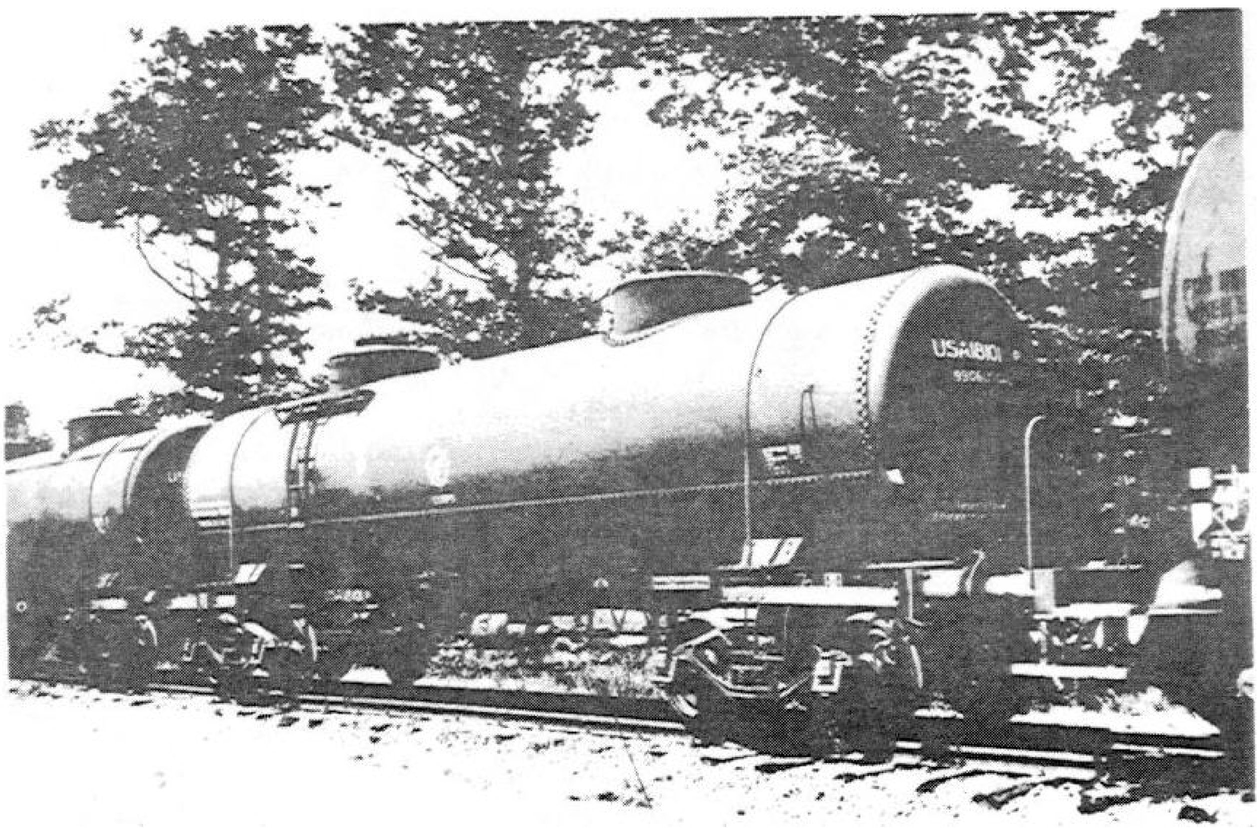


Figure 1.3. Tank Car Designed for Foreign Service.

1.7. CABOOSE

The caboose is a special car used as the last car on a train. It is designed to provide accommodations for the train crew and carries such emergency equipment as lanterns and signal devices. Cabooses are of two basic designs, both permitting men riding in them to observe train operations: they have either a raised glass cupola or glass bays set into the sides of the car. Today many cabooses are equipped with microwave radios that provide communications between the conductor in the caboose and the engine crew, yardmen, and dispatchers.

1.8. PASSENGER CAR

For a smooth and comfortable ride and for safety reasons, a passenger car is of heavier construction than a freight car. Built for high-speed service, today's new commercial passenger cars are constructed of aluminum or stainless steel; this makes them of much lighter weight than older ones. All cars used in a passenger train, whether for mail or baggage, must meet the same safety regulations as those carrying people. Although the Army has cars for transporting troops, for carrying guards when accompanying classified shipments, and for use in ambulance service, the bulk of its rail equipment is for moving freight. For that reason, this text concentrates almost entirely on freight cars.

1.9. SUMMARY

Railway rolling stock is divided into seven broad categories: flatcar, enclosed car, gondola, hopper, tank car, caboose, and passenger car. Many specialized variations in each category have been developed. The trend in the design of rolling stock has been to modify equipment to meet changing transportation needs.

The open cars, such as flats, gondolas, and hoppers, are used primarily to transport equipment and bulk products that do not need protection from the weather. With the development of containers and piggyback trailers, the use of flats and gondolas has become more extensive. These containers and trailers offer their own protection of contents from the weather. Perishable goods and cargo subject to damage from the weather are transported in enclosed cars, such as the boxcar, the refrigerator car, and the heater car. Stock cars with slatted sides are used to transport livestock and produce. These cars provide ventilation and some protection from the weather. Tank cars are used for carrying liquids, petroleum products, and compressed gases; domes are found on top of the tank, generally one for each compartment.

The last car on a freight train, the caboose, carries men in the train crew as well as emergency equipment. It is constructed with either a raised glass cupola or glass bays, giving those in the caboose a good view of train operations.

Now that you are familiar with the general types of rolling stock with their distinctive superstructures, you are ready for a description of the different parts of the typical railway car. The next chapter discusses wheels and axles.

Chapter 2

WHEELS AND AXLES

2.1. INTRODUCTION

The variety of rail car superstructures is numbered by the hundreds; however, the parts making up a piece of rolling stock are basically the same in every type of car. Starting from the rails and building upward, the first stop is, of course, at the wheels. Next in order are the axles and then the joining or mating of two wheels with each axle. A separate section is devoted to each of these, in the order mentioned.

Section I. Wheels

2.2. GENERAL

Probably the most important single development in the history of technology is the wheel. Transportation, particularly modern transportation, was built around the wheel, and it wasn't until the advent of rocket propulsion that it began to assume a secondary role. Of all the specialized wheels ever developed, none has ever approached the tonnage-movement capability of the freight-car wheel. When you listen to the sounds of a speeding train and hear the high singing voice of its wheels riding twin ribbons of steel, you can in no way deny the urgent feeling of power in motion. The special wheel used on railway cars carries food from the world's bread baskets, feeds raw materials to the hungry mouths of industry, and distributes industrial byproducts to the ever-increasing, ever-expanding world market: an instrument of peace and prosperity. The railroad wheel has also been used for making war. Each time it has become militarized, it has carried out its mission of rolling troops and supplies to where they were needed. When you, as a transportation officer, become involved with this highly special railroad wheel, it will most probably be used in time of war. You will need to know something about it: how it is made, what can go wrong with it, how much it can be used, and how to determine when its work is finished. These things are explained in this section.

2.3. TYPES OF WHEELS

Two principal types of wheels are in general use in the United States today: cast-steel and wrought-steel. While the Army still has some cast-iron wheels on equipment used only on the utility railroads inside installations, their use in the interchange service in the United States ended in 1967.

Both steel wheels are one-wear, two-wear, or multiple-wear, designating the number of times the rim, after wearing off, can be restored to its original flange contour. In the one-wear wheel, once the flange or tread is worn to the condemning limits, the rim thickness is not great enough to permit any restoring; the two-wear wheel can be restored once and the multiple-wear several times until the condemning limit of the one-wear wheel is reached. The two main points discussed in this section are how to detect wheel defects and how to determine wear limits. First, however, two paragraphs describe briefly the wheels themselves and the processes of manufacturing that conform to the Association of American Railroads (AAR) specifications for foundry practice, inspections, tests, and records.

2.4. CAST-STEEL WHEEL

Used only for freight cars, cast-steel wheels are made of steel melted in electric furnaces. Wheels fall into one of five classes:

Class U--untreated; for general service where an untreated wheel is satisfactory.

Class A--treated; for high-speed service with severe braking conditions but with moderate wheel loads.

Class B--treated; for high-speed service with severe braking conditions and heavier wheel loads.

Class C (l)--treated; for service with light braking conditions and high wheel loads.

(2)--treated; for service with heavier braking conditions where off-tread brakes are used.

The heat treatment for classes A, B, and C wheels includes treatment of the rim only. Wheels are reheated uniformly to refine the grain and then the rims are quenched. After quenching, wheels are put into a furnace for tempering to meet required hardness and then cooled under controlled conditions.

One-wear, cast-steel wheels are still in service but their manufacture has been discontinued.

2.5. WROUGHT-STEEL WHEEL

New two-wear and multiple-wear wrought-steel wheels are generally used on passenger cars, and on high-capacity engines and freight cars. The one-wear wheel is lighter in weight than the multiple-wear wheel and is designed for use primarily on freight cars. Multiple-wear wheels are used initially on passenger cars, and when they are worn to condemning wear limits, they are turned down and restored to original contour and used in freight service. Manufacture of the two-wear wrought-steel wheel has been discontinued. Those still in service are marked AAR-2-W.

The same five classes of cast-steel wheels (par. 2.4) apply also to wrought-steel. One-wear wheels, designated AAR-1-W, have a minimum rim thickness of 1 1/4 inches; multiple-wear, marked AAR-MW, are of heavier construction with a minimum rim thickness of 2 1/2 inches.

The fundamental principles used by manufacturers to make wrought-steel wheels are similar, but they differ in detail. These wheels are made from ingots produced by the open-hearth process of steel manufacture. The open-hearth furnaces usually have a capacity of from 60 to 100 tons; they require from 8 to 12 hours to produce steel ready for pouring from iron and steel scrap. Within these furnaces the molten metal is boiled thoroughly to destroy the impurities and to expel the injurious portions to obtain a homogenous steel containing from 0.7 to 0.8 percent carbon.

Once the molten metal is ready for pouring, one of three methods is used to produce a block or ingot of steel of suitable weight to shape a wheel: (1) a cylindrical block is produced by rolling a large ingot to a wheel bloom 15 to 18 inches in diameter and then hot-shearing (cutting while hot) it to a suitable length; (2) an ingot is cast and then cut when cold to the proper length; or (3) a block of suitable weight is cast in the form of an individual ingot. After the ingots are poured and sized, they are called wheel blanks; these are then rolled into wheels while being rotated on either a vertical or a horizontal plane. The wheels, after the rolling process, have straight plates which are coned or dished by a final pressing operation. At the same time, the circumference of the rim is formed to a true circle. The wheels are then branded with the appropriate symbols and allowed to cool under properly controlled conditions to prevent weak spots from forming in the steel.

The manufacturing process of multiple-wear, wrought-steel wheels includes an additional heat treatment of either the wheel rim or the entire wheel. This treatment increases the hardness of the metal and causes the wheel to wear longer before reaching the wear limits. The letters R for "rim treated" and E for "entire wheel treated" are stamped on the wheel along with other information.

2.6. WHEEL MARKINGS

Both cast-steel and wrought-steel wheels bear markings that provide a skilled observer with complete information about the wheel. The markings, although giving generally the same information, are displayed differently on each type of wheel.

a. Cast-steel wheel markings are hot stamped on the back face of the rim or cast on the back plate of the wheel according to specifications given in the AAR Manual of Standards and Recommended Practices. Figure 2.1 shows the markings on the back plate of a wheel. In letters at least 1 inch high, the marks show the month,

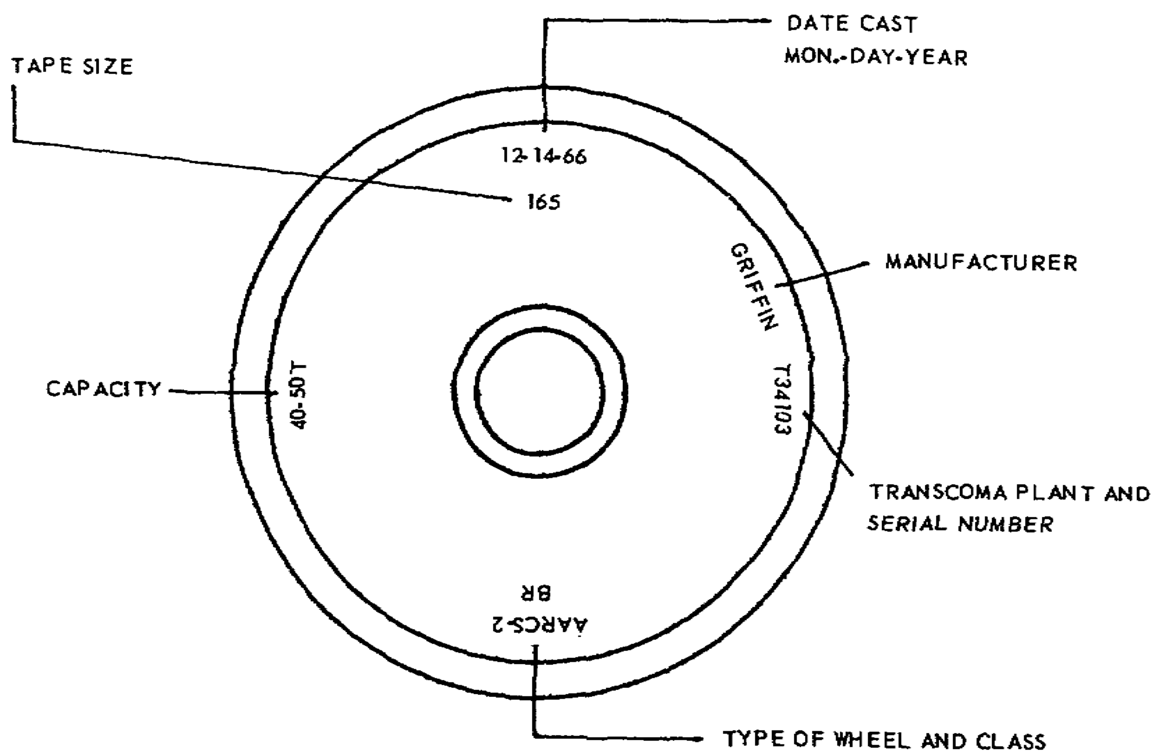


Figure 2.1. Markings on Cast-Steel Wheel.

day, and year of casting; the name of manufacturer, the name of its plant, and the serial number; the type of wheel and the class; and the capacity of the car it can be used on. In figure 2.1, you see for type of wheel and class AARCS-2, BR; these marks stand for cast-steel, two-wear, class B, rim-treated. Untreated wheels, class U, are not marked for class. The tape size is paint-stenciled, shown in the figure as 165. A wheel circumference tape, with sizes calibrated in increments of one inch, is used for measurements. Taping wheels is important to insure that wheels mounted on the same axle have the same diameters.

b. Wheel markings for wrought-steel wheels are somewhat different for one- and multiple-wear wheels. Markings for each are explained in the following subparagraphs and shown in figure 2.2.

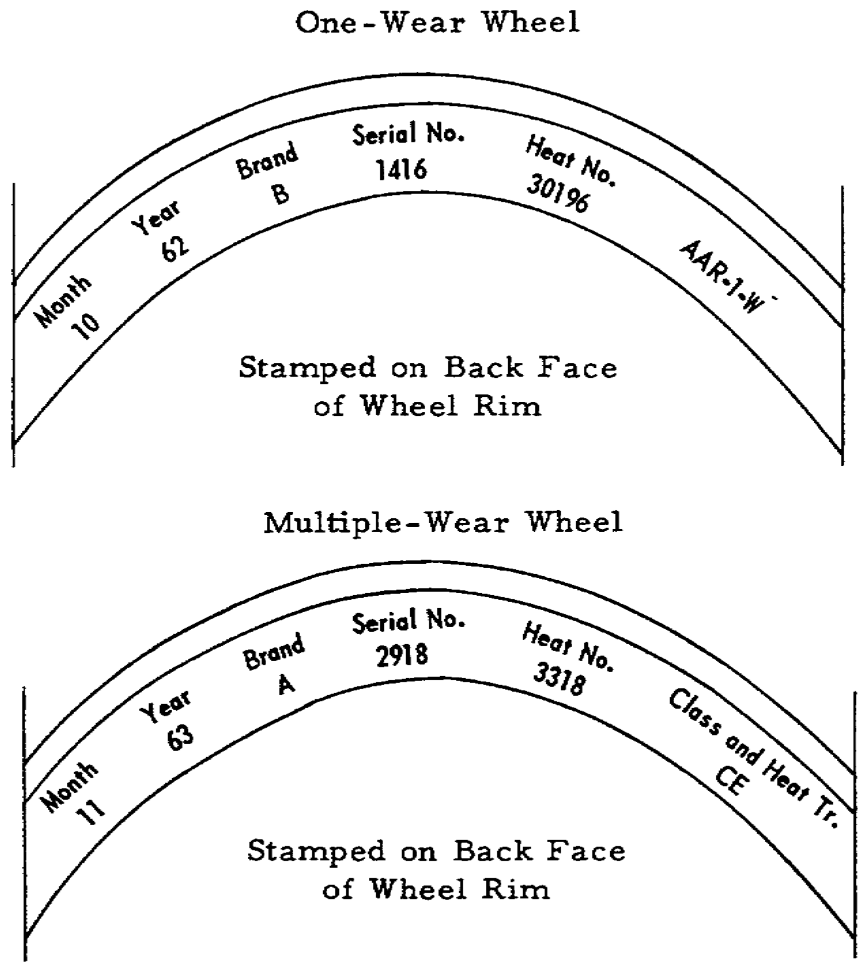


Figure 2.2. Markings on Wrought-Steel Wheels.

(1) On one-wear wheels the month and year the wheel is manufactured, the brand of the manufacturer, the manufacturer's serial number, the heat number, and identification mark AAR-1-W

are stamped on the back face of the wheel rim approximately one-fourth inch from the inner edge of the rim.

(2) On AAR-MW wheels, the month and year of manufacture, the brand and serial number of the manufacturer, the heat number, and the class (A, B, or C) along with the method of heat treatment are stamped on the back face of the rim approximately one-fourth inch from the edge of the rim. The method of heat treatment mentioned here and in the preceding paragraph and the class of the wheel are marked together. The following list shows these marks and what they mean.

AR - Class A, rim treated.

AE - Class A, entire wheel treated.

BR - Class B, rim treated.

BE - Class B, entire wheel treated.

CR - Class C, rim treated.

CE - Class C, entire wheel treated.

Note: Class U, untreated wheels, are not marked for class.

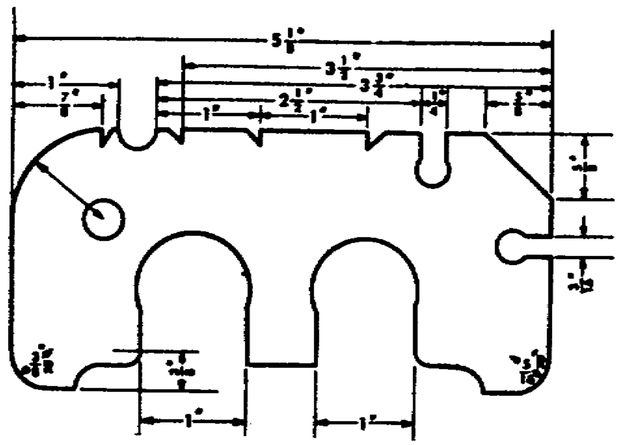
2.7. LIMITS OF WHEEL WEAR AND WHEEL DEFECTS

Now that you are familiar with the types of wheels, we are ready to examine how much each type of wheel may be worn before it is removed from service or restored to original contour. The next paragraphs describe, first, the wheel gages used in measuring wear on different parts of a wheel; second, the most common defects found in cast-steel wheels; and third, those in wrought-steel wheels.

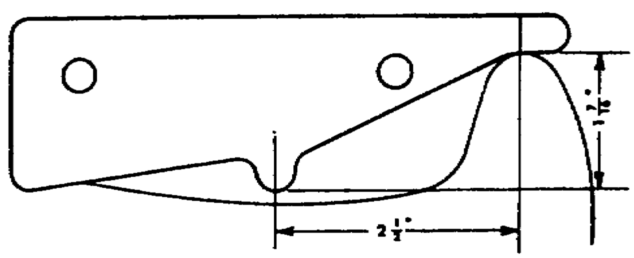
2.8. GAGES

The tools you use to find out the amount of wheel wear and the extent of defects are gages. Only four gages are described here; they are the most frequently used. There are others which you might have to use if you were inspecting wheels, especially new ones.

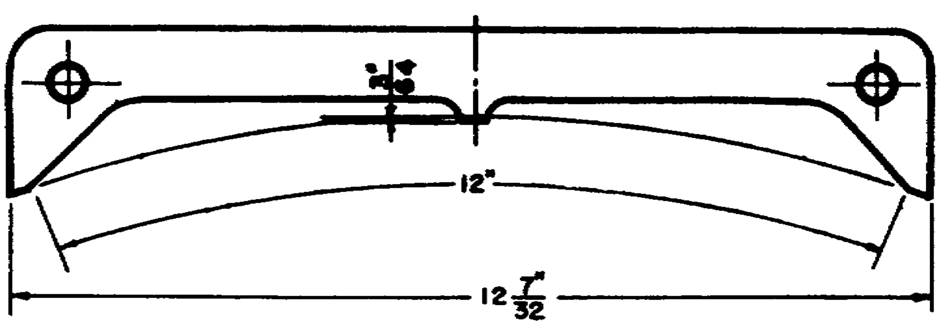
Used for a number of inspections, as you can tell from its long name, is the gage called the wheel defect, worn coupler limit, worn journal collar, and journal fillet. It is shown in the top sketch in figure 2.3. Throughout the rest of the discussion on wheels, this gage is referred to only as the wheel-defect gage; in later parts of your text, its other uses are explained. The wheel-defect gage is used mainly on cast-steel wheels. Two other gages, the tread-worn-hollow and the out-of-round, measure the two defects of the same names, appearing in cast-steel wheels. They are sketched also in figure 2.3.



Wheel defect, worn coupler limit, worn journal collar, and journal fillet gage.



Tread-worn-hollow gage.



Out-of-round gage.

Figure 2.3. Gages Used on Cast-Steel Wheels.

Most of the inspections made on wrought-steel wheels are made with one gage, the steel-wheel gage shown in figure 2.4. When

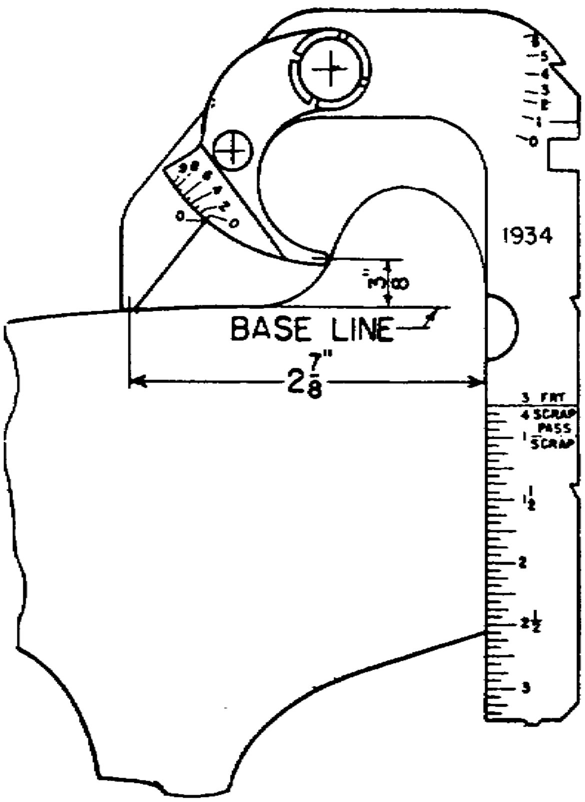


Figure 2.4. Steel-Wheel Gage.

various defects are described in the next two paragraphs, you will see how these four gages are used.

2.9. DEFECT AND WEAR LIMIT--CAST-STEEL WHEELS

United States military railway practices conform generally to the material and maintenance specifications of the Association of American Railroads. Defects and wear limits of cast-steel wheels are covered in the AAR Wheel and Axle Manual; the AAR rule number and the symbol used for marking condemning wheel defects and excessively worn wheels are given along with the name and description of the defects; no attempt is made in this text to cover all possible wheel defects; however, those that occur most frequently are discussed in the following subparagraphs.

a. Slid-flat (Rule 68--AAR symbol 68). When brakes are applied with so much force that the brakeshoe is pressed against the wheel hard enough to prevent the wheel from turning, the wheel slides on the rail. The wheel area in contact with the rail is small and heat is generated rapidly, because of the great amount of friction between the wheel and the rail. The area of the wheel in contact with the rail is worn off quickly, leaving a flat spot whose length depends on the distance the wheel slides. Once the brakes are released, the wheel is free to move, and the slid-flat spot lengthens itself with each rotation of the wheel.

A wheel with a slid-flat defect 2 1/2 inches in length or with two-or more adjoining spots each 2 inches or over is condemnable. Although a slid-flat defect of 2 1/2 inches is not considered dangerous, it causes the car to ride roughly and damage the rails. For these reasons, slid-flat defects on wheels under passenger cars are limited to 1 inch in length. To measure a slid-flat spot, a wheel-defect gage is used, as shown in figure 2.5.

Figure 2.5. Measuring Slid-Flat Spot.

b. Shell-out (Rule 71--AAR symbol 71). Although the true cause of the shell-out defect has not been defined, it is probably caused by foreign material in the wheel tread. The name of this defect is derived from the fact that it looks somewhat like an inverted oyster shell with a high center. The same gage is used as for a slid-flat defect, and the same measurements condemn the wheel from further freight and passenger service. The same rough riding and rail damage occur with this defect as with a slid-flat defect.

c. Seams (Rule 72--AAR symbol 72). Seams are manufacturing defects; they run lengthwise around the wheel and cause either the flange or the rim of the wheel to break off. Any seam detected within 3 3/4 inches of the flange condemns the wheel from further service. Part of a wheel with a seam defect is shown in figure 2.6.

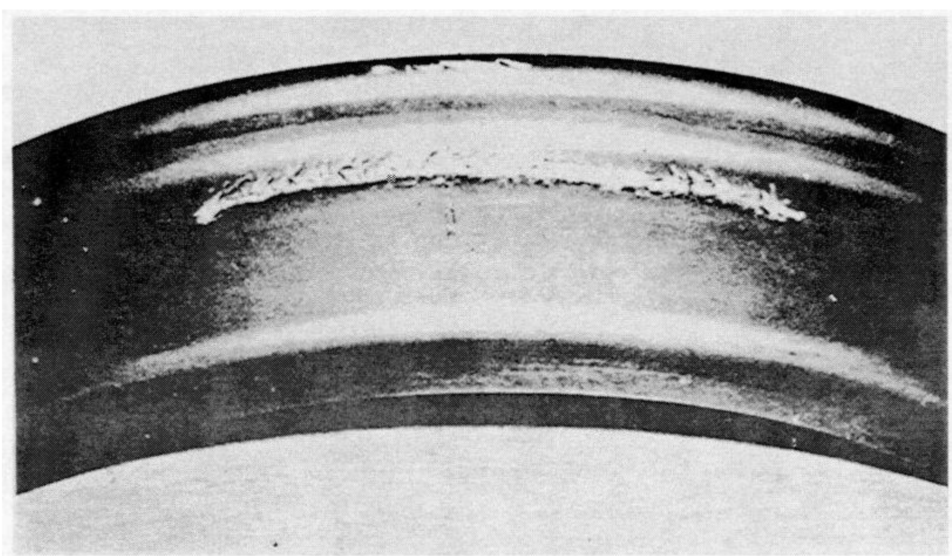
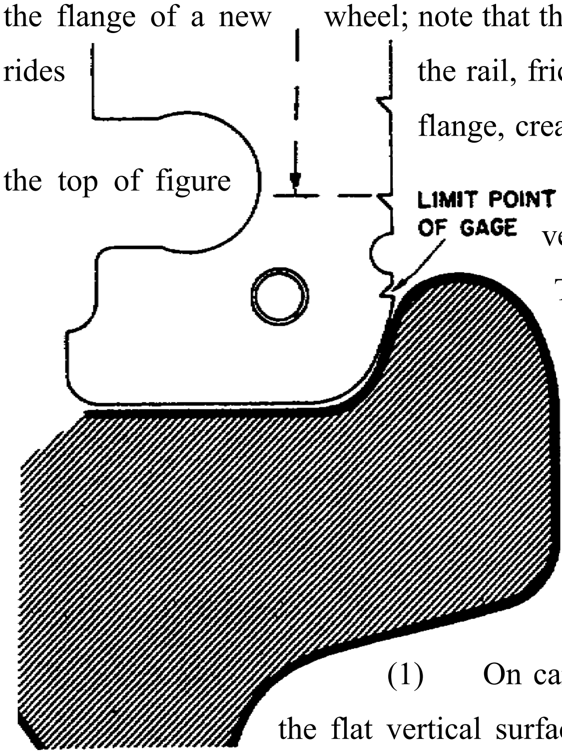
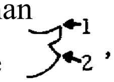


Figure 2.6. Seam Defect.

d. Out-of-round (Rule 73--AAR symbol 73). Although not dangerous, the out-of-round defect is undesirable because of the damage it can cause to equipment, track, and lading when the car it is under is traveling at high speeds. When the flattened area, regardless of the cause, is in excess of 3/64 inch within an arc of 12 inches or less, measured in the center of the tread, the wheel is condemnable. Figure 2.3 shows the application of the out-of-round gage for a wheel with a 33-inch diameter. Wheels with larger diameters must be gaged with out-of-round gages made especially for wheels of their diameter; however, the size of the wheel for which the gage is made is stamped on the gage.

e. Vertical Range (Rule 74--AAR symbol 74-V). The inserted sketch shows a wheel-defect gage applied to the flange of a new wheel; note that the spot marked "limit point" does not touch the flange. As the wheel rides the rail, friction tends to wear down or flatten the inside vertical surface of the flange, creating the defect called vertical flange or sharp flange. The sketch at the top of figure 2.7 shows the wheel-defect gage applied to a flange worn vertically; note here that the gage's limit point now touches the flange. There are two limit points, a 1" limit and a 7/8" limit as seen in used for two different car capacities: less than 80,000 pounds and 80,000 pounds or more. The chief danger of the vertical flange defect is that the flange may split a switch (take the wrong side of the switch point) and derail the equipment or break the switch point.





(1) On cars of less than 80,000-pound capacity, a wheel is condemned when the flat vertical surface of the flange extends 1 inch or more above the tread and thus touches the gage at the 1-inch limit point.

(2) On cars of 80,000-pound capacity or more, a wheel is condemned when the vertically worn surface of the flange extends 7/8 inch above the tread and touches the gage at the 7/8-inch limit point.

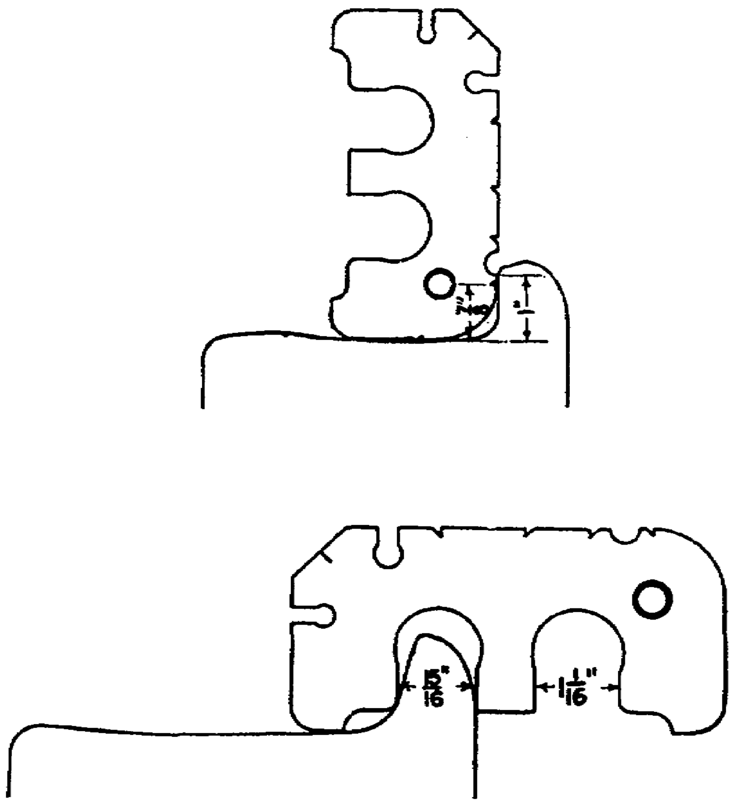


Figure 2.7. Measuring Worn Flanges.

f. Flange worn thin (Rule 74--AAR symbol 74-T). When the flange becomes too thin for safety, the defect is known as "flange worn thin." The principal danger of the defect is the likelihood of the flange chipping or breaking off and causing equipment to derail by riding up on a switch point. The sketch at the bottom of figure 2.7 shows the wheel-defect gage being used to measure a worn-thin flange. The limits of wear differ for the same capacity ranges of cars as for the vertical Range. On cars of less than 80,000-pound capacity, when the flange is 15/16 inch thick or less gaged at a point 3/8 inch above the tread, the wheel is condemned. On cars with 80,000-pound capacity or more a wheel is condemned when the thickness of the Range measures 1 1/16 inches or less gaged 3/8 inch above the tread.

g. Combination tread defects (Rule 75-A--AAR symbol 75-A). Wheels may have a combination of shell-out spots, flat spots, or worn flange. When any combination of these occur within a distance of 12 inches measured circumferentially on the tread, the wheel is condemnable even though no single defect is as great as the individual condemning limits. Combinations of shell-out spots 1 inch or more and flat spots 1 inch or longer condemn the wheel. Figure 2.8 illustrates the combination tread defects and the proper measurements.

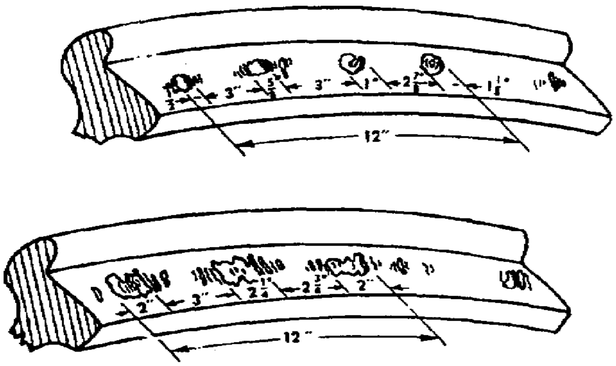


Figure 2.8. Measurements for Combination Tread Defects.

h. Tread-worn-hollow (Rule 76--AAR symbol 76). The tread-worn-hollow gage shown in figure 2.3 is used to measure the extent of hollow wear. The figure also shows the proper application of the gage to the wheel. If the nipple at the bottom center of the gage does not touch the tread when the front and rear bottoms are touching the top of the flange and the top outside of the rim respectively, the wheel is worn beyond the condemning limits. Figure 2.9 shows a condemnable wheel. If, however, the gage rocks back and forth on the nipple when it is applied, the wheel is still safe for service. Many inspectors remove tread-worn wheels before they reach the condemning limits because they feel that they are dangerous and hard on the track; however, condemning wheels before they reach the gaged wear limits is wasteful. It is important to note that very often when one wheel is tread-worn, the mating wheel on the other end of the axle has a worn flange. This develops because the hollow tread on one wheel forms a false flange and tends to hold the flange of the opposite wheel against the rail constantly.

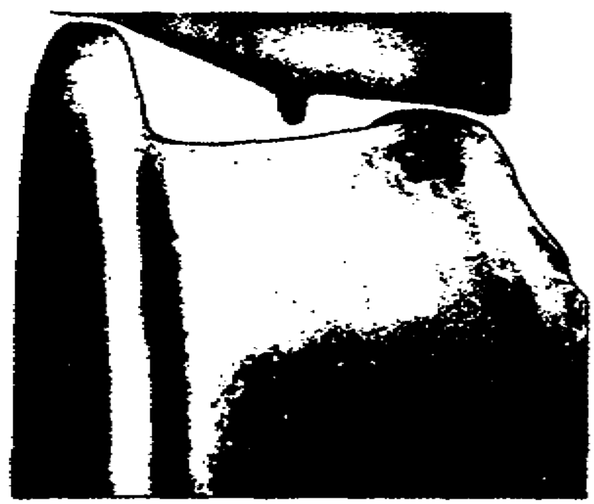


Figure 2.9. Tread-Worn-Hollow Defect.

i. Burst hub (Rule 77--AAR symbol 77). A burst hub is a radial crack in the hub. The burst or cracked hub usually occurs when the wheel is pressed upon the axle. Three causes of the burst-hub defect are excessive pressure, improper wheel-mounting methods, and improper taper in the wheel bore or of the axle seat. Any wheel with a radial crack in the hub is condemnable.

j. Chipped flange (Rule 78--AAR symbol 78). A wheel is condemnable if a piece is chipped from the flange 1 1/2 inches or more in length and 1/2 inch or more in width. This defect is caused by the flange striking guardrails and frogs. If the chipped area is large, the likelihood of equipment derailment is great. A condemned wheel with the chipped-flange defect is shown in figure 2.10.

Figure 2.10. Chipped-Flange Defect.

k. Cracked or broken plates or brackets (Rule 78--AAR symbol 78-B). Any wheel with a cracked or broken plate is condemnable because this defect is quite likely to cause the wheel to fail or collapse. Almost invariably, wheel plates crack from the inside out. Not all causes of this defect are known, but thin and hard plates resulting from improper manufacturing processes are a chief cause. Also, when excessive braking is necessary, such as might be needed on mountain runs, the wheels are subjected to excessive stresses and heating. A picture of a wheel with a cracked plate is shown in figure 2.11.

Figure 2.11. Cracked Plate.

l. Broken rim (Rule 78--AAR symbol 78-R). Minor chipping on the outside edge of the rim does not impair the serviceability of wheels; there are limits, however, that cannot be exceeded. Figure 2.12 shows the methods of gaging the two types of broken rims. If the rim is broken and the slope of the break is inward, the condemning limit is 3 3/4 inches from the flange measured across the tread. If the break is vertical or sloping outward, the condemning limit is 3 1/2 inches measured in the same way.

2.10. DEFECT AND WEAR LIMIT--WROUGHT-STEEL WHEELS

The materials specifications and the details of defect and wear limit for wrought-steel wheels, like cast-steel wheels, are published by the AAR. The rule numbers and AAR symbols are given with the defects in the following sub-paragraphs.

a. Burnt rim or flange (Rule 71--AAR symbol 71-A). If a portion of the flange or rim breaks off with a coarse fracture and a rough granular surface shows, the wheel should be removed from service. The cause of the burnt-rim or -flange defect is overheating during the manufacturing process. The wheel shown in figure 2.13 has a burnt-flange defect.

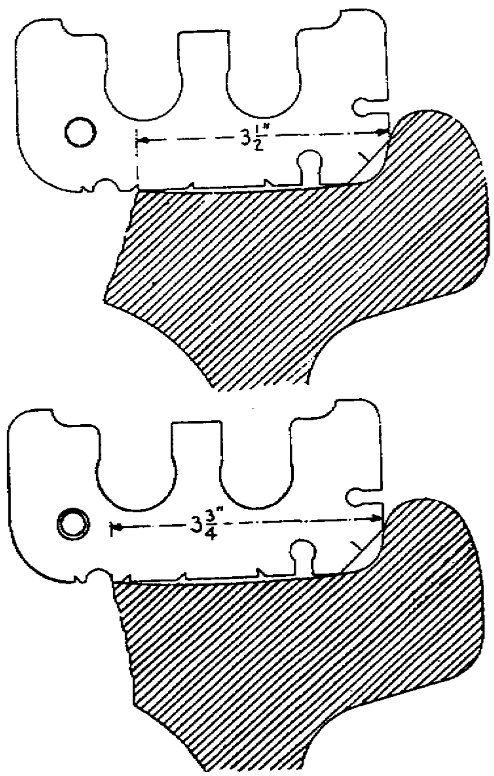


Figure 2.12. Gaging Broken Rims.

b. Shattered rim or flange (Rule 71--AAR symbol 71-B). When a portion of the rim or flange parts from the remainder of the wheel so that a smooth surface is exposed for any considerable distance, the defect is known as a shattered rim or flange. The wheel should be removed from service, and a heavy coating of grease should be applied to the exposed area to preserve the defect, as originally detected, for investigation. Look at figure 2.14 and notice the difference in this defect as compared to the burnt flange shown in figure 2.13.

c. Spread rim (Rule 71--AAR symbol 71-C). When the front or the back face of the rim spreads

Figure 2.13. Burnt-Flange Defect.

outward from the tread, the wheel has a spread-rim defect as shown in figure 2.15. This condition usually indicates an interior defect,

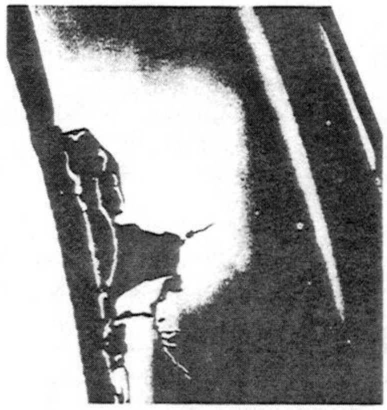


Figure 2.14. Shattered-Rim Defect.

Figure 2.16. Shelled-Tread Defect.

Figure 2.15. Spread Rim.

and the wheel should be removed from service and the condition investigated. The length of the spread-rim defect is usually less than 12 inches, and the spread area tends to flatten out so that it resembles a large slid-flat defect. It is believed that the same interior defect causes both the spread rim and the shattered rim.

d. Shelled tread (Rule 71--AAR symbol 71-E). When the surface metal of the tread breaks down and flakes or chips off, the wheel has a shelled-tread defect, shown in figure 2.16. Extreme defects of this kind may extend completely around the circumference of the tread and penetrate to a considerable depth. When this defect is detected, the wheel should be removed and turned on a wheel lathe. A cut, called a spotting cut, 3/8 inch deep should be made in the tread with a round-nosed roughing tool. If the cut exceeds the depth of the shelled area, all of the tread and flange should be shaped to the original contour. If the spotting cut fails to exceed the depth of the shelled area, the wheel should be set aside for further inspection and the shelled area coated with a heavy lubricant.

e. Thermal cracks (Rule 75--AAR symbol 75). When intensive braking pressures develop high temperatures in the wheel tread, thermal or transverse cracks can result. These cracks invariably run at right angles to the tread and flange, and they can occur in both as shown in figure 2.17. Any wheel with this defect must be removed from service, because there is no way of determining the size of the cracks in the wheel. Thermal cracks in a highly stressed wheel can weaken the structure of the wheel to the point where it will fail. Often pieces of metal between thermal cracks will fall out and resemble a shelled-tread defect. A roughing cut should be made on a wheel with thermal cracks while it is being turned on a lathe. If the depth of the roughing cut exceeds the depth of the cracks, the wheel should be completely turned down and the tread and flange restored to original contour. If the roughing cut has to be deep enough to reach the wear limits of the wheel before the depth of the thermal crack is reached, the wheel must be discarded.

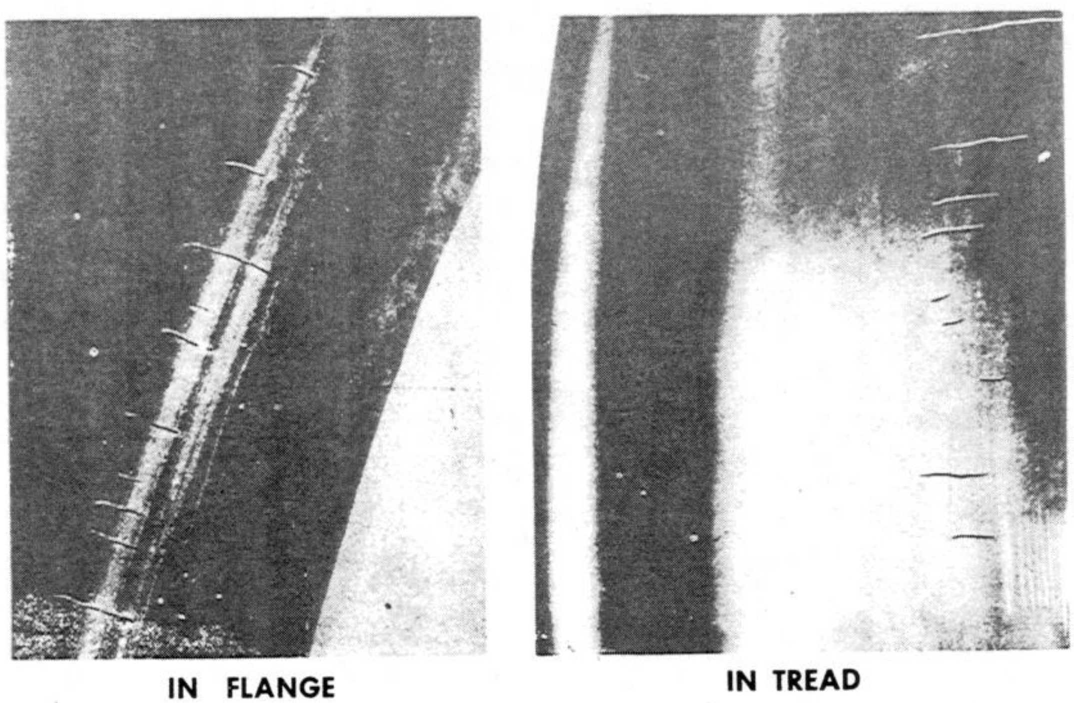


Figure 2.17. Thermal Cracks.

f. High flange (Rule 76--AAR symbol 76). When the height of the flange is 1 1/2 inches or more above the center of the tread, the wheel has a high flange and must be turned on a lathe until the tread and flange are restored to original contour. Figure 2.4 shows how to measure for the high flange with the standard steel-wheel gage. When the tip of the flange touches the horizontal part of the gage, applied as shown, the wheel is condemnable.

g. Thin rim (Rule 79--AAR symbol 79). Wheels that have rims worn down to 3/4 inch should be removed from freight service, and wheels with rims as thin as 1 inch should be removed from passenger service. If any wheel is turned to remove any other defect and the limits above are reached in the process, the wheel should be removed from service; however, if the 1-inch limit for passenger service is reached, the wheel can be restored to original tread and flange contour and used in freight service until the condemning limit of 3/4-inch rim thickness is reached.

h. Cracked plates (Rule 80--AAR symbol 80-A). Radial cracks in wheel plates almost always originate in either the hub or the rim and should be reported and marked either cracked-hub or cracked-rim. Either defect condemns the wheel from service. Circumferential cracks can be detected easily with careful inspection of wheels. If neglected, a 2-or 3-inch crack will grow into the "cupid's bow" crack shown in figure 2.18. The name is derived from the bow shape the crack takes when the two ends turn outward toward the rim. If neglected still longer, the crack will extend through the rim, as shown in figure 2.19, and the wheel will fail. Therefore, any wheel with a crack in its plate should be removed from service.

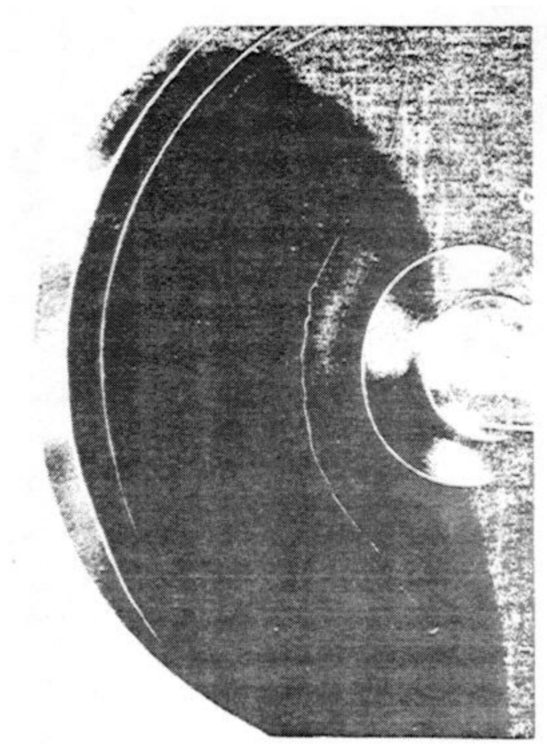


Figure 2.18. Circumferential Cupid's Bow Crack.

i. Built-up tread (AAR symbol 107). Figure 2.20 shows a wheel with a built-up tread. This defect is caused in one of two ways: part of the tread metal is dragged over other parts of the tread; or metal from a brake shoe is deposited on the tread while the brakeshoe metal is in a plastic state resulting

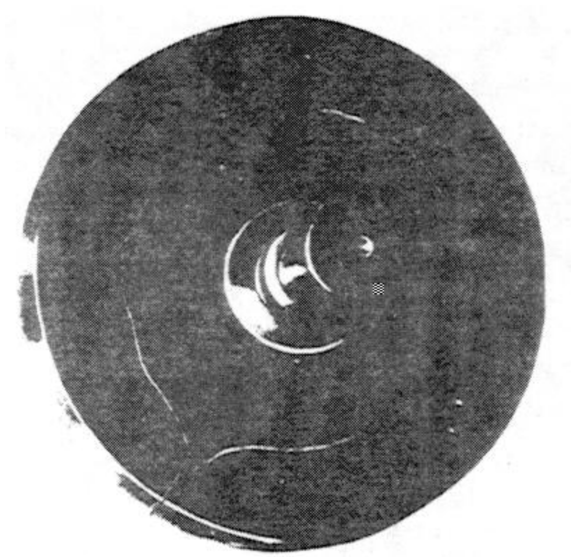


Figure 2.19. Circumferential Crack Through Rim.

from the high temperatures generated by excessive braking pressures. Wheels with this defect should be removed and turned to restore original flange and tread contour because the tread is irregular and out-of-round due to the raised or built-up area.

2.11. ORIGINAL CONTOUR AND WEAR LIMIT

During the preceding discussions, several references have been made to restoring treads and flanges to original contour. As explained earlier, any one-wear wheel is discarded when any of the wear limits is reached or when any defect is detected that is bad enough to condemn the wheel. However, multiple-wear wheels can be turned or reclaimed as many times as is necessary until certain limits are reached. Figure 2.21 is a diagram showing the tread and flange line when the wheel is new and the condemning limits of wear.

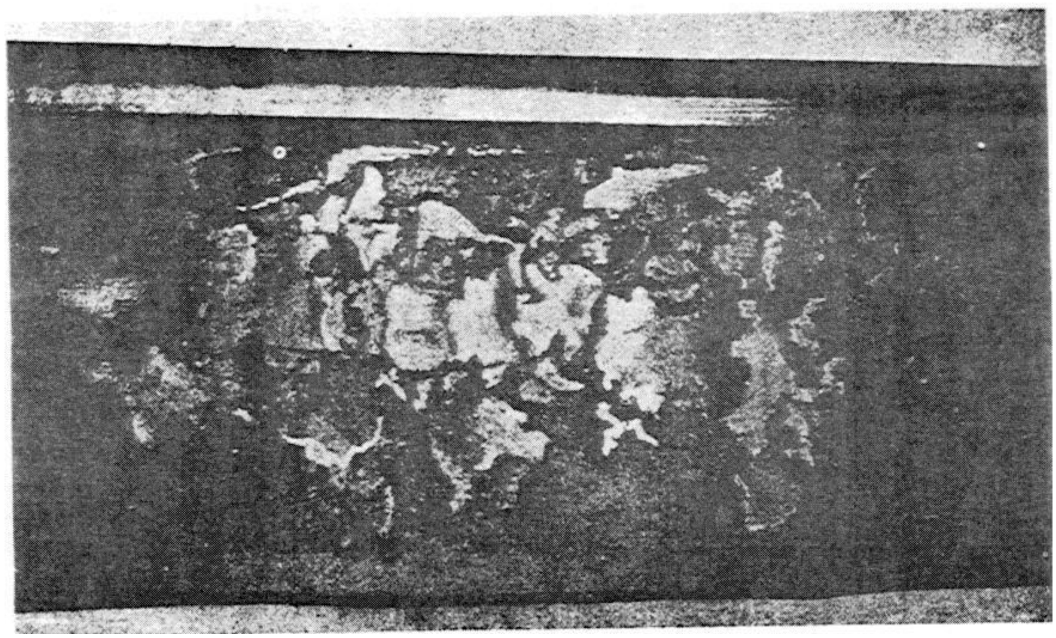


Figure 2.20. Built-Up Tread.

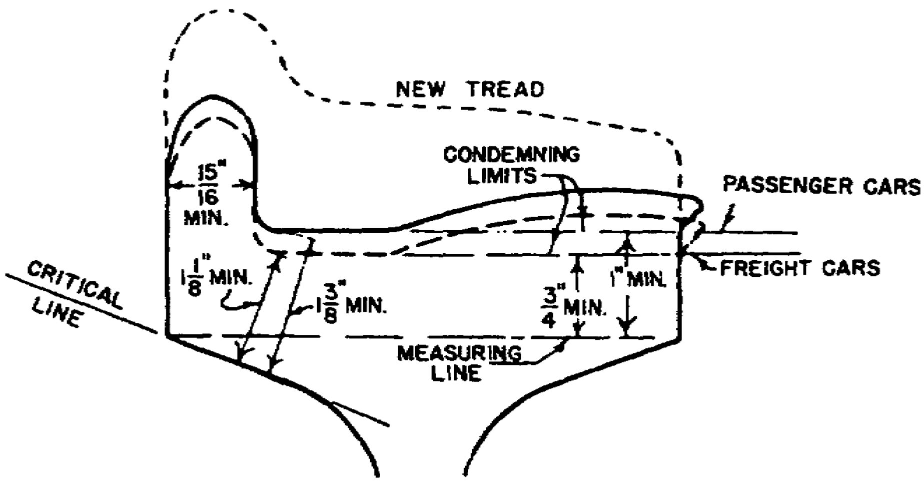


Figure 2.21. New and Condemning Limits for Wrought-Steel Wheels.

You can easily see that a small defect occurring on the tread or flange of a new wheel could be turned and the original contour of the tread and flange restored without reaching any of the several condemning limits. However, at any time that any limit is reached whether it results from defects or from wear, the wheel must be removed from service. Again, there are limits for passenger service and limits for freight service. It is quite possible, in fact recommended, that any wheel reaching the passenger-service limit but not reaching the freight-service limit be removed from passenger and placed in freight service until some limit in it is reached.

2.12. SUMMARY

The important points in this section are the differences between one-wear and multiple-wear wheels. When defects are serious enough or when wear limits have been reached on one-wear wheels, they are discarded; however, multiple-wear wheels may be reclaimed by turning them on lathes until the minimum wear limits are reached or defects force their removal from the service. The multiple-wear wheels have two wear limits: one for passenger service and another for freight service. More wear is allowed on wheels used in freight service. A wheel may be removed from passenger service and used in freight service until the limits of wear have been reached for the latter service. To be able to determine when a wheel should be removed from service or reclaimed, you must know how to recognize the many defects and be able to measure the extent of the defects and the amount of wear through proper application of the right gages.

Some wheel defects result from faulty manufacturing, such as seams, cracked or broken plates, burnt rim or flange, and spread rim. Others come from wear; for example, slid-flat spots and thermal cracks from excessive braking, burst hub from improper wheel mounting, and chipped flange from the flange striking guard-rails and frogs. For cast-steel wheels, many defects are measured with the wheel-defect gage; the tread-worn-hollow and out-of-round gages measure defects carrying the same names. The steel-wheel gage is used for inspecting and measuring most defects on wrought-steel wheels.

Each time a wheel under a freight car turns, the wheel adjacent to it on the opposite rail also turns the same amount. The reason for this is because of the solid and fixed connection between the wheels: the axle. Axles are the object of our studies in the following section.

Section II. Axles

2.13. GENERAL

Railway car axles have two principal functions: they hold the wheels to track gage, and they transmit the weight of the car and its lading from the journal bearings to the wheels. Figure 2.22 contains a drawing showing the parts of an axle designed for friction bearings, and figure 2.23 shows the parts of an axle designed for roller bearings. Note, in figure 2.22, the end collar designated "A"; you find this missing in the axle diagramed in figure 2.23. Both kinds of

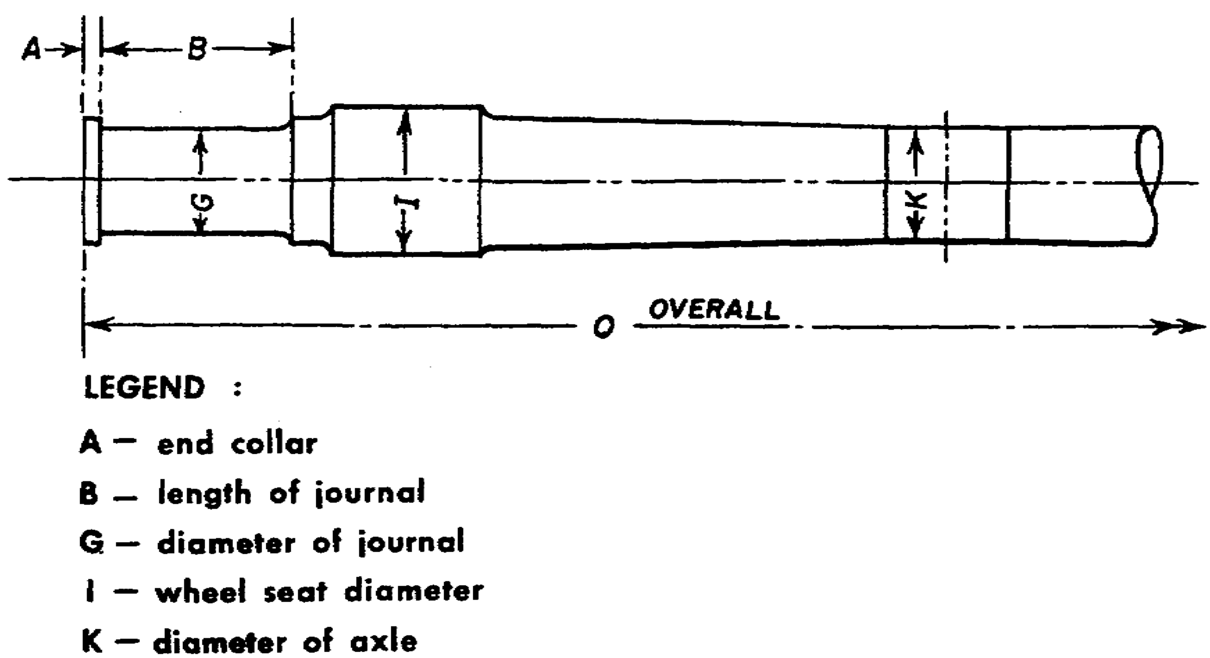
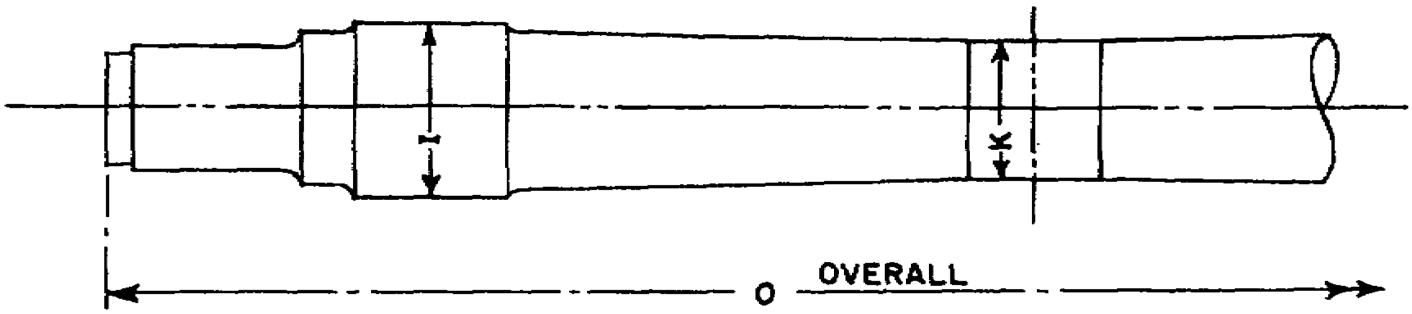


Figure 2.22. Axle With Friction Bearings.



Legend:
I - wheel seat diameter
K - diameter of axle

Figure 2.23. Axle With Roller Bearings.

bearings work against the journal which has a fixed size in relation to the load rating of the particular axle design. In table I, the AAR axle designations are given along with the axle sizes and the corresponding load ratings for new passenger car axles when trains run at speeds up to 85 mph and above 85 mph. For example, AMR axle D has a journal 5 1/2 inches in diameter and 10 inches long. This axle's load capacity is rated at 34,000 pounds at speeds up to and including 85 mph; however, from 86 to 100 mph its capacity is rated at only 32,000 pounds. Besides the AAR axle designations A through F, there are three basic types of axles. Each type has prescribed markings, dimensions when new, wear limits, and possible defects that can cause the axle to be withdrawn from service. These are explained in this section in the order mentioned.

Table I. Axle Designations and Load Ratings.

		Capacity in pounds for axles for normal maximum operating speeds of	
AAR axle designation	Size of journal in inches	Up to and including 85 mph	86 to 100 mph
A --------	3 3/4 x 7------	12,500	12,000
B --------	4 1/4 x 8------	20,500	19,000
C --------	5 x 9 ---------	27,000	25,500
D --------	5 1/2 x 10-----	34,000	32,000
E --------	6 x 11 --------	42,500	40,000
F --------	6 1/2 x 12-----	51,000	48,000

2.14. TYPES

Three types of AAR axles are used under freight and passenger cars. The first is an early designed solid axle used with friction bearings; it has a collar inside of each wheel seat called the black collar. The second type, designed in 1940, has no black collar but has a raised wheel seat and is used with either friction or roller bearings. The chief difference between the two is the way the journal is designed. The third type is a tubular axle and may be used with either friction or roller bearings. These axles and their new dimensions are explained in paragraph 2.16.

2.15. MARKINGS

Markings on axles are made by cold stamping them in letters not less than 1/4 inch high in one of three ways. On friction-bearing journals used under freight cars, the markings are made on the face of the end collar; on roller-bearing journals used under freight cars, the axles are marked on the journal end. Markings on axles used under passenger cars having roller bearings are made around the outer rim of the journal end. Each of the three ways of marking axles is shown in figure 2.24. The numbered notes in the legend are explained in the following subparagraphs (there are no notes numbered 2 and 5).

a. Laboratory acceptance stamp--Note 1. The steel in each heat or group of axles is laboratory tested for chemical composition and physical properties. If the steel meets the AAR specifications, the axles are stamped as approved.

b. Manufacturer's name or brand--Note 3. If, for example, the patented trade name for Raleigh Associated Steel Company was RASCO, these letters would be stamped as shown just below the date.

c. Date--Note 4. The month and year that the axle was made is shown. For example, if an axle was made in September 1964, the numbers 9-64 would appear.

d. Grade of axle--Note 6. Axles are of three grades designated by the letters U, D, and F. The letter U indicates that the axle is untreated (not reheated); D indicates that the axle has been through an annealing process; and F means that the axle has been normalized and tempered (reheated and re-formed to standard design).

e. Heat number--Note 7. Each ladle of molten steel is called a "heat" and given a number. All axles made from this one

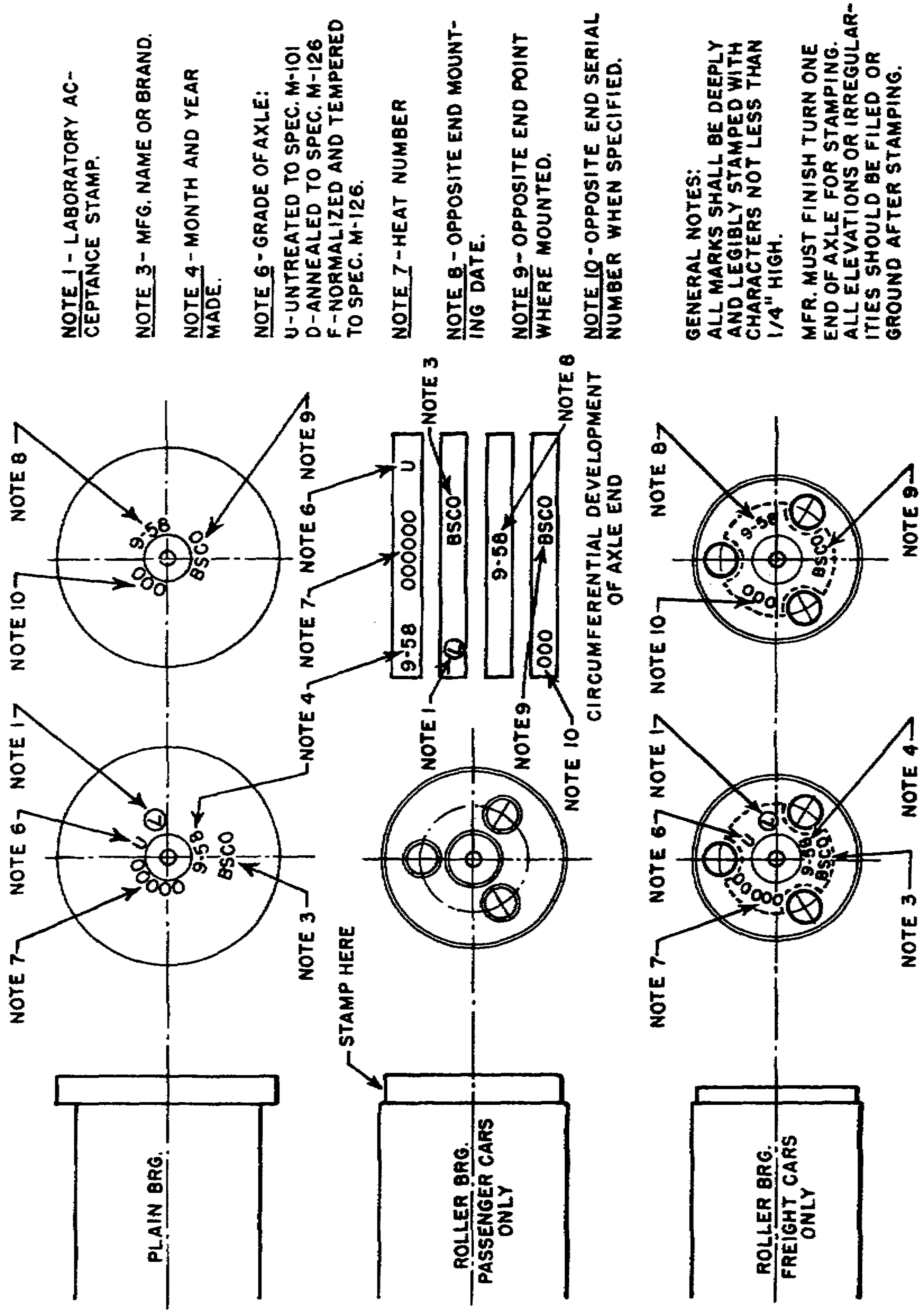


Figure 2.24. Axle Markings.

heat have the same number stamped on them. One important reason for recording the heat number is that whenever any axle is found to have a manufacturing defect attributed to improper heating and forging, all axles with the same number can be inspected for the same defect or removed from service. The manufacturer keeps a record of all axle heat numbers and the consumer who purchased them.

f. Mounting date--Note 8. The date that the wheels are mounted on the axle is given by month and year on the opposite end of the axle from the date of manufacturer.

g. Point of mounting--Note 9. The place where the wheels are mounted upon the axles is stamped on the end opposite the place of manufacture. However, both manufacture and mounting may be done at the same place, and the manufacturer's name or brand may appear on both ends of the axle.

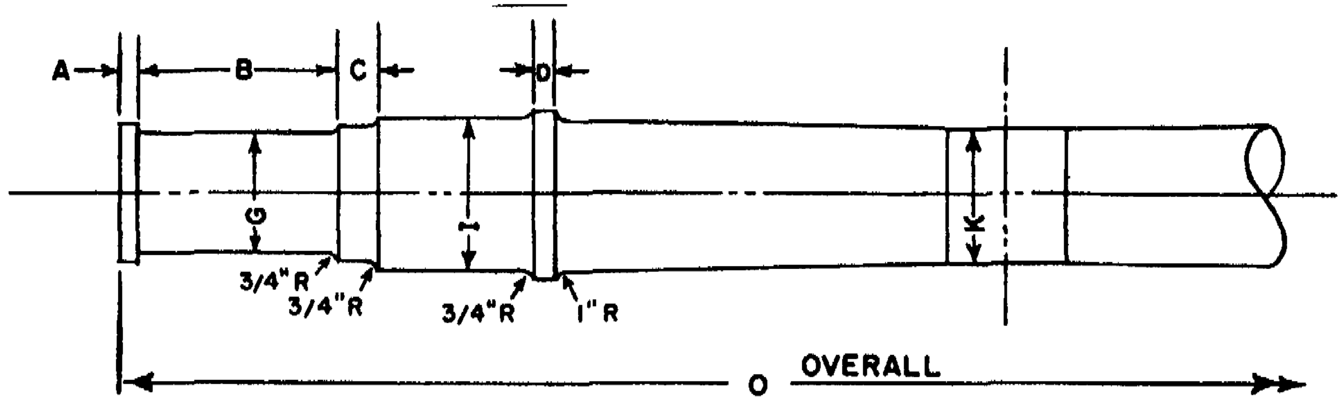
h. Serial number--Note 10. If from any one heat, numerous axles are made, and if the customer specifies it, each axle is given a serial number. This number is on the opposite end of the axle from the heat number.

2.16. NEW DIMENSIONS

The AAR Wheel and Axle Manual provides the dimensions for axles including standard dimensions for new axles. The new dimensions for each of the three types of axles are explained in separate subparagraphs.

a. Standard freight car axle (solid-friction bearing). Although most new freight cars being built for commercial railroads in the United States have axles designed for use with roller bearings, the majority of the axles used on U.S. military railroads and in foreign countries are the black collar solid axles designed for use with friction bearings. These axles do not last as long as those designed for roller bearings because the journals wear more quickly. However, they require less maintenance skill and less exacting inspections. Table II shows a labeled diagram of this axle along with the new dimensions for it. Notice that the curved surfaces on the exterior and interior ends of the dust guard collar and the black collar are marked as 1" R or 3/4" R. These markings establish the curvature of these surfaces by defining the radius of the curve they would make if the complete circumference was drawn. For example, the interior curved surface of the black collar is marked 1" R. If that curved surface or arc was continued for a full 360°, the radius of the circle then established would be 1 inch. The diameter would be 2 inches.

Table II. Black Collar Freight Car Axle Dimensions



Legend:
A - end collar
B - length of journal
C - dust guard collar
D - black collar
G - diameter of journal
I - wheel seat diameter
K - diameter of axle
R - radius

		ROAD SERVICE LIMITS Requiring the removal of axle from service							SHOP LIMITS Axles must not be applied in passenger service or under foreign equipment if not within the following limits.							DIMENSIONS NEW Note 1 - "Oversize" axles may be 1/8" larger than shown under dimension "I" Note 2 - Dimension "O" may be 1/8" greater than shown below.						
CLASSI-FICATION OF AXLE	JOURNAL SIZE	WHEN REACHED			WHEN LESS THAN				IF GREATER THAN		WHEN LESS THAN											
		A	B Frt.	B-1 Pass.	G Frt.	G-1 Pass.	I	K	B Frt.	B-1 Pass.	A	G Frt.	G-1 Pass.	I	K	A	B	G	I	K	O	
	INCHES	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	Ft.	In.
A	3 3/4x7	3/16	7 11/16	7 9/16	3 1/4	3 1/4	4 7/8	4 1/4	7 9/16	7 7/16	1/4	3 3/8	3 3/8	4 7/8	4 1/4	3/8	7	3 3/4	5 1/8	4 1/4	6	11 1/4
B	4 1/4x8	3/16	8 11/16	8 9/16	3 3/4	3 3/4	5 1/2	4 3/4	8 9/16	8 7/16	1/4	3 7/8	3 7/8	5 1/2	4 3/4	5/8	8	4 1/4	5 3/4	4 3/4	7	0 1/4
C	5x9	3/16	9 11/16	9 9/16	4 1/2	4 1/2	6 1/4	5 3/8	9 9/16	9 7/16	1/4	4 5/8	4 5/8	6 1/4	5 3/8	3/4	9	5	6 1/2	5 3/8	7	2 1/2
D	5 1/2x10	3/16	10 11/16	10 9/16	5	5	6 3/4	5 7/8	10 9/16	10 7/16	1/4	5 1/8	5 1/8	6 3/4	5 7/8	3/4	10	5 1/2	7	5 7/8	7	4 1/2
E	6x11	3/16	11 11/16	11 9/16	5 1/2	5 1/2	7 3/8	6 7/16	11 9/16	11 7/16	1/4	5 5/8	5 3/8	7 3/8	6 7/16	7/8	11	6	7 5/8	6 7/16	7	6 3/4
F	6 1/2x12	3/16	12 11/16	12 9/16	6	6	7 7/8	6 7/8	12 9/16	12 7/16	1/4	6 1/8	6 1/8	7 7/8	6 7/8	1/8	12	6 1/2	8 1/8	6 7/6	7	8 3/4

b. Passenger car axle, 1940-design (solid-friction or roller bearing). The principal difference between the 1940-design axle and the earlier standard axle is the absence of the "black collar" and the raised wheel seat. Figure 2.23 is a diagram of the 1940-design passenger car axle designed for use with roller bearings. Table III contains the new dimensions for it. Notice the absence of the end collar on the roller bearing axle, a characteristic of all journals designed for roller bearings.

c. All-purpose tubular axle (friction and roller bearings). The dimensions, when new, of the distance between the wheel seats of tubular axles (table IV) are larger than the same dimensions on solid axles (table III). Note in the diagram in table IV, the dotted lines inside the solid contour lines; these outline the outer surface of the hollow in the axle.

2.17. AXLE WEAR LIMITS

Much of the wear of axles takes place on the journal. Because of the weight and friction concentrated on it, the journal tends to wear and become smaller in diameter and longer. As the journal wears, its load limit decreases until it reaches a point where it is no longer safe and must be removed from service. As the journal lengthens, more lateral movement is permitted, and this excessive sidesway is dangerous.

The wear limits for the three types of axles are shown in tables II, III, and IV. By comparing these with the new dimensions, you can see that axle wear is considered critical and the tolerances are small. However, axles may be turned on a lathe to restore the original contours or to refinish the journal. Small scratches can be removed and the axle returned to service. When a defect is severe enough the axle must be removed and restored; when any limit of wear is reached, it must be scrapped. The following paragraph explains axle defects.

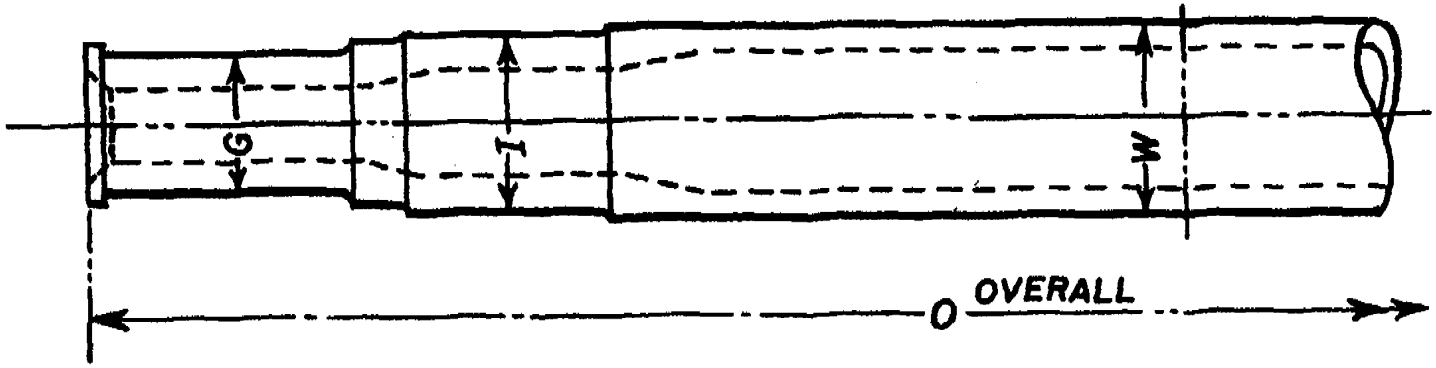
2.18. DEFECTS

As with wheels, the standards for axle wear limits and defects are defined in the AAR Wheel and Axle Manual. Some of the major and more frequently occurring defects are explained in the following subparagraphs, and the AAR symbols for them are given. When an axle is condemned, the appropriate symbol is marked on it to identify the defect or cause for removing the axle from service.

Table III. Dimensions of the 1940-design Axle

		ROAD SERVICE LIMITS Requiring the removal of axle from service					SHOP LIMITS Axles must not be applied in passenger service or under foreign equipment if not within the following limits.					DIMENSIONS-NEW Note 1 - "Oversize" axles may be 1/8" larger than shown under dimension "I" Note 2 - Dimension "O" may be ± 1/32 than shown below.						
CLASSI-FICATION OF AXLE	JOURNAL SIZE	WHEN REACHED		WHEN LESS THAN			IF GREATER THAN	WHEN LESS THAN										
			I			K				I	K				I	K	O	
	INCHES	In.	Ins.	Ins.	Ins.	Ins.	Ins.	In.	Ins.	Ins.	Ins.	In.	Ins.	Ins.	Ins.	Ins.	Ft.	Ins.
B	4 1/4x8		6 1/16			4 3/4				6 1/16	4 3/4				6 5/16	4 3/4	6	11
C	5x9		6 3/4			5 3/8				6 3/4	5 3/8				7	5 3/8	7	1
D	5 1/2x10		7 5/16			5 7/8				7 5/16	5 7/8				7 9/16	5 7/8	7	2 1/2
E	6x11		8			6 7/16				8	6 7/16				8 1/4	6 7/16	7	4 1/4
F	6 1/2x12		8 1/2			6 7/8				8 1/2	6 7/8				8 3/4	6 7/8	7	6 3/4

Table IV. All-purpose Tubular Axle Dimensions



CLASSI-FICATION OF AXLE	JOURNAL SIZE	ROAD SERVICE LIMITS Requiring the removal of axle from service							SHOP LIMITS Axles must not be applied in passenger service or under foreign equipment if not within the following limits.							DIMENSIONS NEW Note 1 - "Oversize" axles may be 1/8" larger than shown under dimension "I" Note 2 - Dimension "O" may be 1/8" greater than shown below.						
		WHEN REACHED			WHEN LESS THAN				IF GREATER THAN		WHEN LESS THAN											
		A	B Frt.	B-1 Pass.	G Frt.	G-1 Pass.	I	W	B Frt.	B-1 Pass.	A	G Frt.	G-1 Pass.	I	W	A	B	G	I	W	O	
	INCHES	In.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	In.	Ins.	Ins.	Ins.	Ins.	In.	Ins.	Ins.	Ins.	Ins.	Ft.	Ins.
B	4 1/4 x8	3/16	8 11/16	8 9/16	3 3/4	3 3/4	5 1/2	5 7/8	8 9/16	8 7/16	1/4	3 7/8	3 7/8	5 1/2	5 7/8	5/8	8	4 1/4	5 3/4	6	7	0 1/4
C	5 x9	3/16	9 11/16	9 9/16	4 1/2	4 1/2	6 1/4	6 5/8	9 9/16	9 7/16	1/4	4 5/8	4 5/8	6 1/4	6 5/8	3/4	9	5	6 1/2	6 3/4	7	2 1/2
D	5 1/2 x10	3/16	10 11/16	10 9/16	5	5	6 3/4	7 1/8	10 9/16	10 7/16	1/4	5 1/8	5 1/8	6 3/4	7 1/8	3/4	10	5 1/2	7	7 1/4	7	4 1/2
E	6 x11	3/16	11 11/16	11 9/16	5 1/2	5 1/2	7 3/8	7 3/4	11 9/16	11 7/16	1/4	5 5/8	5 5/8	7 3/8	7 3/4	7/8	11	6	7 5/8	7 7/8	7	6 3/4
F	6 1/2 x12	3/16	12 11/16	12 9/16	6	6	7 7/8	8 1/4	12 9/16	12 7/16	1/4	6 1/8	6 1/8	7 7/8	8 1/4	7/8	12	6 1/2	8 1/8	8 3/8	7	8 3/4

a. Burnt journal (AAR symbol 84). Any burned depression or continuous streak on the surface metal of the journal or wheel seat may cause the axle to break or cause a hot journal, known as a "hotbox." An axle with this defect must be removed from service and turned on a lathe. If the defect can be removed without reaching the wear limits, the axle may be returned to service. If any wear limit given in tables II, III, or IV, is reached or exceeded, the axle is scrapped.

b. Bent axle (AAR symbol 84-A). All second-hand axles should be checked in the lathe for roundness, concentricity, and taper of wheel seats and journals after they have been dismounted. If they are bent, they should be scrapped unless the wheel seats and journals can be trued within the prescribed limits.

c. Broken axle (AAR symbol 85). Any circumferential laps or seams in any portion of the axle can cause it to break. A broken axle or one with a broken end collar must be scrapped.

d. Back journal fillet (AAR symbol 85-B). The back journal fillet should have the same radius as the standard radius for a new axle; however, when the fillet is worn it should be restored to the original radius unless in doing so the journal would exceed the length limits and require the axle to be scrapped. The AAR rules permit the use of secondhand axles with minimum back fillet radii of 1/8 inch for A axles, 5/16 inch for B axles, and 3/8 inch for C through F axles. The wheel-defect gage shown in figure 2.3 is used to measure the back journal fillet.

e. Journal length worn to limit (AAR symbol 85-C). Figure 2.25 shows how to measure the length of a worn journal, and figure 2.26 shows the gage most commonly used to measure this defect. When the length of the journal measures 11/16 inch more than the original length of the journal on an axle A through F, the axle must be removed from service. Axles are usually scrapped because

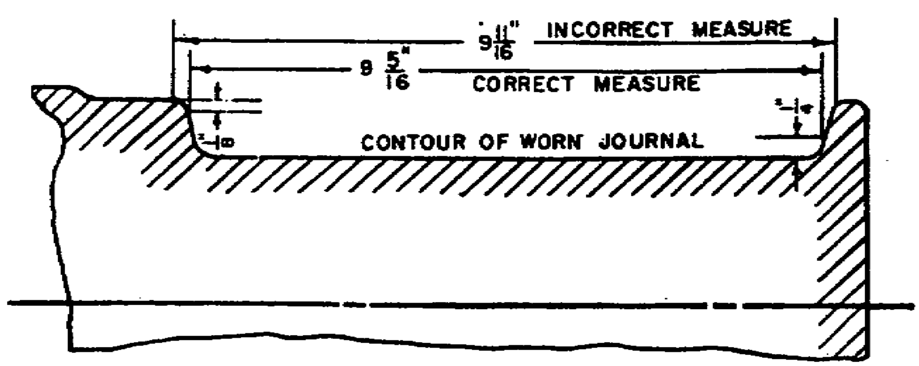


Figure 2.25. Measurement of Worn Journal.

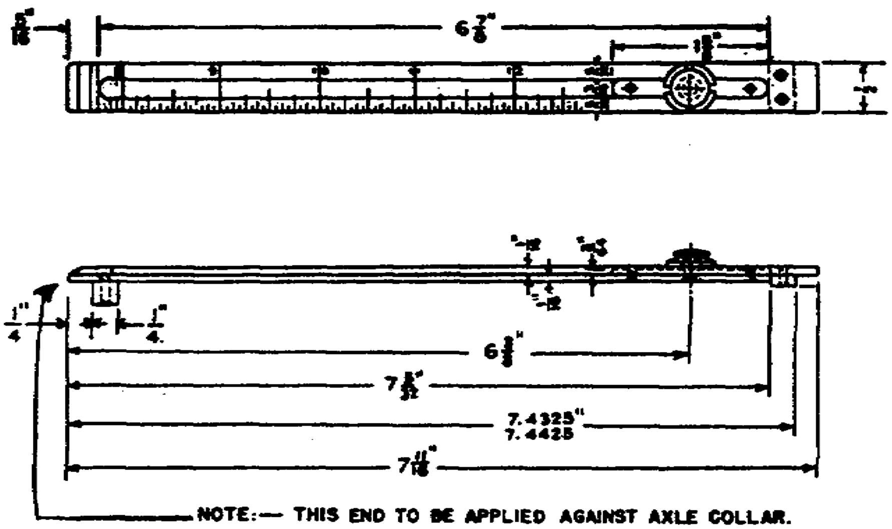


Figure <u>2.26</u>. <u>Gage for Measuring Worn Journal</u>.

journals have reached condemning lengths rather than because they have reached condemning diameters.

<u>f</u>. <u>Collar worn to limit (AAR symbol 85-D)</u>. The new dimensions for collar thickness for A and B axles are 5/8 inch, for C and D axles 3/4 inch, and for E and F axles 7/8 inch. When the end collar on any axle reaches 3/16 inch measured with the wheel-defect gage, the axle is removed from service. If the gage will fit on the collar, the axle is condemnable.

<u>g</u>. <u>Journal diameter worn below limits (AAR symbol 86-D).</u> When through normal wear, or through re-turning, the diameter of the journal reaches the wear limits, the axle must be removed from service. Outside calipers are used to measure journal diameters.

<u>h</u>. <u>Wheel seat worn below limit (AAR symbol 86-A).</u> Outside calipers are also used to measure the diameter wear of wheel seats. When condemning limits are reached, the axle is removed from service.

2.19. SUMMARY

Transmitting the weight of the car and its lading from the journal bearing to the wheels and keeping the wheels in gage are the two functions of railway axles. There are solid axles used only with friction bearings; and solid and tubular axles used with either friction or roller bearings. All axles are rated according to their load capacity established by the size of their journals. Axles with the smallest journals and the least load capacity are designated A, and the largest and heaviest capacity axles are designated F. Because of the tremendous amount of friction generated between the bearings and the journals, much of the wear on axles and many of the defects occur at the journals. However, axles do bend and break, and collars and wheel seats do become worn. Thorough inspections must be made of the axles to prevent axle failures and hotboxes. When an axle is found defective or worn to the condemning limits, it should be removed from service and marked with the appropriate symbol.

First we talked about wheels; then we discussed axles. Now we are ready for explanations of how the wheels are matched, mounted, and dismounted from the axle. The third and final section of this chapter is devoted to these explanations.

Section III. Wheels on Axles

2.20. GENERAL

Railway wheels are pressed onto axles under high pressure. The fit must be exact for the wheel to remain seated on the axle under the extreme stresses placed upon it in service. To insure a tight and secure fit, wheels must be selected that fit the dimensions of the axle upon which they are to be mounted. The two wheels chosen for a particular axle must also match each other.

During the mounting process, the journals, the wheel seats, and the wheel bores must be protected and lubricated to prevent damage that could develop into serious trouble later when wheels and axles are placed in service. The wheels must be exactly centered on the axle and exactly the right distance apart or they will not roll true. Unless the mounted wheels and axles are going into service immediately, proper provision must be made for their storage to prevent damage and protect them from the weather. Finally, since the multiple-wear wheel may be removed, restored, and remounted, provision must be made for dismounting wheels. This section explains each of these processes in the order mentioned.

2.21. MATCHING WHEELS AND AXLES

The two principal problems involved in the business of putting the right wheels on the right axles are to select the right size bore in the wheel for the axle it is to be mounted upon, and to match the two wheels for type, size, and amount of wear.

a. Wheels to axles. The proper selection of the right wheel for a particular axle is complicated. But the time and money spent

in following prescribed procedures pays off. The following practices are quoted directly from the AAR Wheel and Axle Manual.

1. Select wheels for application to an axle which will involve a minimum loss of metal in the bore.

2. Apply new wheels whenever possible to second-hand axles with reduced wheel seat diameters.

3. Apply second-hand wheels or worn wheels to new axles or to second-hand axles with wheel seats nearly standard in diameter.

4. If new wheels must be applied to new axles, the wheel seats should be standard diameter.

5. Second-hand wheels with bores too large for standard wheel seat diameters should be applied to axles with wheel seats not in excess of 1/8 inch larger than standard.

b. Matching wheels. When matching two wheels for one axle, be sure that they are the same kind, type, and size. It would not be practical or economical to mount a cast-steel wheel and a wrought-steel wheel on the same axle because of the difference in their wearing characteristics. The same thing is true with one-wear and multiple-wear wheels. The size of the mated wheels should be as nearly the same as possible. You certainly would not match two new wheels with different diameters. In like manner you should select two wheels with similar amounts of wear left on the treads and flanges and with circumferences of the same size. For example, if you were using multiple-wear, wrought-steel wheels, you should not pick one wheel with either the flange or tread worn down near the minimum sizes to mate with another wheel with measurements near the maximum or new dimensions. Pick two wheels with nearly the same amount of wear left on them.

Remember that the bore sizes must fit the axle seats. If you have matched two wheels and you find one bore too small for the wheel seat, always re-bore the wheel--do not re-turn the axle wheel seat. You should try to avoid doing either when you are selecting wheels, but if you cannot find two that match each other and at the same time fit the axle, you must re-bore the wheel.

2.22. MOUNTING WHEELS

For mounting wheels on an axle two basic kinds of wheel-mounting presses are used: the single-end and the double-end. The designs of each may vary as do the amounts of pressure each is capable of developing. However, the operating principle is the same for both: the wheel is held firmly in place and a pressured ram forces the axle into the wheel bore. The only difference in the two types of presses is the advantage the double-end press has over the single end. The mounted wheel and axle must be completely removed from the single-end press, turned around, and replaced in the press before the second wheel can be mounted. This procedure is not necessary with the double-end press which can press the axle from both ends. One wheel is mounted, the second wheel is placed on the opposite end of the axle, and the ram forces the axle from the end opposite the unmounted wheel. This type of press saves time and labor.

The amount of pressure the presses can develop varies from 200 to 600 tons. The reason for the great variation is that different pressures are needed for mounting wheels and for dismounting. Wheel presses used for mounting should have a capacity from 200 to 300 tons; those used for dismounting need capacities of 400 to 600 tons. Whenever possible, two separate presses should be used; however, if you have only one press, it should have the higher pressure capacity. Each press should have both a dial pressure gage and a pressure recording gage. The latter should be mounted separate from the press to protect it from the shock of the pressing operation. Both gages should be checked frequently to insure that they agree with each other. Master gages are used to make the check. If the same press is used for both mounting and dismounting, the gages should be disconnected before applying the higher dismounting pressures. Table V shows the maximum and minimum pressures in tons that are required to mount steel wheels on each axle classification.

2.23. PROCEDURES FOR WHEEL MOUNTING

The process of properly mounting wheels on axles is a technical business requiring highly skilled men. The complete process is too lengthy and complex to be included in this text; however, you should be familiar with some of the important procedures of wheel mounting. The following subparagraphs discuss journal protection, cleaning of bores and wheel seats, positioning high spots on flanges, centering wheels, and checking gage.

Table V. Wheel-mounting Pressures in Tons

<table>
<tr><th rowspan="2">Class of axle</th><th rowspan="2">Journal size (inches)</th><th rowspan="2">Normal wheel seat diameter (inches) *</th><th colspan="2">Steel wheels</th></tr>
<tr><th>Min</th><th>Max</th></tr>
<tr><td rowspan="2">A</td><td rowspan="2">3 3/4 x 7</td><td>5 1/8</td><td>50</td><td>70</td></tr>
<tr><td>5 1/2</td><td rowspan="2">55</td><td rowspan="2">80</td></tr>
<tr><td rowspan="2">B</td><td rowspan="2">4 1/4 x 8</td><td>5 3/4</td></tr>
<tr><td>6 5/16</td><td rowspan="2">70</td><td rowspan="2">100</td></tr>
<tr><td rowspan="2">C</td><td rowspan="2">5 x 9</td><td>6 1/2</td></tr>
<tr><td>7</td><td rowspan="2">75</td><td rowspan="2">110</td></tr>
<tr><td rowspan="2">D</td><td rowspan="2">5 1/2 x 10</td><td>7</td></tr>
<tr><td>7 9/16</td><td rowspan="2">80</td><td rowspan="2">120</td></tr>
<tr><td rowspan="2">E</td><td rowspan="2">6 x 11</td><td>7 5/8</td></tr>
<tr><td>8 1/4</td><td rowspan="2">85</td><td rowspan="2">130</td></tr>
<tr><td rowspan="2">F</td><td rowspan="2">6 1/2 x 12</td><td>8 1/8</td></tr>
<tr><td>8 3/4</td><td>90</td><td>140</td></tr>
</table>

*Nominal wheel seat diameters of AAR axles.
Note. No tolerances permitted below minimum or above maximum pressures shown.

a. Protecting axle journals. The highly polished surfaces of journals should be protected during the wheel-mounting operation. Guards should be placed over them and, when possible, fitted so that the dust guard collar is also covered. To prevent the guards from nicking or scratching the journal, they should be made of softer material than the axle or lined with soft materials.

b. Cleaning and lubricating. All injurious material, such as rust, grit, chips, and grease, should be removed from the wheel bores and wheel seats before the mounting operation begins. Both wheel seats and wheel bores should be coated with a lubricant consisting of a mixture of basic carbonate white lead and boiled, not raw, linseed oil. This lubrication prevents scoring of the mounting surfaces as the wheel is started onto the wheel seat. The correct blend of the lubricant is 12 pounds of white lead thoroughly mixed with 1 gallon of boiled linseed oil. The mixture should be made at least 12 hours before it is to be used. Only a few days supply should be mixed at a time because the linseed oil tends to dry allowing the mixture to thicken. Improper wheel fits can result when the lubricant is too thick. It is important that dirt and grit be prevented from getting into the mixture or on the brush used to apply it. This would nullify the cleaning process and cause scratches on the mounting surfaces of wheel seats and bores.

c. Matching high spots. In normal use, the flanges of wheels develop high spots. These spots may not be high enough to condemn the wheel; however, when they are remounted on an axle, the high spots should be marked and placed opposite the low spots on the mating wheel. If high spots on both wheels were mounted in the same place, they would cause a bumpy roll.

d. Centering wheels. When wheels are being mounted, they should be exactly centered on the axle both during the mounting process and at its completion. If a wheel is not properly centered during mounting, the bore of the wheel will scratch and gouge the wheel seat. If this is not observed and corrected and the wheel is mounted off center, excessive flange wear will occur on the wheels and overheated journals will result. Several gages have been developed to determine if wheels are centered properly.

e. Checking gage. When two wheels are mounted upon an axle, they must be in gage--the exact distance to match the gage of the rail line over which they are to be operated. In the United States, all rail lines are standard gage, 56 1/2 inches. The gage of a rail line is the distance between the top inside of the heads of the rails. Since the wheel treads ride the top of the heads of the rails and the wheel flanges contact the inside of the heads, you can see that it is a must for wheels to be mounted to proper gage. For example, if you were mounting wheels for a standard-gage rail line, and you mounted two wheels on an axle so that the flanges were 59 1/2 inches apart, they obviously would not fit your railroad.

Several gages are used to check the gage of wheels on axles; figure 2.27 gives the dimensions of a check gage. When this gage is used, one wheel should be mounted and the gage placed on the mounted wheel and held over the other wheel while it is slowly being pressed onto the wheel seat. When the gage fits over the flange and rests on the tread of the wheel, as illustrated in figure 2.27, the

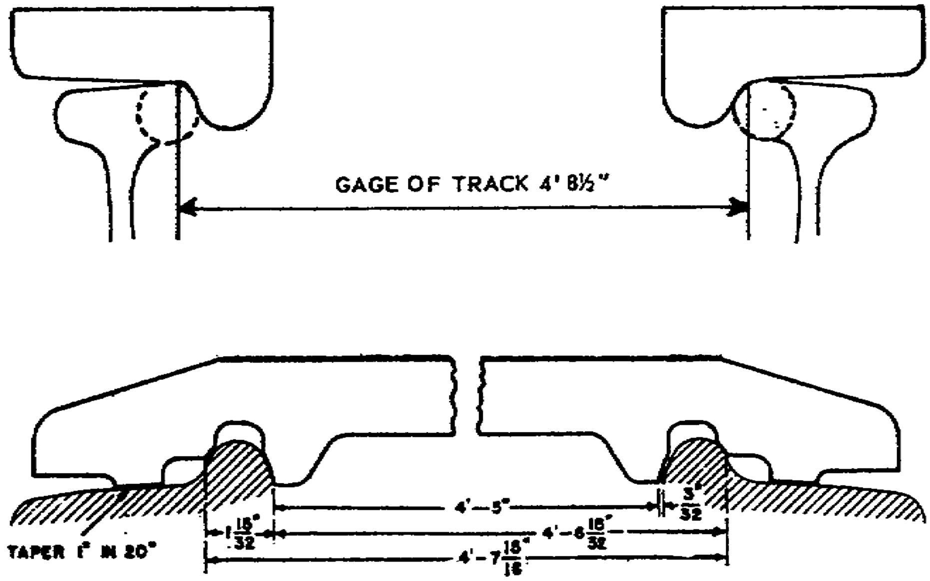


Figure 2.27. Check Gage.

wheels are in gage. After the mounting process is completed, the gage should be tried at three or more equidistant points around the circumference of the wheels. If the gage fits properly at all points, the wheels are in gage, the axle is not bent, and the wheels have been bored in the right line so that they will run true in service.

2.24. STORING MOUNTED WHEELS AND AXLES

Once wheels have been mounted on axles, they will probably have to be stored for a short or long time depending upon how soon they are needed. The storage area should be large enough to permit several separations of mounted wheels and axles; and it should be arranged so that neither wheels nor axles are damaged by contact with each other. Also, wheels and axles must be protected from the weather and from rusting.

a. Sorting. It is not a good practice to store all wheels and axles together. When the storage area is large enough, they should be sorted and grouped according to the size and type of the axle and the diameter of the wheels; multiple-wear, wrought-steel wheels should be separated according to rim thickness.

b. Storing. Both manpower and money would be wasted if trouble is taken to turn axles and polish journals, turn wheels and match them, and mount the right wheels on the right axles properly, only to store them on tracks so that they could roll together and chip flanges, nick journals, or break or bend the axles.
Storage tracks should be spaced so that the flanges of one pair of wheels cannot

strike either the journal or the center portion of the adjacent axle. If a journal is nicked, it may cause an overheated journal bearing or a hotbox. If the wheel flange forcibly strikes and thereby nicks the center portion of the axle, breakage may occur. Offsetting pairs of storage tracks 6 inches will prevent this damage as the treads will strike the hub of the next wheel, as you can see in figure 2.28.

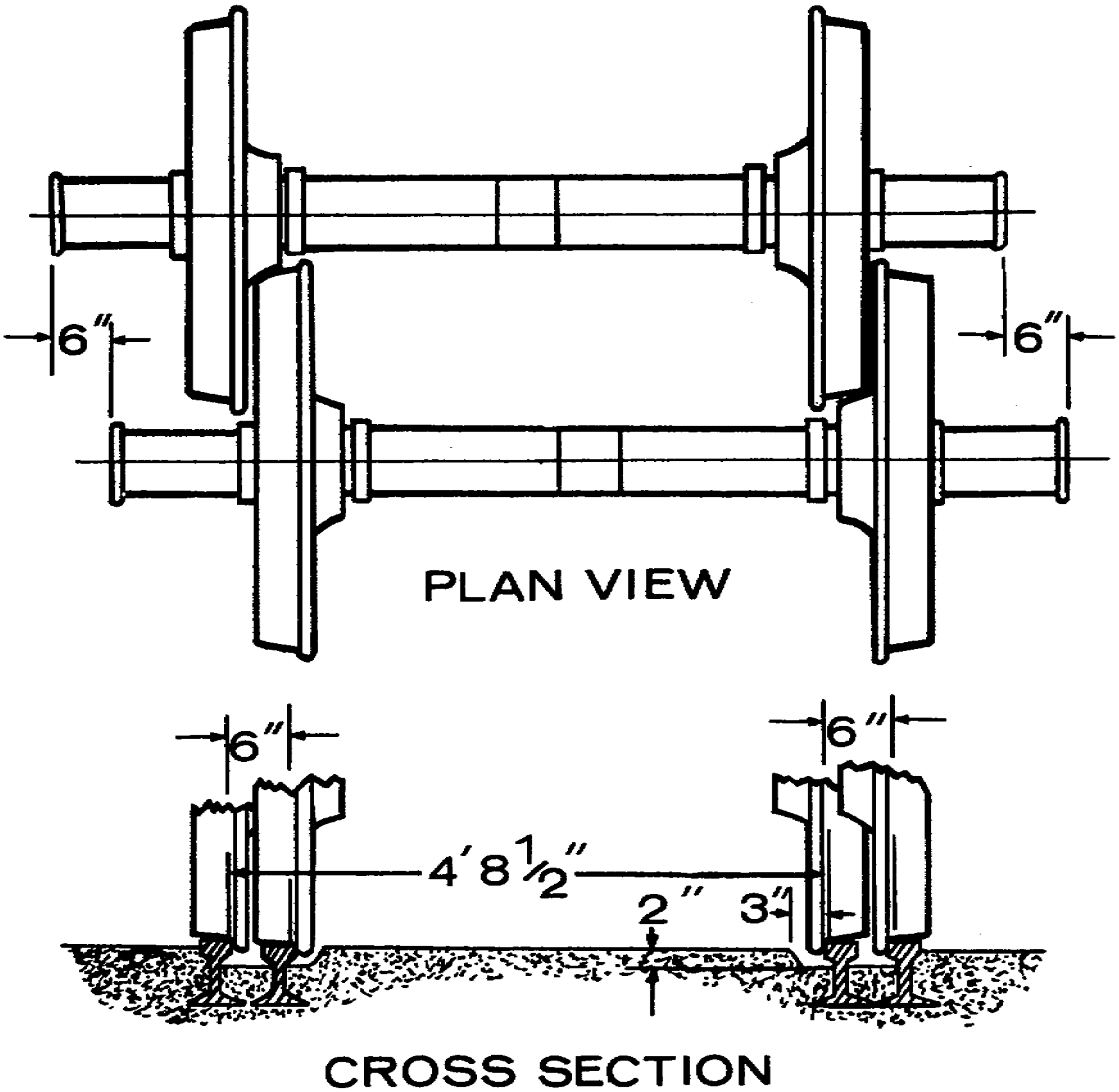


Figure 2.28. Storing Wheels.

c. Lubricating. Highly polished journals rust rapidly if left unprotected even though the axles may be stored inside out of the weather. To prevent them from rusting, they should be completely coated with a heavy lubricant or rust preventive that will not easily wash away but can be readily wiped off. A mixture of paint and heavy oil has proved effective for this purpose.

2.25. DISMOUNTING WHEELS

A wheel press with a capacity of 400 to 600 tons is necessary for dismounting wheels. The process is exactly reversed from that of mounting wheels but the principle is the same. The wheel is held firmly in place and the ram forces the axle from the wheel. The biggest job in the dismounting process is dislodging a tight wheel. Neither the wheel nor the axle should ever be heated with a torch to assist in loosening the wheel. If any evidence of the use of a torch is found, that part affected should be removed from service. A hole burnt in a wheel plate as shown in figure 2.29 will cause the plate to crack and the wheel to fail. A burnt spot on an axle generally causes the axle to break under load.

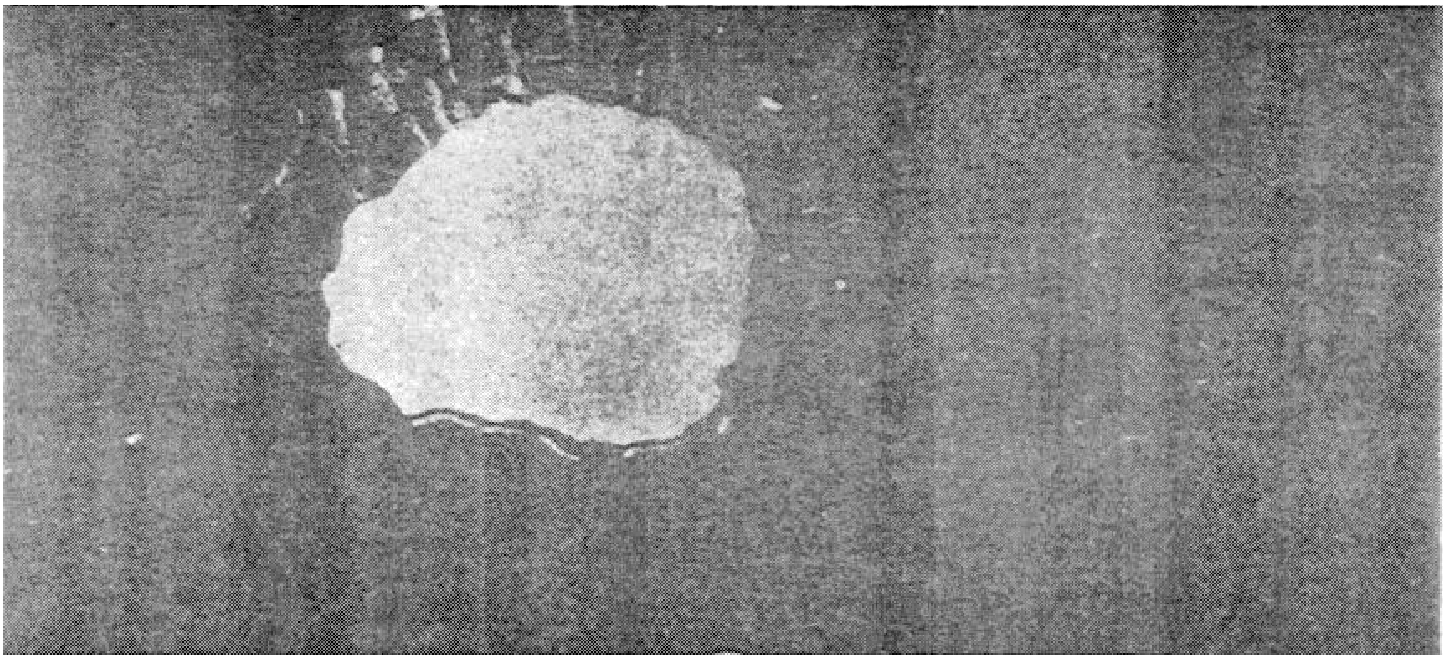


Figure 2.29. Cracked Caused by Hole Burnt in Wheel Plate.

2.26. SUMMARY

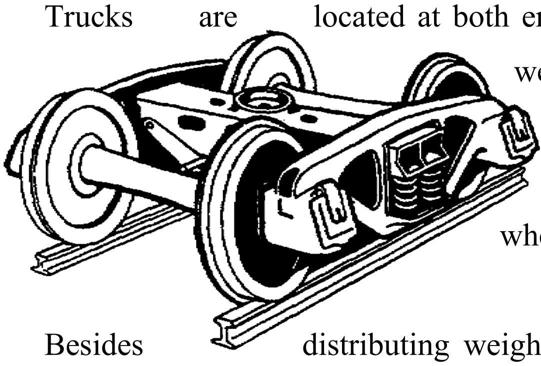
Putting the right two wheels on the right axle to make a complete unit ready for service is a complicated process. The wheels selected must fit the axle and match each other in size and type. In the mounting process, protection and lubrication must be given to both the wheels and the axle while the high-capacity presses seat the wheels on the axle wheel seats. To make sure that the unit will operate properly, the wheels must be exactly centered on the axle and pressed to the proper gage. Once the mounting process is complete, the wheel and axle units must be properly stored to protect them from damage and weather until they are placed in service. Finally, the same procedure used to mount wheels is used to dismount them except that it is reversed and the amount of pressure required to dislodge the wheel from the axle seat is much greater than that required to mount it.

Let's assume that the wheel and axle units we have developed are now ready to be placed into service. They are placed on units called trucks, the general term covering the assembly of parts which, as whole structures, support a car body at each end. In the next chapter you will see how they are added to the car truck and how the truck is constructed to distribute the weight of the car and its contents to the axle journals, to the wheels, and finally to the rails.

Chapter 3

TRUCKS

3.1. GENERAL



Trucks are located at both ends of a railway car. Supporting the car body, they distribute the weight of the car and its contents to the wheels and axles attached to them. Since the majority of trucks in general use have only four wheels, this chapter concentrates upon them. Those with six wheels are designed to carry very heavy loads or run at high speeds.

Besides distributing weight to the wheels, trucks have several other functions. They must swivel freely beneath the car to permit it to travel over curved track without derailing and they must not interfere with the operation of other car parts. As a railway car is pulled over the rails, many shocks and vibrations develop; trucks must provide a means of absorbing them to keep the lading from being damaged or the passengers from being uncomfortable. Finally, just as wheels must have a source of energy to start and keep them rolling, they must have brakes to slow or stop them; trucks must provide a means of mounting brake rigging that works efficiently with other parts of the braking system mounted on the car body.

To provide all these functions in varying degrees, a variety of trucks have been designed and constructed. This chapter does not attempt to cover all different designs, but one typical four-wheel truck, with all of its parts and their functions, is explained in detail. Some of the more common variations are also presented. Paragraph 3.7 describes briefly a six-wheel truck.

3.2. MAJOR COMPONENTS

The typical truck, shown in figure 3.1, consists of the truck bolster assembly, the side frame with its journal box assembly, the brake rigging, and the wheel and axle assembly. With the exception of the wheel and axle assembly covered in the preceding chapter, each of these major components is explained in the order mentioned. As each component is explained, the way in which it is

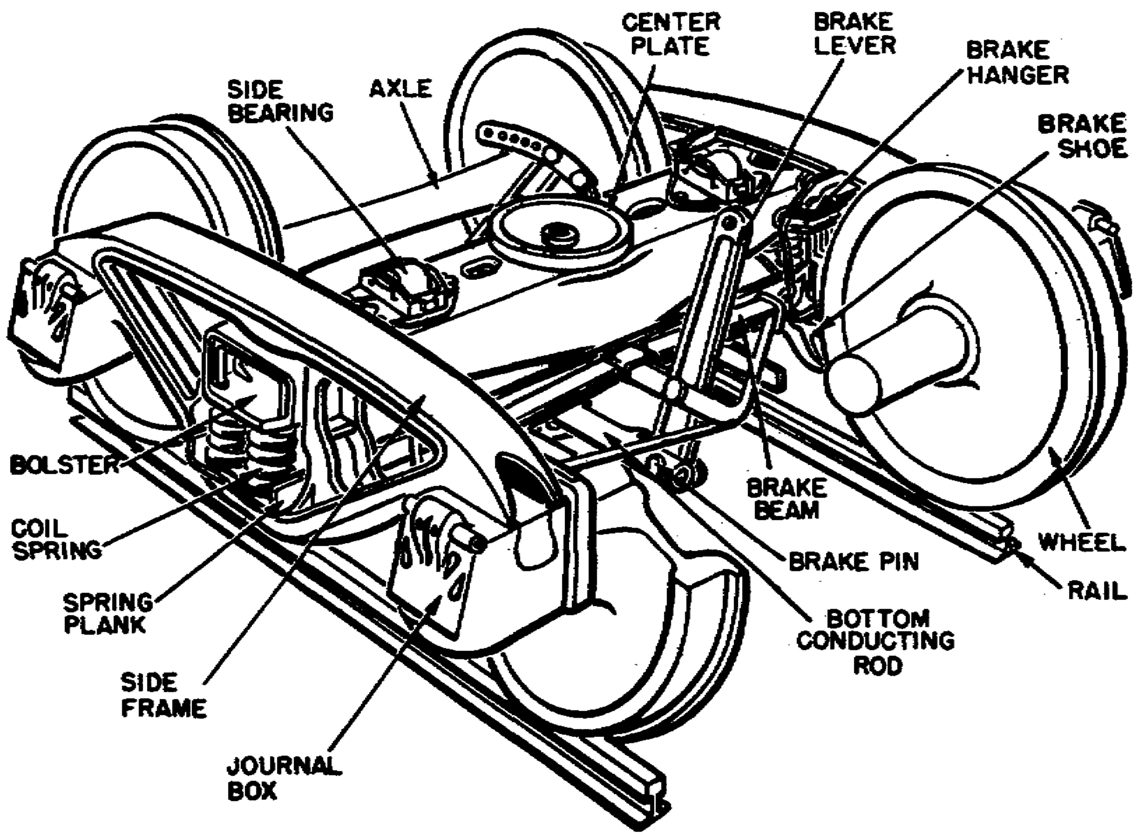


Figure 3.1. Typical Truck.

integrated with other truck components and other car parts is also discussed.

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3.3. BOLSTER ASSEMBLY

The truck bolster is a heavy crossmember at the center of the truck set parallel with the axles. The bolster initially receives the weight of the car body and distributes it to the two side frames. It has three important parts: the center plate, the bolster ends, and the side bearings.

a. Center plate. The circular raised plate in the center of the truck bolster is a forged or cast-steel female member that matches a similar male center plate on the car body bolster. A pin from the body bolster fits into the recessed hole in the truck bolster center plate. This connection permits the truck to swivel beneath the car while maintaining contact between the center plates. A heavy lubricant must be applied between these plates to retard wear. When the car is on straight track, most of the weight of the car and its contents is directly upon the center plate; when the car is moving on curved track, the side bearings support some of the weight as explained in subparagraph c.

b. Bolster ends. The truck bolster interlocks at both ends with the truck side frames, tying them together and preventing lateral movement. The interlock is made by bolster guides that ride up and down the columns of the side frames. The bottom of the bolster has, on both ends, built-up, shouldered spring pockets that seat unit clusters of coil springs upon which the bolster rests. The springs are seated at the bottom in matching pockets either on a spring plank or in the side frame itself. In a spring-plank truck, a steel plank runs across the truck, beneath the bolster, and interlocks with the two side frames. It is important to note that the same number and same size of springs are used on both sides of the truck; however, the number and size of springs vary with different type trucks depending upon the loads and speeds for which they were designed. The typical freight car truck has five coil springs beneath each end of the truck bolster.

c. Side bearings. Special steel plates, fabricated as part of the truck bolster, with flat bearing surfaces are designed to make contact with similar bearing surfaces on the bottom of the car body. The truck side bearings are located on the top of the bolster between the side frames and the center plate. These bearings steady the car and prevent most of the side-to-side rocking motion that develops as the car moves over uneven track or around curves. When the car is moving at a slow rate of speed around a section of track that curves to the left, the left side bearings make contact with the bearing surfaces of the car body; when the car is moving at a high rate of speed, the right bearings make contact because of the centrifugal force acting on the car body. When the car is on straight, level track, none of the side bearings are in contact with the car body bearing surfaces. A heavy lubricant should be applied to these bearing surfaces to reduce wear.

3.4. SIDE FRAME

The side frame of the truck, shown in figure 3.2, is a cast-steel, dual-trussed member, having two connecting columns to which the truck bolster interlocks. A journal box is cast integrally with the side-frame on each end. The bottom truss is cast to fit either the spring plank or the springs themselves; between the columns and the journal boxes on the top truss, brake-rig lugs are cast to provide a means for hanging brake beams. The truck side frames are subjected to severe stresses and strains when the car is under load and being pulled at a high rate of speed. They should be inspected frequently and carefully for cracks or chips because a failure of either frame would cause the car to derail.

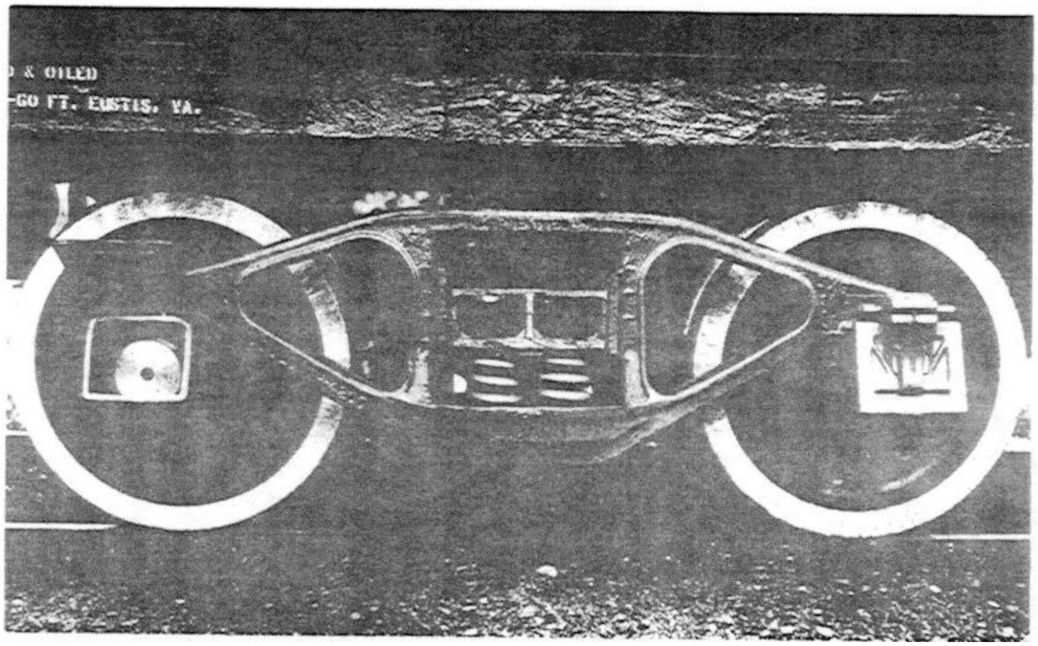


Figure 3.2. Side Frame.

Because of the important function of the journal box and the inspections and maintenance it requires, it is discussed in a separate paragraph.

3.5. JOURNAL BOX

The axle journal, discussed in the preceding chapter, is housed in the journal box. A typical journal box with solid friction bearing is shown in figure 3.3. The box has three principal functions: it distributes the weight of the car and lading evenly over the journal, provides for continuous lubrication of the journal, and dissipates heat generated within it. Each part of the journal box is explained in the following subparagraphs.

a. The dust guard and plug are inserted in a vertical slot in the back end of the box. The plug fits closely with the turned axle dust-guard seat to prevent dust, cinders, dirt, or moisture from entering the box from the rear. The dust guard and plug are inserted into the slot before the journal is fitted into the box.

b. The journal friction bearing is cast in a contour to match the axle journal. It is made of bronze, brass, or special iron and is set on top of the journal. The journal bearing has a babbitt-metal

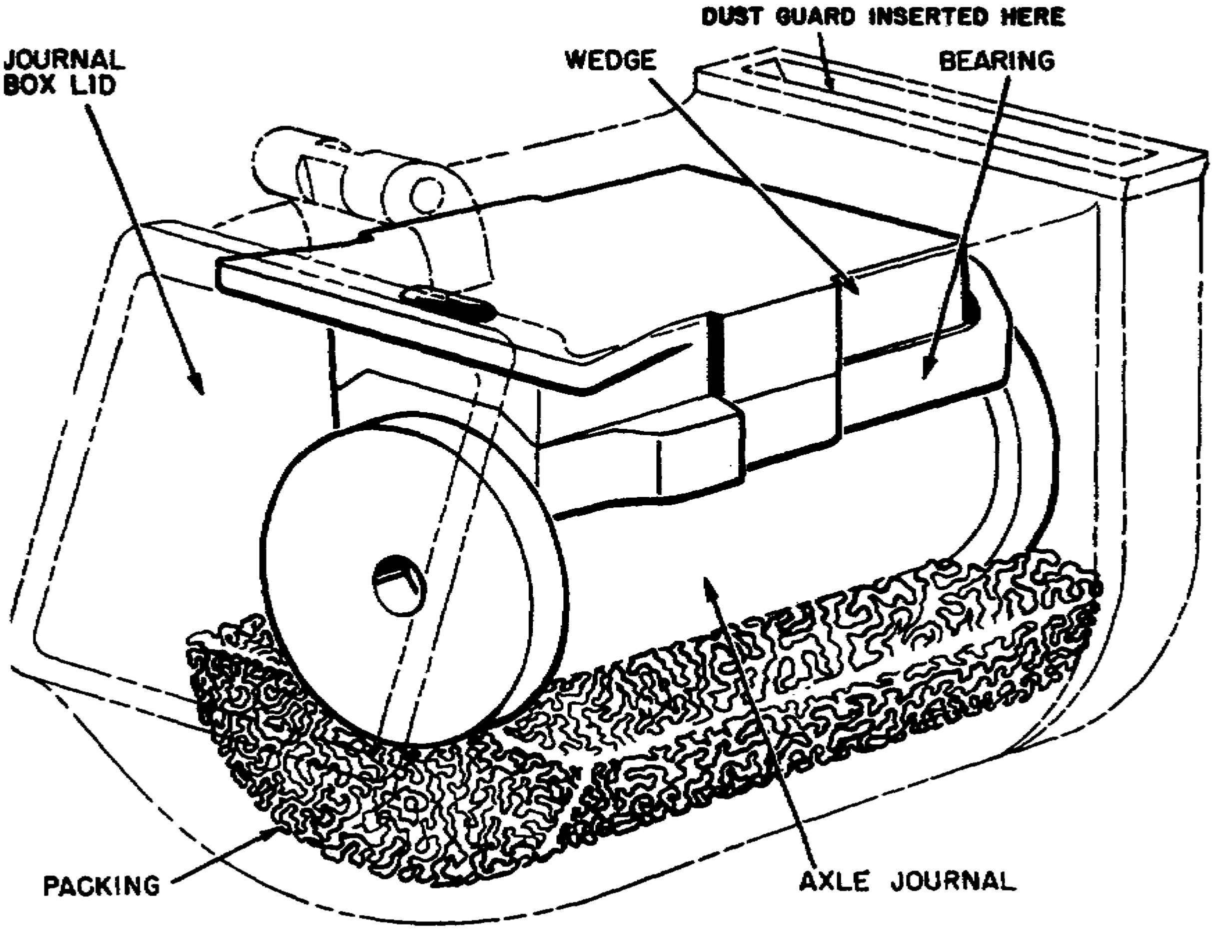


Figure 3.3. Typical Journal Box Assembly.

lining that is soft but tough and durable. Because a bearing is subject to continuous wear while the car is in motion, it is designed for easy removal and replacement.

Journal roller bearings have been in use on passenger cars for some time and, in the last few years, the number of freight cars equipped with roller bearings has more than doubled; in the future, all new freight cars and more and more old ones going into shops for major repairs will be equipped with some type of roller bearing. Because the journal roller bearing assembly, with its sealed lubrication unit, can run for 3 years without requiring any added lubricant, maintenance and inspection time will be greatly reduced and the traditional hotbox troubles causing schedule delays will be considerably less.

The Army has few freight cars with journal roller bearings: its passenger and ambulance cars, however, have journal boxes using grease-lubricated roller bearings. Because of the need for special equipment to replace the lubricant, Army rail cars with these bearings have been taken care of by commercial shops.

c. The wedge is a companion piece -to the friction bearing. It is constructed with a rocker contour that distributes weight evenly over the journal bearing. The wedge receives the proportionate weight of the car and lading from the journal box and in turn transfers the weight to the bearing; weight is then transferred to the journal, to the wheels, and to the rails. With heat transfer, the reverse process is true. Heat generated between the bearing and the journal is transferred through the wedge to the journal box where it is dissipated into the atmosphere.

d. The packing and lubricant, required with the friction bearing, are housed in the bottom of the journal box. As the journal turns, it picks up lubricant from the packing which acts as a wick. Lubricant is poured into the bottom of the journal box in a sufficient quantity to keep the packing saturated. If the lubricant gets low and the journal becomes dry, a hot journal, called a hotbox, will develop. Prolonged overheating of the journal causes it to break, resulting in car derailment.

A newer method of journal lubrication has been adopted by most commercial railroads in this country, and to some extent by the military. Instead of packing separate pieces or rolls of waste beneath the journal, a special, one-piece lubricator pad is soaked in lubricant for a minimum of 48 hours and then placed beneath the journal. The Association of American Railroads has approved several different designs and makes of these pads, but the principle in each is the same. Journal lubricating pads have substantially reduced the number of hotboxes and the amount of maintenance required when journal boxes are packed in the old way.

e. The journal box lid is hinged at the top of the box and is spring loaded. The lid should remain closed at all times to prevent any foreign matter from entering the journal box. In a theater of operations, the lid may be fitted with locking devices to prevent theft of the brass bearing and the waste packing.

3.6. BRAKE RIGGING

The typical freight car has part of the braking apparatus mounted on the truck and part mounted on the car underframe. This paragraph deals with the brake rigging mounted on the truck only. The remainder of the apparatus is discussed in a separate chapter.

Figure 3.4 shows the braking apparatus for a typical freight car equipped with four-wheel trucks. Notice that the top rods are connected to the live truck levers by a pin. This connecting point divides the truck-mounted brake rigging from the body-mounted braking apparatus. When the live truck lever is moved, the brakes are applied or released depending upon the direction of the lever movement. The braking or releasing force is transmitted from the live truck lever, the lever that is actuated, to the inside brake beam, through the bottom rod to the dead truck lever, and then to the outside brake beam. As the two brake beams move, they apply braking pressure to the four wheels of the truck by forcing brakeshoes against the wheel treads; they release the braking pressure when moved in the opposite direction.

The truck-mounted brake rigging is connected to the truck side frame by four brake hangers, one at each end of both brake beams. The dead lever guide provides a connection for the dead truck lever. This guide is connected to the truck bolster and anchors the dead lever guide at the end opposite the connection with the dead truck lever.

3.7. SIX-WHEEL TRUCKS

As mentioned earlier, high-speed freight cars and passenger cars are equipped with trucks designed especially for increased stresses and shocks. The six-wheel trucks give better performance at higher speeds than four-wheel trucks and absorb more shock and vibration. The safer, smoother riding qualities are necessary for passenger comfort. The six-wheel truck shown in figure 3.5 has many features common to all passenger car trucks. Side frames are of much heavier construction than in four-wheel trucks; in addition to coil springs, the truck is equipped with elliptical springs similar in design to those found on some automobiles and motor trucks. With a system of equalizers, this combination of springs reduces the sidesway and vertical shocks that would normally be transferred to the car body. The brake rigging of the six-wheel truck is also different from that of the conventional four-wheel truck in that two brakeshoes, one on either side of each wheel, make contact with the wheel tread as contrasted with the four-wheel types that have one shoe per wheel.

Another difference in the six-wheel truck is also shown in figure 3.5. Notice the brake cylinder mounted on the side of the truck. Some heavy-duty freight cars have depressed centers or well-hole centers, or are designed in a way that prevents mounting

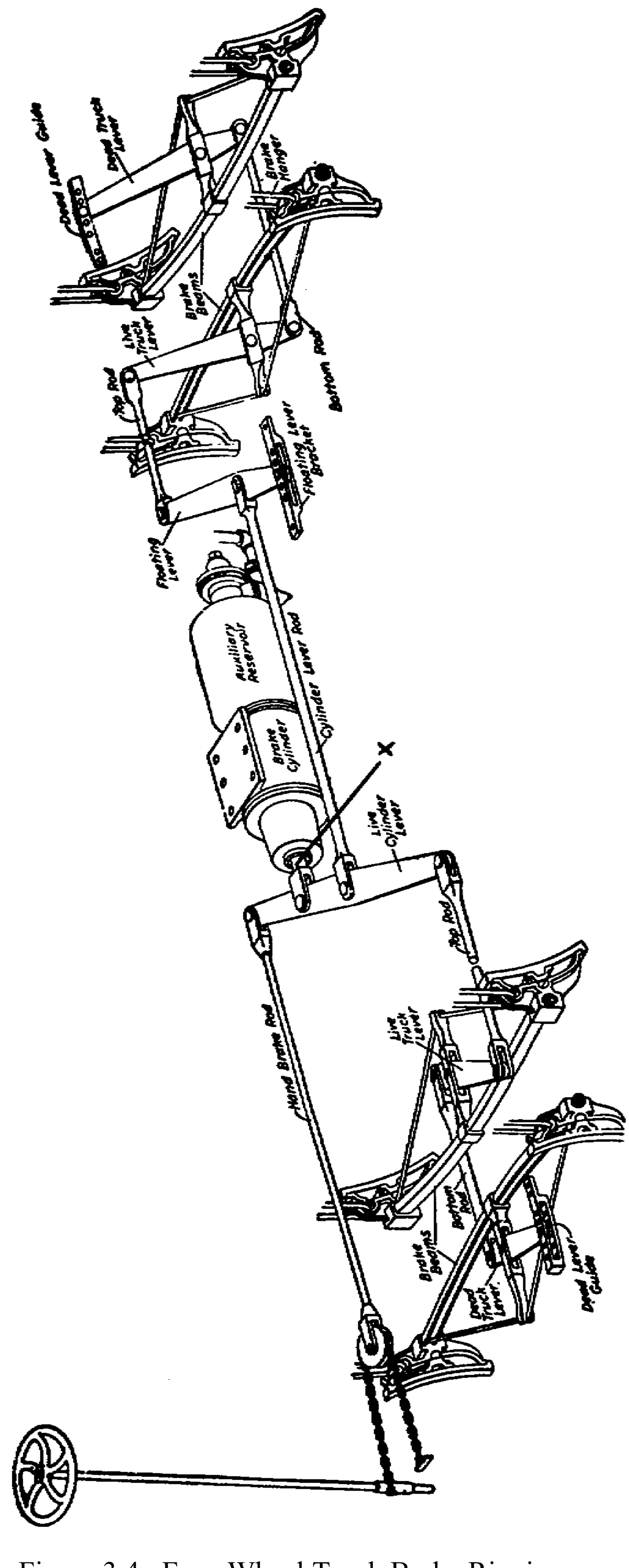


Figure 3.4. Four-Wheel Truck Brake Rigging.

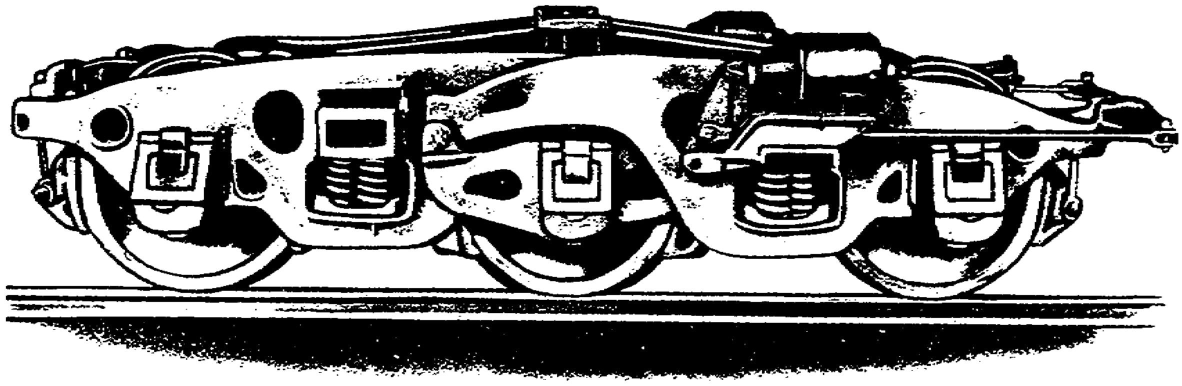


Figure 3.5. Typical Six-Wheel Truck.

the brake cylinder on the bottom of the car body. These cars have the brake cylinder mounted on the truck side frame. The cylinder, with all other body-mounted braking apparatus, is discussed in chapter 6.

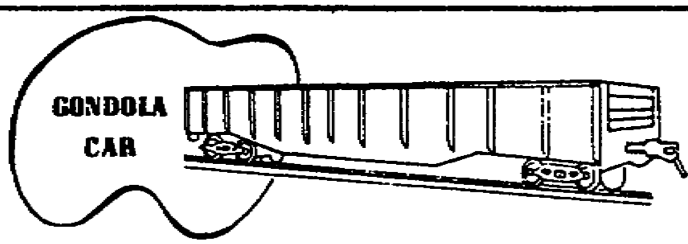
3.8. SUMMARY

Most of the rolling stock in service on railroads throughout the world is equipped with four-wheel trucks. In addition to the wheels and axles, the principal parts of the truck are the bolster assembly, side frame, journal box, and brake rigging.

Set parallel to the axle, the truck bolster has three main parts: a raised center plate that connects with a similar plate on the car body, permitting the car to swivel; ends that interlock with the truck side frame, preventing lateral movement; and side bearings, located on the bolster top midway between the ends and center plate, to steady the car and prevent most of its rocking motion. The truck side frame interlocks with the bolster.

Cast into the side frame is the journal box with parts that have important functions. The dust guard keeps dust, dirt, and moisture from entering the box itself from the rear; a wedge distributes the weight of the car and lading evenly over the axle journal; packing and lubricant keep the journal from overheating; and a lid on the outer end of the box keeps anything from getting into the box.

Braking force is transmitted through levers to brake beams that force brakeshoes against wheel treads. Part of the braking apparatus is mounted on the truck and part on the car underframe, described in the next chapter.



Chapter 4

UNDERFRAME

4.1. GENERAL

The underframe is the structural framework to which the trucks discussed in the previous chapter are connected. The parts of this framework are welded or riveted together, or both. The assembled underframe is the platform upon which the superstructure of the car is built. It supports the combined weight of the car body and any lading the car may be carrying, and receives and absorbs the pulling stresses and the buffing shocks while the car is being coupled and moved. The underframe consists of all the framework below the floor of the car including the sills, body bolsters, cross' bearers, crossties, floor stringers, striker plates, and safety attachments. These main parts are common to any underframe, except that used for some tank cars.

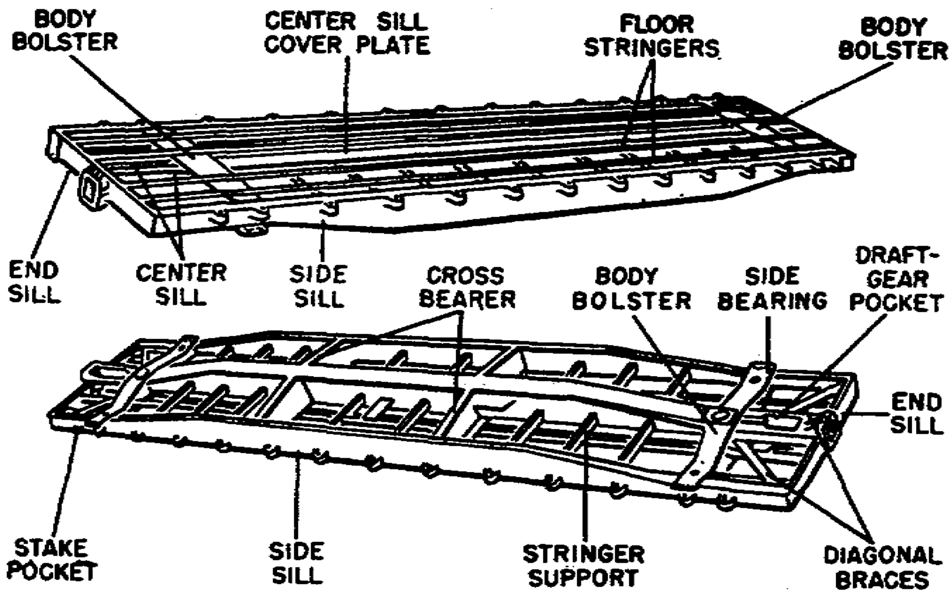
Figure 4.1 shows both a typical riveted underframe and a welded-steel underframe. Refer to this figure as you study each part of the underframe as it is discussed in the following paragraphs.

4.2. SILLS

Three of the structural members of the underframe are the center, side, and end sills. Actually there are five members: one center sill, two side sills, and two end sills. They are discussed in the following subparagraphs and labeled in figure 4.1.

a. The center sill is the main longitudinal member of the underframe structure. It is the backbone of the frame and transmits the pulling stresses and the buffing shocks from one end of the car to the other. Pockets are located in each end of the center sill to house the draft gear and couplers discussed in the next chapter. The thickness of the sill is, in some cars, increased between the two body bolsters. This increase in thickness results in an increase in the structural strength of the underframe. As a rule, an increase in the thickness of the center sill is accompanied by a similar increase in the thickness of the side sills.

Riveted



Welded-steel

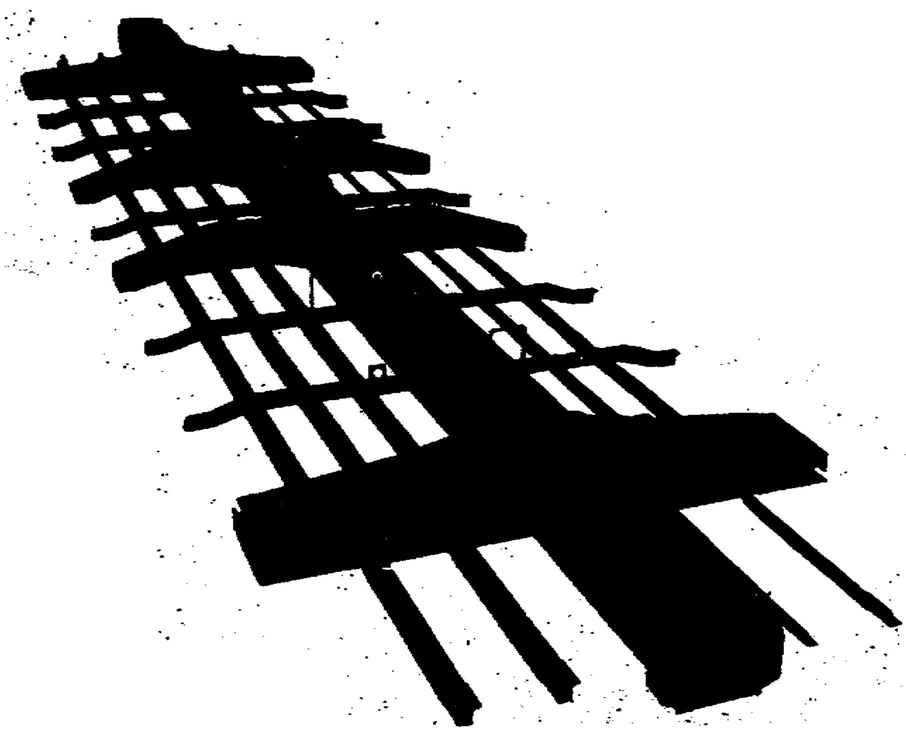


Figure 4.1. Riveted and Welded-Steel Underframes.

b. The side sills are outside longitudinal members running the entire length of the car, one on each side. They are constructed so that a channel is formed by two flanges that extend toward the inside of the car and have a flat surface on the outside. The cross-members, discussed in subsequent paragraphs, fit into the channel of the side frames. On some cars, the side sills are thickened in the center to increase their strength, and, on flatcars, stake pockets are cast, riveted, or welded on the flat, outside surface of the side sills.

c. The end sills are transverse members that extend across the ends of the longitudinal center and side sills, one at each end of the car. They are channel beams with flanges and are considerably heavier than the side sills. Angle bars and plates are riveted or welded to the end sills to connect them with the longitudinal members. An opening in the center of each end sill provides access to the draft gear pockets in the center sill.

4.3. BODY BOLSTER

The next important parts of the underframe are the two body bolsters, the transverse or cross members of the frame. In an earlier discussion of car trucks, it was pointed out that the truck bolster has a matching counterpart that is a part of the car under-frame; this is the body bolster. As you probably remember, the truck bolster has a center plate that matches and contacts the center plate of the body bolster. A center pin secures the connection between the two plates, and the weight of the car and its lading is transmitted to the truck by the contact and connection of these plates. Therefore, the body bolster must be a strong structural member of the underframe because it is in the direct line of weight transmittal.

Body bolsters are located near each end of the underframe and are perpendicular and attached to the center sill or backbone of the frame. Each consists of a center plate, top and bottom cover plates, and two side bearings. The center plate has already been discussed. The top cover plate passes above the center sill, and the bottom cover plate has the center plate and the two side bearings attached to it. Again, remember the truck bolster side bearings that were discussed earlier (par. 3.3c). Their matching members are located on the bottom of the body bolster, and together they prevent excessive sidesway of the car.

4.4. CROSSBEARERS AND CROSSTIES

The crossbearers are heavy transverse members between the two body bolsters. They tie the side sills to the center sill, stiffen the structure, and help to distribute the weight of the car and lading. Some crossbearers extend from one side sill to the other, and these have fillers between the two beams that form the center sill. Because of the thickness of the crossbearers, holes are usually drilled in them on either side of the center sill so that airbrake and steam lines can pass through them. However, some freight car underframes have angle iron brackets either riveted or welded on to various parts of the underframe to secure these lines. An example of this kind of construction is shown in the welded-steel underframe in figure 4.1.

Crossties differ from crossbearers in size. They are smaller and lighter, and they connect the side sills to the near side of the center sill. Crossties do not extend from one side sill to the other. They are sometimes called stringer supports.

4.5. FLOOR STRINGERS

The floor stringers are longitudinal members located between the center sill and the side sills. They usually run the length of the car between the end sills, and the flooring of the car is attached to them. Secured to all transverse members, they strengthen the framework. Although they occupy the same positions as sills, they are not designed to function as sills.

4.6. STRIKER PLATES AND SAFETY ATTACHMENTS

To protect the draft gear and the center sill, striker plates are welded or riveted around the coupler opening in the end sills. The coupler horn strikes these plates when the car is being coupled to another car.

To protect operating personnel from injury, several safety attachments are placed on the underframe. These attachments are discussed separately in chapter 7.

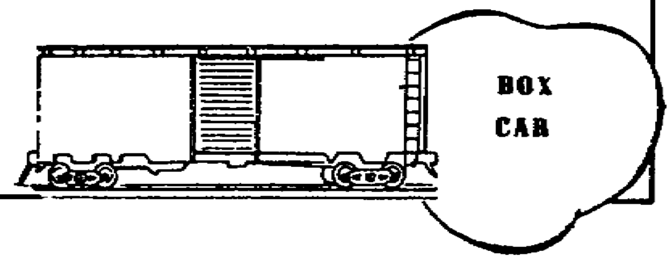
4.7. SUMMARY

The two principal types of railway car underframes are of riveted and welded-steel construction. Both types consist of several different members that vary in size and strength depending upon the capacity for which the car was designed. The center sill is the backbone of the underframe which is "boxed-in" by the side and end sills. The remainder of the underframe could be called the ribs, except for the floor stringers that provide only a mounting place for the car flooring.

The underframe has openings at both ends into which the draft gear is seated. Connected to the draft gear are the couplers. Both of these pieces of equipment are discussed in the next chapter.

Chapter 5

DRAFT GEAR AND COUPLERS



5.1. INTRODUCTION

Railway cars are made up into trains. They are connected end to end or, in railway jargon, coupled. The devices used in the coupling, pulling, pushing, and uncoupling processes are the draft gear and coupler. The draft gear is connected to the car underframe and seated in the center sill pocket. It receives and reduces the shocks and pulling stresses before transmitting them to the car body. The coupler is attached to the draft gear.

This chapter discusses, first, the draft gear and coupler used in the United States; and, second, those found on rail equipment in foreign countries.

5.2. DRAFT GEAR

The draft gear connects the coupler to the car underframe and cushions the shock caused when cars are coupled or train speed is suddenly changed. A certain amount of slack is purposely left in the couplers of a standing train so that it can be started one car at a time. Cars are usually coupled at a speed of about 5 miles per hour. You can imagine what would happen if a heavily loaded freight car, standing on a siding, was struck in the coupling by a group of cars moving at 5 miles per hour with a solid connection between the coupler and the underframe. Something would have to give! It is at the end of this run-in and run-out of slack that the shock occurs; the draft gear, placed between the coupler and the underframe, is designed to cushion such shocks. The two basic types of draft gear used in the United States are the friction and rubber.

5.3. FRICTION DRAFT GEAR

All types of friction draft gear have two major parts contained within a housing: a unit of coil springs and a friction unit. Figure 5.1 shows three different kinds of draft gear, and figure 5.2 is a diagram showing the internal parts of two types. Notice that

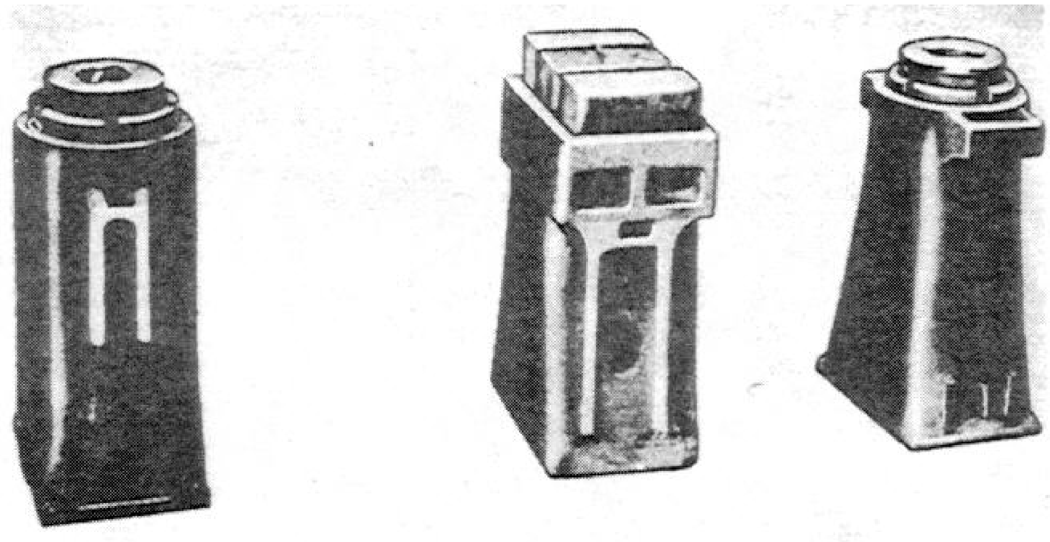


Figure 5.1. Friction Draft Gears.

within the housing of both there are coil springs and friction units made up of plates and wedges.

As the coil springs begin to compress, they meet the resistance of the friction unit. The more the springs compress the harder they bear against the friction plates and thus the more the resistance to the compression pressure. The resistance action permits cars to be started smoothly; when pressure is released, the friction unit prevents the springs from recoiling too rapidly. A draft gear operates the same way when a car is suddenly pushed rather than pulled.

5.4. RUBBER DRAFT GEAR

Designed to fit the standard draft gear pocket in the underframe, the rubber draft gear has been used on locomotives and passenger cars for over 30 years. Its use on freight equipment is gradually becoming more frequent. At present, rubber draft gear is found on the Army's diesel-electric locomotives, on cars in ambulance trains, and on some troop and kitchen cars. The gear unit, as seen in figure 5.3, includes a series of rubber plates that take care of shocks during coupling.

5.5. COUPLER

A coupler does three things: connects one car with another, holds the connection, and then disconnects the two cars. Cars built in this country before 1933 were equipped with what was known as the

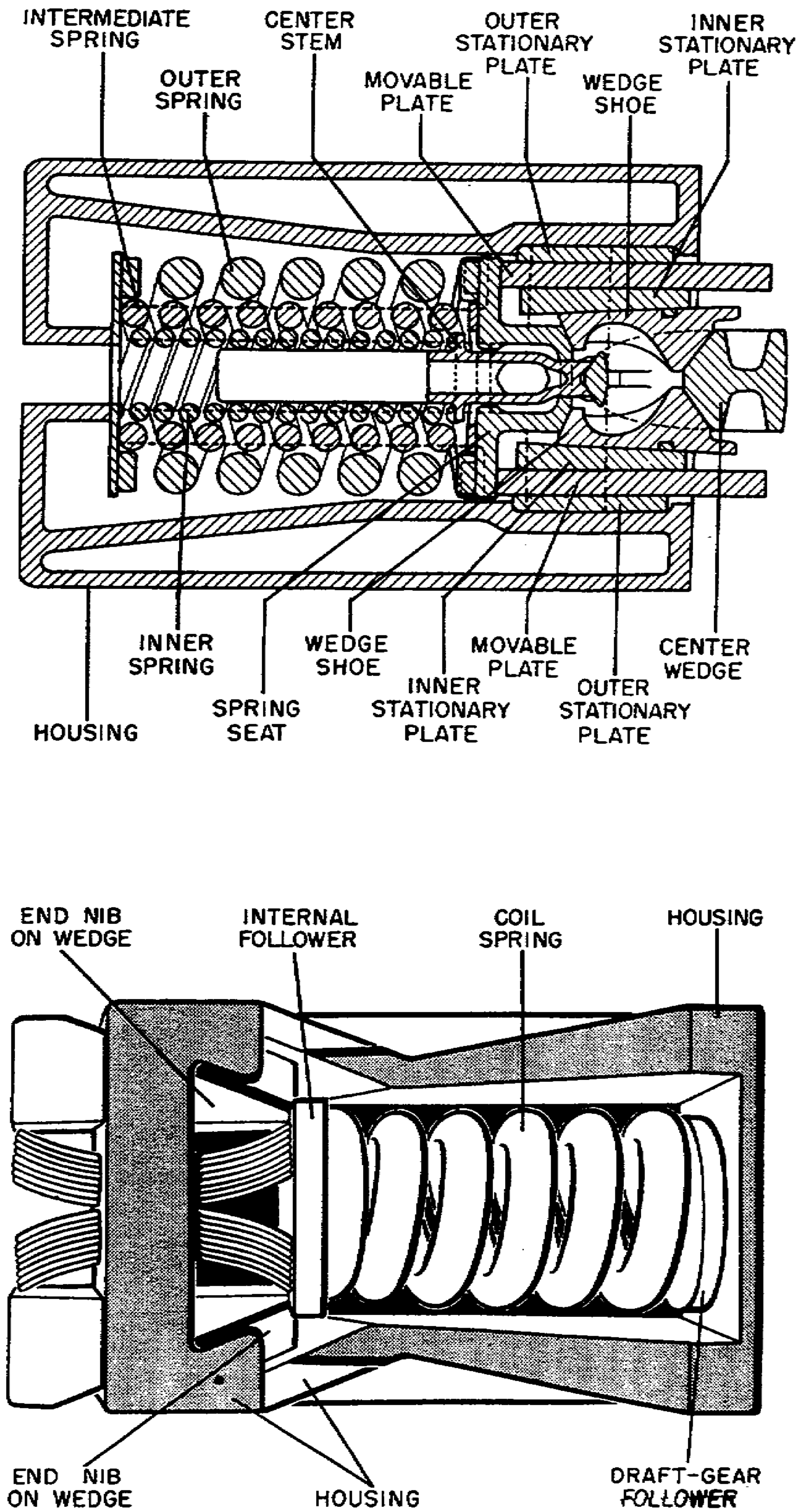


Figure 5.2. Interior of Two Friction Draft Gears.

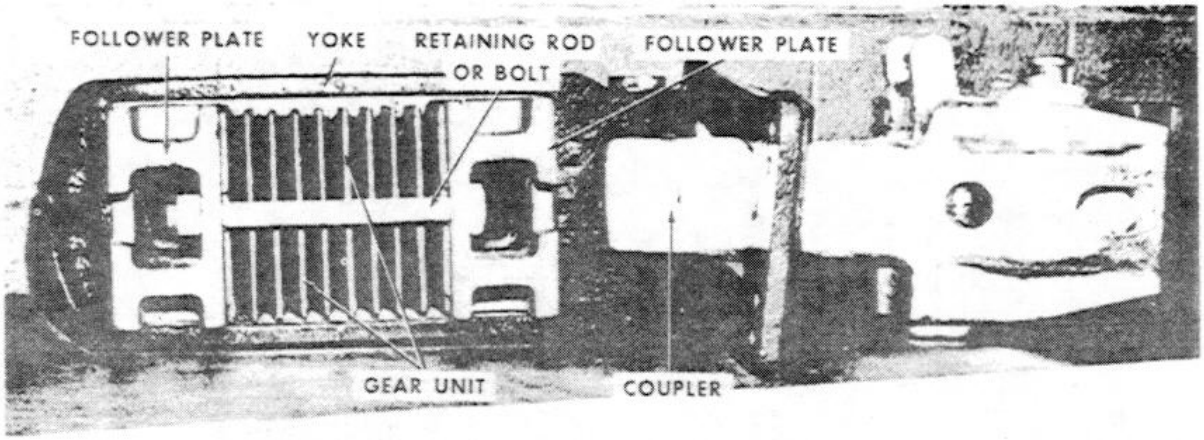


Figure 5.3. Rubber Draft Gear, Cutaway View.

D coupler. Since then almost all freight cars have had the E coupler; some are being equipped recently with an F coupler and passenger cars have an H coupler. The working principles of the E, F, and H, however, are the same.

The next two paragraphs discuss the E coupler and its maintenance. After that the Willison and hook-and-link couplers found on foreign equipment are described.

5.6. E COUPLER

The complete E coupler is shown in figure 5.4 and its working parts are diagramed and labeled in figure 5.5. The coupler is completely automatic in the locking or coupling process; however, it must be manually unlocked before cars can be uncoupled.

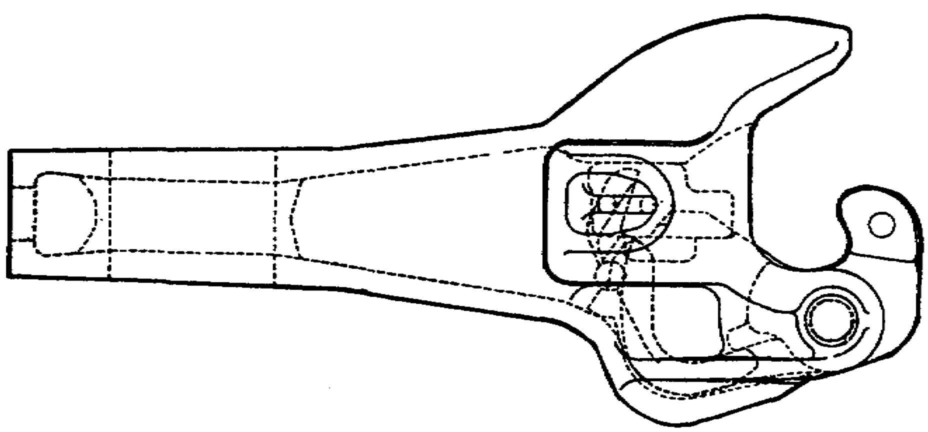


Figure 5.4. Typical E Coupler.

The coupler may be unlocked from either the top or the bottom depending upon how the rotary lock lifter and its actuating parts are assembled. The coupler is designed so that these parts can be changed for either top or bottom operation. Either operation is performed safely from beside the car by raising the uncoupling lever that is connected to the rotary lock lifter.

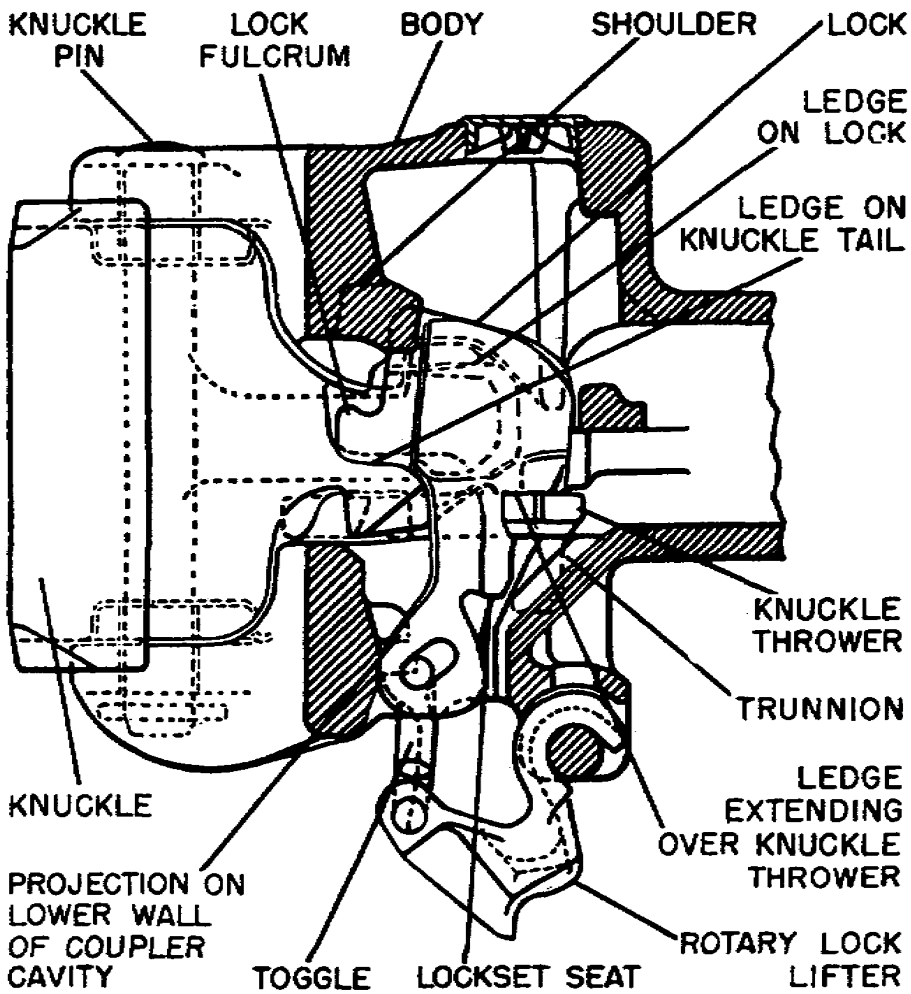


Figure 5.5. Working Parts of E Coupler.

The main working parts of the coupler are as follows: The body is the main section that includes the horn, guard arm, shank, butt, and head that houses the coupler's operating parts. The knuckle is the rotating hook, hinged on the knuckle pin, that connects with the knuckle of another coupler. A knuckle lock drops into place when the knuckle locks and prevents uncoupling. The lifter, when moved by the uncoupling lever, lifts the knuckle lock and frees the knuckle for throwing. The knuckle thrower throws the knuckle open as the uncoupling lever continues to be raised. The toggle works with the lifter to lift the knuckle lock on bottom-operated couplers.

5.7. COUPLER MAINTENANCE

Regulations cover all phases of maintenance requirements on couplers; however, most of them are minor in relation to the two important requirements discussed in the following subparagraphs. These two requirements deal with the proper coupler height from the rails and the amount of play in the knuckle.

a. Coupler height. If the coupler is too low, cars do not couple properly; then, when they are moving, it is possible for them to uncouple. Coupler height is measured from the top of the rails to the center of the face of the coupler knuckle using the tool shown in figure 5.6. Because of the difference in weight pushing downward on the car, different measurement requirements exist for empty and loaded freight cars. On empty cars, the knuckle centerline must be raised to 34 1/2 inches if it is 32 1/2 inches or less from the top of the rails. A coupler on a loaded car must be adjusted to 33 1/2 inches when the knuckle centerline drops to 31 1/2 inches or less. The height of a coupler can be adjusted by adding shims beneath the truck springs, or between the center plates on the truck and the body bolsters, or both.

b. Coupler knuckle play. Excessive knuckle play causes the distance from the knuckle to the guard arm to be too great when the coupler is in a locked or closed position. When this occurs, the coupler parts from its mate. In chapter 2, the full name of the wheel-defect gage was given; part of its name is worn coupler limit. Figure 5.7 shows this gage being used to measure coupler knuckle play. If the opening between the knuckle and the guard arm is too large, one of three things may be causing the defect: the guard arm may be out of contour and the entire coupler may need to be replaced; the knuckle pin or the knuckle pin hole may be worn and either one or both of the parts should be replaced; or the knuckle face or the lock fulcrum may be worn and the knuckle should be replaced or the lock fulcrum built up by welding. If two or more of these causes exist at the same time, it would probably be safer and cheaper to replace the entire coupler.

5.8. FOREIGN COUPLERS

Although most of the rolling stock in North America is equipped with automatic couplers and draft gear that absorbs both pulling stress and impact shock, most foreign countries do not have railway cars so equipped. The hook-and-link and Willison couplers are found in most oversea areas except in Korea, Japan, and China where AAR automatic couplers are used. Because military railway

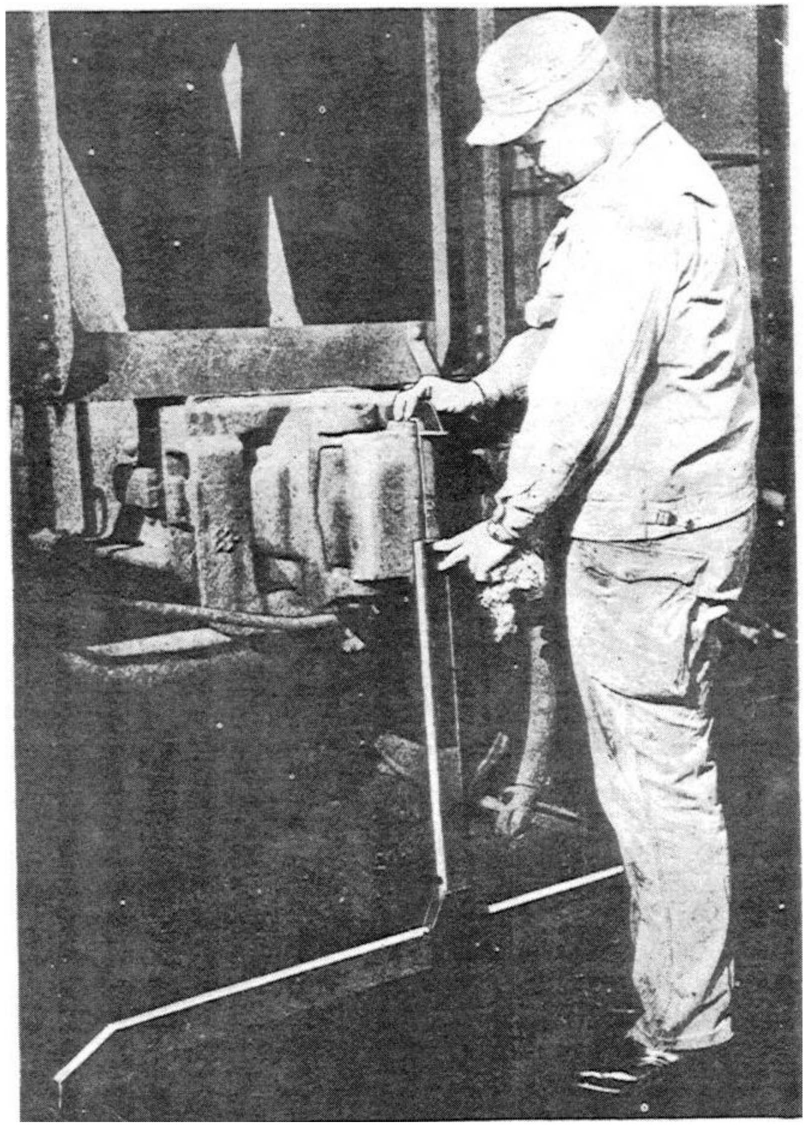


Figure 5.6. Measuring Coupler Height.

organizations will use any equipment they find in a theater of operations, you should be familiar with these two coupling devices.

a. Hook-and-link. The three main parts of the hook-and-link coupler, seen in figure 5.8, are the screw coupling (link), the draw hook, and two side buffer assemblies. Figure 5.9 shows the parts on the end of a railway car. The draw hook forms a part of the car's underframe; the screw coupling is mounted at the base of the hook; the buffers are located one on each side of the hook and

Figure 5.7. Measuring Coupler Knuckle Play.

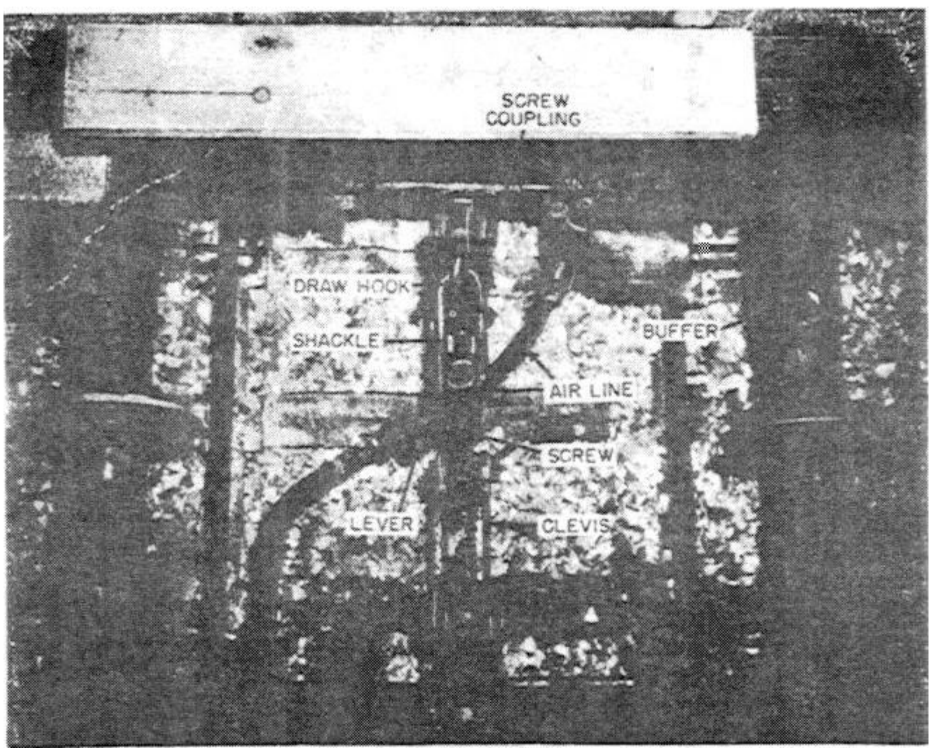


Figure 5.8. Hook-and-Link Coupler.

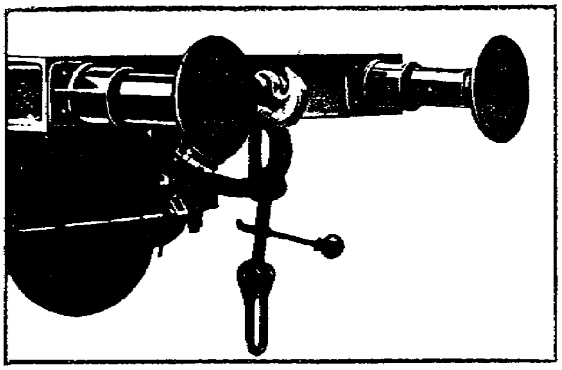


Figure 5.9. Side Buffers.

coupling toward the outer ends of the car. The buffer has a housing, attached to the car, and a spring-loaded section extending out of the housing. The coupling operation is entirely manual.

To couple cars, the shackle of one screw coupler is hooked over the hook on the other car; the lever tightens the screw until all slack is taken up. Faces of the two buffers on the one car should then be pushed squarely against the faces of those on the other car. When the train starts or runs, the screw coupling carries the pulling load; the buffers protect the cars and lading by absorbing jolts and shocks, and prevent cars from running together--the function of the draft gear on U.S. equipment. To uncouple, the lever unloosens the screw until there is enough slack to lift the shackle off the hook. Besides the danger to men working between the cars, this type of coupling equipment makes switching a slow, time-consuming operation.

b. Willison. Working on the same general principles as the E coupler on U.S. equipment, the Willison coupler has one marked difference: a transition device, shown in figure 5.10 as note six, makes it possible to couple to the hook-and-link coupler. Although coupling is automatic like the E coupler, jolts and shocks are absorbed by side buffers not by draft gear.

5.9. SUMMARY

Connecting the coupler to the car underframe, draft gear cushions the shock when cars are coupled together or when train speed changes suddenly. Friction draft gear, found on most U.S. rolling stock, has a unit of coil springs and a friction unit contained within a housing. As the springs compress, they push against the plates and wedges of the friction unit, setting up resistance and permitting cars to start smoothly. Rubber draft gear, used on locomotives, passenger cars, and some freight cars, offers the same resistance through a series of rubber plates that absorb shocks during coupling.

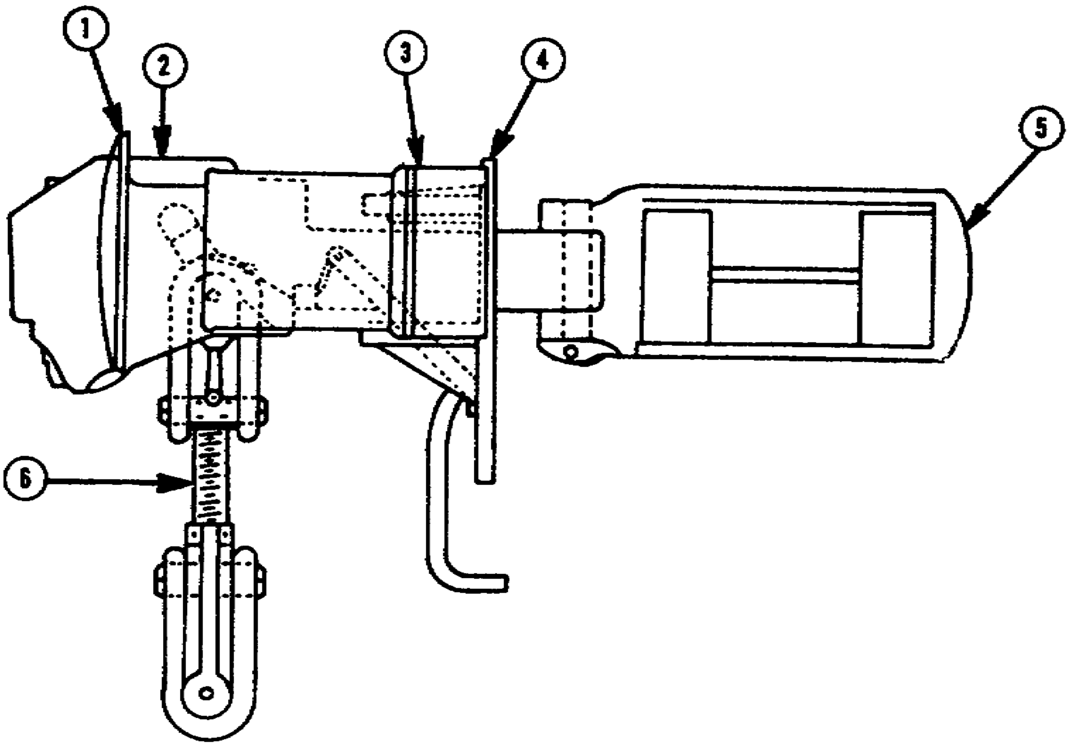
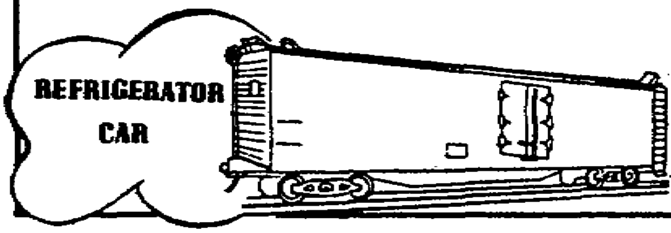


Figure 5.10. Willison Coupler.

When a railroad car must be moved from one place to another, it must be coupled with other cars in a train, the coupling must be maintained until the car reaches its destination, and then the coupler must be unlocked to disconnect the car from the other cars. Since 1933, freight cars in the United States have been equipped with the E coupler that performs these three functions. It automatically couples and locks, but it must be uncoupled manually. For a safe, efficient operation the coupler height must be properly set and the knuckle play must not be excessive.

Couplers on most foreign equipment are either the hook-and-link or the Willison. Requiring manual coupling and uncoupling, the hook-and-link has a link that is placed over a hook on another car's coupler; a lever then tightens the connection until all slack is taken up. Buffers on either side of the coupler absorb jolts and shocks and prevent cars from running together. The Willison coupler is like the E coupler in that it couples automatically but it, too, is used with buffers on the ends of the car. It has a transition device--a hook-and-link--that makes it possible to connect the car it is installed on with a car equipped with-the hook-and-link coupler.



Chapter 6

BRAKES

6.1. INTRODUCTION

All railway cars are equipped with a braking system that can be operated by a compressed air supply from the locomotive or by hand. When cars are coupled together and then to a locomotive, the locomotive engineer can operate the airbrake system on all the cars from his cab. He can regulate the braking pressure for gradually slowing the train or, in an emergency, he can apply full pressure to stop the train as quickly as possible. The conductor, riding in the caboose, has a valve with which he can apply emergency pressure to the braking system.

Handbrakes, however, are necessary because cars are not always connected to a locomotive and consequently have no source of air pressure to work the airbrake system. Cars sitting on sidings waiting to be repaired, loaded, or unloaded can have their brakes applied manually by operating the handbrake. When cars are being switched in a yard, they are often pushed by a switch engine until they gain momentum. Then, when they are rolling free, yard crewmen can use the handbrake to control their speed and stop them when necessary.

What kind of equipment is used to perform these braking functions? Section I explains the equipment and operation of some of the more common airbrake systems, and Section II describes the handbrake.

Section I. Airbrakes

6.2. GENERAL

In this section, three types of airbrakes are discussed: the straight airbrake, the KC system, and the AB system. Several other variations of airbrakes are in use, but these three are the most common types. Each type is discussed in the order mentioned.

6.3. STRAIGHT AIRBRAKE

The simplest form of airbrake is the system that is activated by a charge of air from the locomotive straight to the brake cylinder of each car. Air is compressed and held in the supply reservoir of the locomotive. Through a control valve in the locomotive cab, compressed air is piped directly to the brake cylinder of each car. The air pressure on the braking apparatus can be maintained, and by exhausting the air, the brakes can be released. The air compressor on the locomotive must recharge the reservoir after each prolonged application of the brakes. This system is now obsolete and is rarely used in the United States except on some electric railway cars and automotive trucks and buses.

6.4. THE KC AIRBRAKE

Although the KC airbrake system, diagramed in figure 6.1, is no longer accepted in interchange service in the United States, much of the Army-owned rolling stock for oversea use is equipped with it. The system has a brake cylinder attached directly to an auxiliary reservoir under each car. A pipe running through the body of this reservoir connects the brake cylinder to the KC triple valve that is connected to the opposite end of the reservoir. Actually, the valve has three pipe connections: one to the brake cylinder, one to the auxiliary reservoir, and one to the branch pipe. The valve operates in one of three ways in response to increases and decreases of air pressure in the branch pipe: it charges the auxiliary reservoir by opening the line to it from the branch pipe; applies the brakes by allowing the compressed air stored in the auxiliary reservoir to flow into the brake cylinder; and releases the brakes by allowing the air in the brake cylinder to escape to the atmosphere.

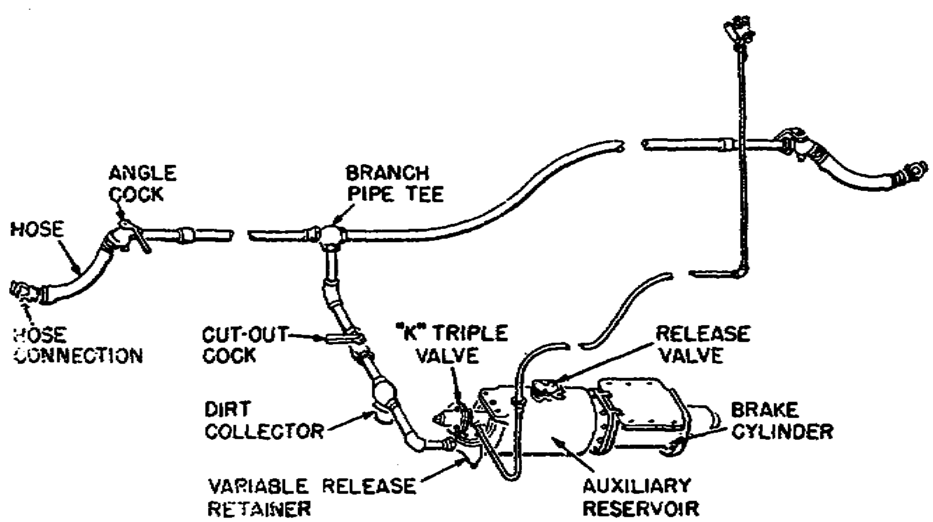


Figure 6.1. The KC Airbrake System.

6.5. THE AB AIRBRAKE

Most freight cars are now equipped with the AB airbrake system diagramed in figure 6.2. By comparing figures 6.1 and 6.2, you can see that the reservoir, valve, and brake cylinder are mounted separately in the AB system rather than together as in the KC. Notice also in the AB system that the reservoir under each car is divided into two parts by a separator plate; one side is the auxiliary reservoir, and the other side is the emergency reservoir. The AB, like the KC, has a triple valve that performs the same three basic functions: it charges the reservoirs, directs air to the brake cylinder to apply the brakes, and exhausts air from the system to release them. Instead of three pipe connection, it has five: one to each side of the reservoir, one to the brake cylinder, one to the release control retainer, and one to the dirt collector on the branch pipe.

The AB airbrake system has several advantages over the KC system. It provides for quicker application and release of the brakes, is capable of instant emergency application of the brakes that increases the braking ability by 20 percent, and has an air filter in the triple valve that catches minute particles of dust not trapped in the dirt collector. This final advantage prolongs the time between maintenance overhauls.

6.6. PARTS OF THE BRAKING SYSTEMS

Now that the three basic airbrake systems have been discussed generally, let's find out the names, locations, and functions of the parts that make up each system. However, before beginning, let's narrow the field to two systems by eliminating the straight airbrakes; this system is simple and has few parts when compared with the KC and AB systems. The other two systems are much more complicated and involve many parts; the most important are discussed in the following subparagraphs. As you follow these discussions, refer to figures 6.1 and 6.2.

a. The train line is a combination of hoses and pipes that, when coupled together at both ends of the car, form a continuous air line from the locomotive reservoir or air supply to the end of the train. At each end of this line, on each car, a section of flexible hose is connected. A hose connection or coupling is attached that mates with that of other cars.

b. The angle cock is a two-position valve that is open when its handle is parallel with the train line and closed when the handle is

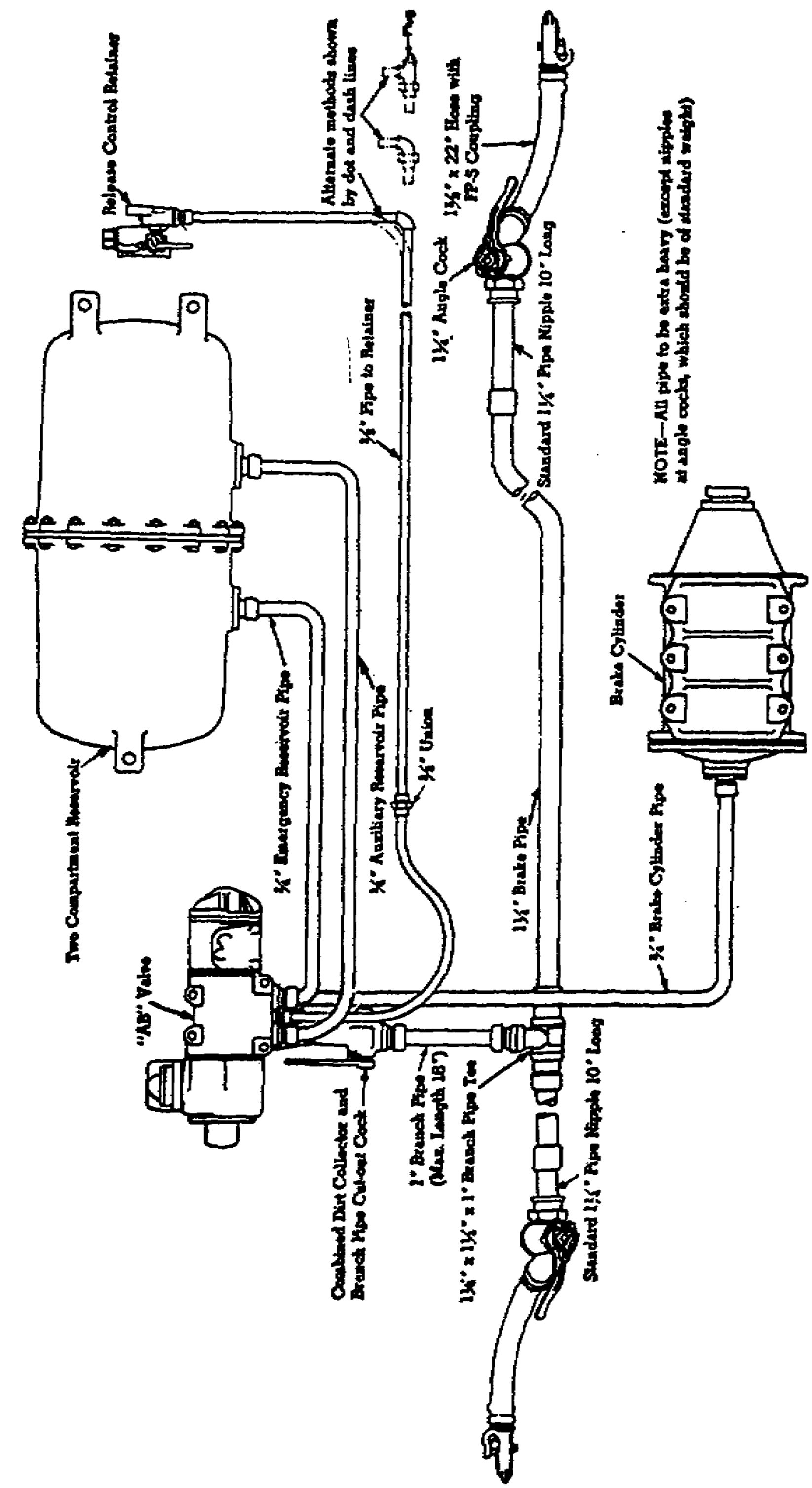


Figure 6.2. The AB Airbrakes System.

turned crosswise or at right angles to the train line. When closed, the air pressure in the main line is stopped; throughout a train, all angle cocks must be open except the one on the last car. An angle cock on the end of each car is usually positioned between the flexible hose and the pipe on the train line. The handle locks in both the opened and closed positions, and it must be raised slightly before it can be turned. This prevents the valve from being accidentally opened or closed while the train is in operation.

c. The branch-pipe tee, or branch-line tee, is the joint at which the individual car airbraking apparatus is connected to the train line.

d. The cut-out cock is a valve on the branch line that permits the car to be "cut out" of the train airbraking system but still allows the flow of air through its train line to other cars farther to the rear of the train. This valve is normally positioned on the side of the car beneath the side sill so that it is easily reached by trainmen. When some part of the car's braking system is inoperative and the car is already coupled in a train, it is desirable to cut this car from the train braking system. Regulations control the number of cars with inoperative brakes that are permissible in a train. Table VI shows how many cars with inoperative brakes are permitted in trains of various lengths.

e. The dirt collector, in the KC system, is connected in the branch line as near as possible to the KC triple valve. In the AB system, it is combined with the cut-out cock and attached directly to the AB valve. The dirt collector is designed to trap dust, pipe scale, and any other foreign matter that may be in the air lines; its bottom part is removable for easy cleaning.

f. The triple valve has been discussed in previous paragraphs. It controls the flow of air to the various parts of the car braking system by "recognizing" changes in air pressures.

g. The air reservoir on a railway car equipped with the KC airbrake is known as the auxiliary reservoir. It was discussed previously. The air reservoir on a railway car equipped with the AB brake is a dual-compartment reservoir. One side is the auxiliary reservoir that contains the compressed air supplied to the brake cylinder for a normal service application of the brakes. The other side is the emergency reservoir that contains compressed air for increasing the braking pressure in an emergency. The air charges and releases, to and from both of the reservoirs, are controlled by the triple valve.

Table VI. Number of Cars per Train Permitted with Inoperative Brakes

Number of cars in train	Maximum number of cars with inoperative airbrakes	Number of cars in train	Maximum number of cars with inoperative airbrakes
6 or less	0	74 to 79	11
7 to 13	1	80 to 86	12
14 to 19	2	87 to 93	13
20 to 26	3	94 to 99	14
27 to 33	4	100 to 106	15
34 to 39	5	107 to 113	16
40 to 46	6	114 to 119	17
47 to 53	7	120 to 126	18
54 to 59	8	127 to 133	19
60 to 66	9	134 to 139	20
67 to 73	10	140 to 146	21

h. The release valve is attached to the AB valve to allow the air pressure to be drained from the auxiliary reservoir alone or from both the auxiliary and the emergency reservoirs. Rods connected to this valve extend to both sides of the car, near the middle, so that they can be hand-operated easily. When the rod is pulled part way through the extent of its travel, air is released from the auxiliary reservoir alone; when it is pulled all the way out, air is exhausted from both sides of the reservoir. The KC brake system has a release valve that is also operated by rods.

i. The release control retainer is a valve located at the end of the car in the vicinity of the handbrake. It is used to retain air in the brake cylinder for varying periods, depending on the position of the handle, while the reservoirs are being recharged. It is used mainly in mountainous territory. The position of the handle is regulated manually by a member of the crew.

j. The brake cylinder contains a spring-loaded piston and piston rod. When air pressure enters the cylinder, the piston is pushed outward against spring tension forcing the piston rod to move outward. When the air pressure is exhausted, the spring returns the piston to its original position, pulling the piston rod inward and thus releasing the brakes.

k. The live cylinder lever is connected to the piston rod, the cylinder lever rod, the floating lever, and the top rods. When the piston rod moves, the live cylinder lever is actuated and transfers the motion and pressure through these other rods and levers to the live truck levers, discussed in paragraph 3.6. To one end of the live cylinder lever, the handbrake rod is attached; however, this rod is part of the manual braking apparatus discussed in the next section.

6.7. SUMMARY

Each railway car is equipped with its own individual braking system. Earlier cars had a straight airbrake system with the sole air supply located on the locomotive. Later cars were equipped with reservoirs and valves operated automatically by variations in air pressure. The first of these was the KC system with triple valve, auxiliary reservoir, and brake cylinder connected in one unit. In interchange service in the United States, the AB system has replaced the older KC system. With a modified and more efficient triple valve, it has a dual-compartment reservoir capable of storing air pressure for emergency application of the brakes. The AB system has the triple valve, reservoir, and brake cylinder mounted separately. Although main air lines or train lines must be connected on all cars, any individual car braking system can be "cut out." Regulations govern the number of cars per train that may be cut out or have inoperative airbrakes.

Section II. Handbrakes

6.8. GENERAL

All railway cars must be equipped with some means of slowing down or stopping the car by hand. When cars are being switched in railway yards, they are frequently in motion with no locomotive coupled to them; handbrakes are necessary if the trainmen are to control their movement. Two requirements are placed on any handbrake: it must be capable of stopping the car and it must work in harmony with the airbrake system. You remember earlier in this chapter it was explained that the handbrake rod is connected to the live cylinder lever which is in turn connected to the piston rod. The handbrake apparatus is always located on the end of the car toward which the piston rod is pointing. Through its connection with the live cylinder lever, the handbrake apparatus can actuate the brakes through the system of rods and levers used in the airbrake system.

There are several types of handbrakes but, in general, all types consist of a handwheel (or hand lever), handbrake shaft, handbrake rod, and handbrake chain connecting the shaft with the rod. These parts are pictured in figure 3.4, the illustration showing the brake rigging on a four-wheel truck. Handbrakes are classified as either horizontal or vertical; either classification may be one of two types: straight shaft or geared. The classification of a handbrake depends upon the position of the handwheel: if it is horizontal, the handbrake is classified as horizontal; if vertical, it is classified as vertical. The two types are discussed in the paragraphs that follow.

6.9. STRAIGHT SHAFT

The typical straight-shaft handbrake has a handwheel or lever connected directly to a vertical handbrake shaft which is anchored, at the bottom end, in a bracket attached to the underframe as illustrated in figure 6.3. A chain is attached to this vertical shaft that winds around it as it is turned by the handwheel. As the chain winds onto the vertical shaft, force is applied to the handbrake rod and consequently to the live truck lever which actuates the other rods and levers necessary to apply the brakes. Near the top of the vertical shaft, a gear-and-pawl arrangement holds the shaft in place in the position to which it is turned. The pawl fits into each tooth in the gear as the shaft is turned. To unwind the chain and release the brakes, the pawl must be manually disengaged from the gear and the handwheel turned in the opposite direction.

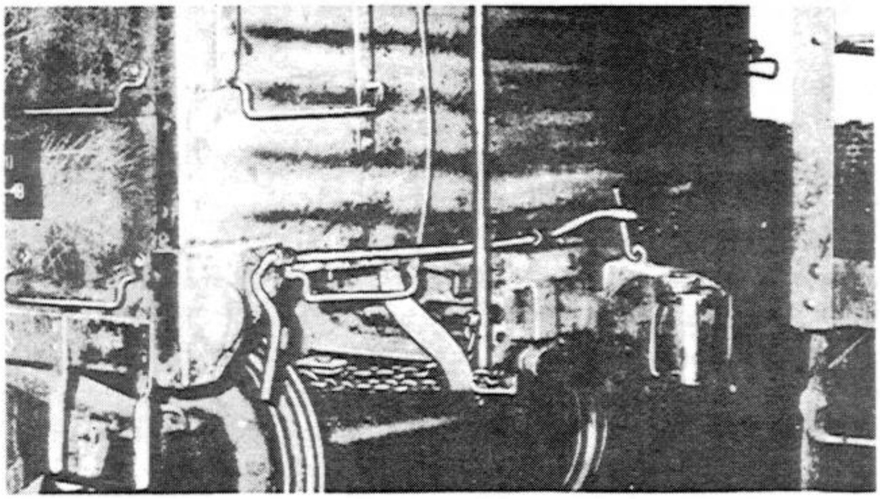


Figure 6.3. Straight-Shaft Handbrake.

6.10. GEARED

The operation of the geared handbrake is similar to that of the straight shaft. However, instead of the handbrake chain winding around the vertical shaft, a system of gears is employed at the bottom of the vertical shaft as illustrated in figure 6.4. This type of

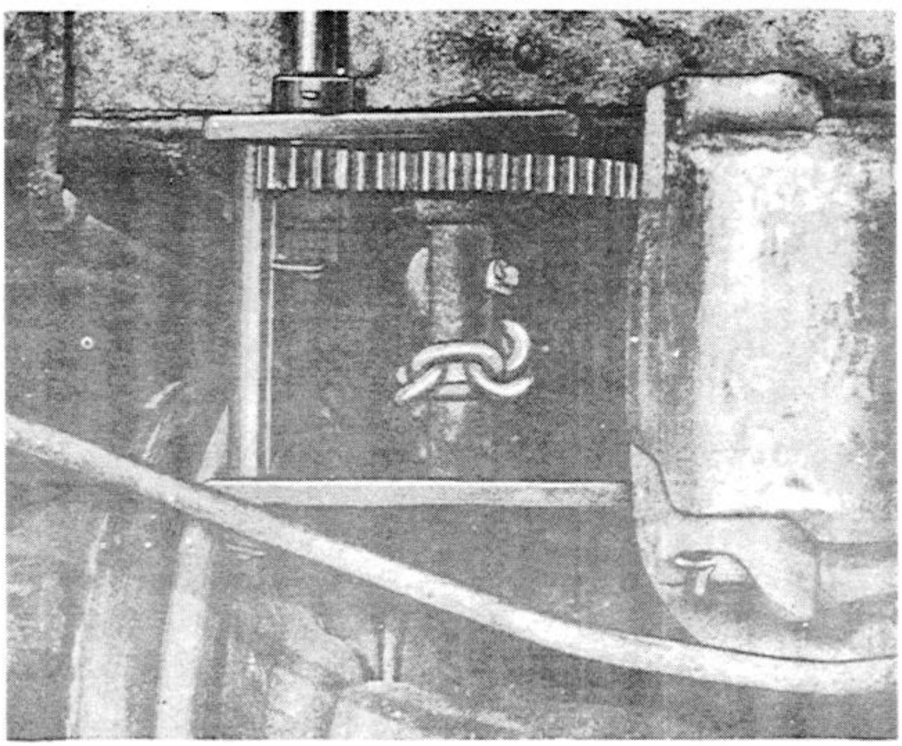


Figure 6.4. Geared Handbrake.

handbrake provides a smoother operation and is more easily controlled by the person operating the brakes. The gear on the end of the vertical shaft is the pinion gear. It meshes with a gear attached to the shaft upon which the chain winds and unwinds as the gears turn.

6.11. SUMMARY

Handbrakes are mandatory equipment for all railway cars. They are operated manually and provide a means for slowing and stopping the cars. They work in conjunction with the airbrake system. Handbrakes are used primarily by trainmen when the cars are being switched in rail yards. They are classified as either horizontal or vertical depending upon the position of the handwheel. Of the two types, the geared handbrake provides a smoother operation than does the straight shaft. However, the operation of both types is similar.

Chapter 7

SAFETY APPLIANCES

7.1. GENERAL

All railway cars are equipped with ladders, handholds, and other attachments that trainmen use while working on cars in yards, on sidings, or on main lines. These attachments are especially designed and specifically located to increase the safety of trainmen while they are working. Because of the difference in the construction of the various types of cars, the safety appliances are placed on them differently. Each type of car is discussed in a separate paragraph. However, before describing where the appliances are, what their functions are, and how they are constructed and applied, this chapter first explains how the ends and the sides of cars are distinguished, one from the other.

7.2. DESIGNATION OF ENDS OF CAR

The two ends of a railway car are designated the A end and the B end. The end on which the handbrake wheel and shaft are located, or, more accurately, the end toward which the brake-cylinder piston rod is pointed, is the B end of the car. The left and right sides of the car are determined by facing the B end. Some cars have handbrakes on both ends but they are not common; the ends of these cars have the letters A and B stenciled on both sides of the car near the respective ends.

7.3. ENCLOSED CAR

A typical enclosed car, the boxcar, is illustrated in figure 7.1. Some of the safety appliances and their locations are shown. The discussions in the following subparagraphs explain the locations, construction requirements, and descriptions of the safety appliances. Handbrake equipment, discussed in the previous chapter, has some safety features; they are also described.

a. Handbrake. The handbrake wheel must be located so that it can be operated safely while the car is in motion. It is generally located on the end of the car, on the left side, not less than 17 inches

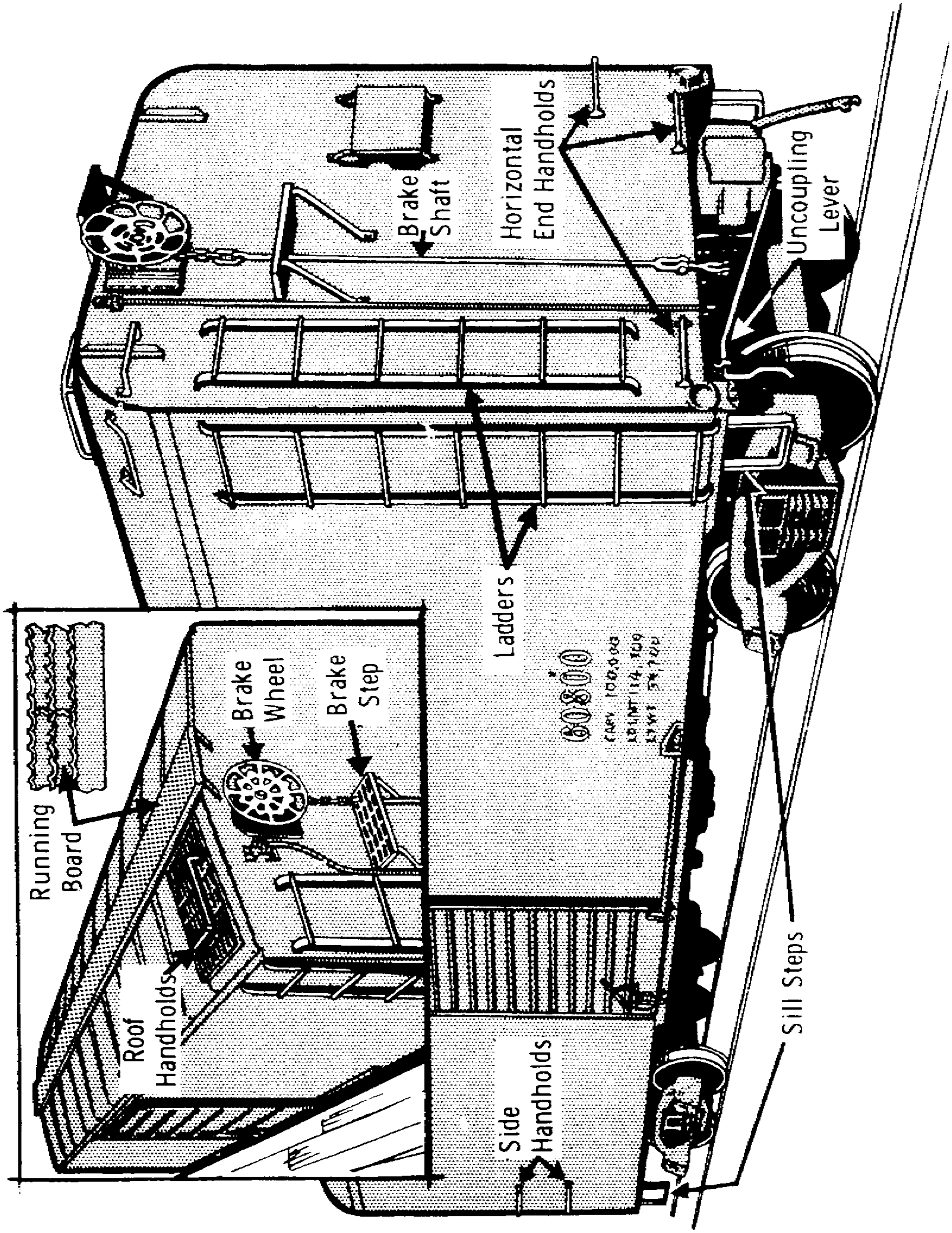


Figure 7.1. Boxcar with Safety Appliances.

nor more than 22 inches from the centerline. The wheel may be flat or dished; not less than 15 inches in diameter, preferably 16 inches; and made of wrought iron or steel.

A brake step is provided for trainmen to stand upon while operating the handbrake. It must not be less than 28 inches long; its outside edge must not be less than 8 inches from the face of the car; and it must be fastened to the body of the car with two metal braces either bolted or riveted with not less than 1/2-inch bolts or rivets.

b. Uncoupling levers. To operate the coupler without stepping between the cars, uncoupling levers are provided, of either a single or double design. The single lever design is not common; it is placed on the left side on the end of the car. The handles of these levers are not more than 12 inches, preferably 9 inches, from the side of the car. They are not less than 18 inches from the top of the rails when the coupler is unlocked.

c. Running boards. A running board is a longitudinal strip at least 18 inches wide centered on the roof of an enclosed car that extends the entire length of the car. To reach the running board, trainmen use transverse, right-angle extensions that lead from the side ladders to the running board. The extensions must be at least 24 inches wide; these extensions may not be found on refrigerator cars because they interfere with hatches in the tops of the cars through which ice is passed to the refrigerating bunkers.

d. Ladders. Four ladders are required on enclosed cars; one is on each side, not more than 8 inches from the A end of the car, and one on each end not more than 8 inches from the left side of the car. The maximum distance between the treads or rungs on ladders is 19 inches. The top tread or rung must not be less than 12 inches nor more than 18 inches from the roof of the car at the eaves.

e. Sill steps. Four sill steps, made of wrought iron or steel, are placed on each car with one located on each side near each end. The distance from the end of the car to the center of the step's tread must not be more than 18 inches. The tread must be at least 1/2 inch thick, 1 1/2 inches wide, and 10 inches from side to side. There must be at least an 8-inch clearance between the tread and the car. When the clearance is in excess of 21 inches, an additional tread is needed. The sill steps are securely fastened with 1/2-inch bolts with outside nuts riveted over, or they are riveted with not less than 1/2-inch rivets.

f. Handholds. Enclosed cars are usually equipped with four kinds of handholds: side, roof, horizontal end, and vertical end.

(1) Side handholds are located near each end on both sides of the car. They are not less than 24 nor more than 30 inches above the centerline of the coupler except where the tread of the ladder is the handhold.

(2) Roof handholds are located above each ladder. They are parallel to the treads of the ladder and are not less than 8 inches nor more than 15 inches from the edge of the roof except on refrigerator cars. These cars may have hatches in the roofs that would prevent the roof handholds from being so positioned. The handholds may be closer to the edge of the roof to avoid interfering with the ice hatches. Handholds positioned at right angles to the treads may be substituted for two or more parallel handholds.

(3) Horizontal end handholds are required on the ends of all cars. Four handholds are located on each end except when the tread of the ladder is considered an end handhold. The outer end of these handholds must not be more than 8 inches from the side of the car.

(4) Vertical end handholds are required on cars with a full-width end platform, as found on a caboose. One is placed on each end of the car opposite the ladder.

7.4. FLAT CAR

Each flatcar must have a handbrake located so that it can be safely operated while the car is in motion. The brake shaft is located on the end of the car to the left of center or on the side of the car not more than 36 inches from the right hand end.

All flatcars must have four end handholds. One is located near each side on each end of the car on the face of the end sill. The outer end of the handhold must not be more than 16 inches from the side of the car.

7.5. TANK CAR WITH SIDE PLATFORM

Many of the same safety appliances found on enclosed cars and and flatcars are also found on tank cars. Some additional attachments, however, are required on tank cars and an explanation of them follows. Figure 7.2 illustrates the location of safety appliances on a typical tank car.

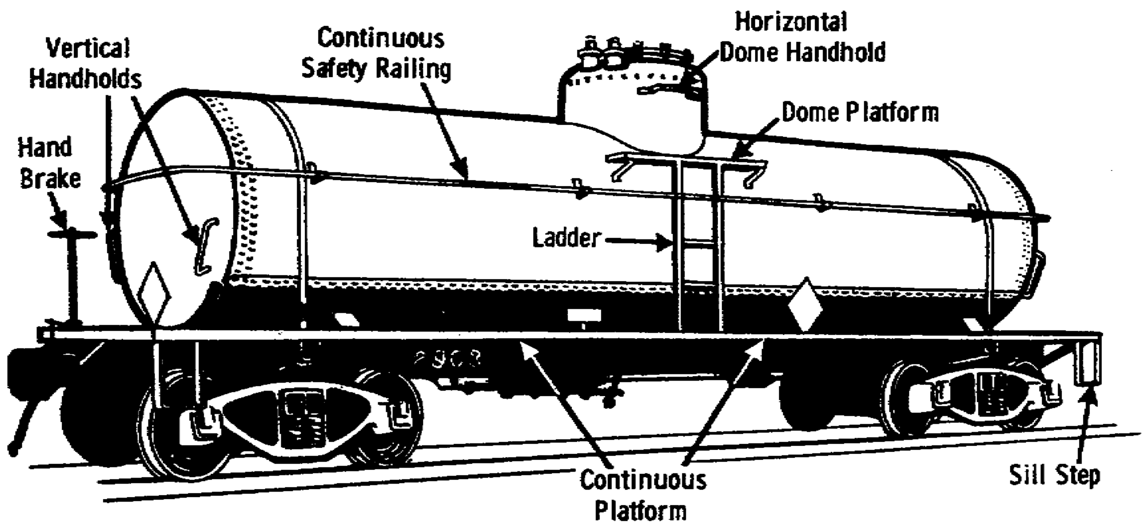


Figure 7.2. Safety Appliances on Tank Car.

A continuous safety railing of not less than 3/4-inch iron should run around the sides and ends of the tank at a height of not less than 30 and not more than 60 inches above the platform. It should be securely fastened to the tank at the ends and along the sides. If the railing does not extend around the ends of the tank, it must extend down the entire length on both sides and be fastened to upright corner posts. This kind of railing requires an end handhold on each end of the tank that must extend to within 6 inches of the outer sides of the tank.

7.6. TANK CAR WITHOUT SIDE SILLS

Tank cars constructed either without side sills on the underframe or with short side sills and end platforms must have one continuous running board around the sides and ends, or one running board extending the full length of the tank on each side. The minimum width of this running board on the sides is 10 inches, and on the ends 6 inches. Figure 7.3 shows side and end running boards.

These cars must have sill steps located at each end on each side under the side handhold. The outside edge of the tread of this step is not more than 4 inches inside the face of the side of the car and preferably flush with the side of the car. The tread is not more than 24 inches above the top of the rail.

Tank cars with short side sills must have side handholds located on the faces of each side sill near each end. On tank cars without any side sill, the side handholds are attached to the running boards projecting outward above the sill steps or ladders. If side

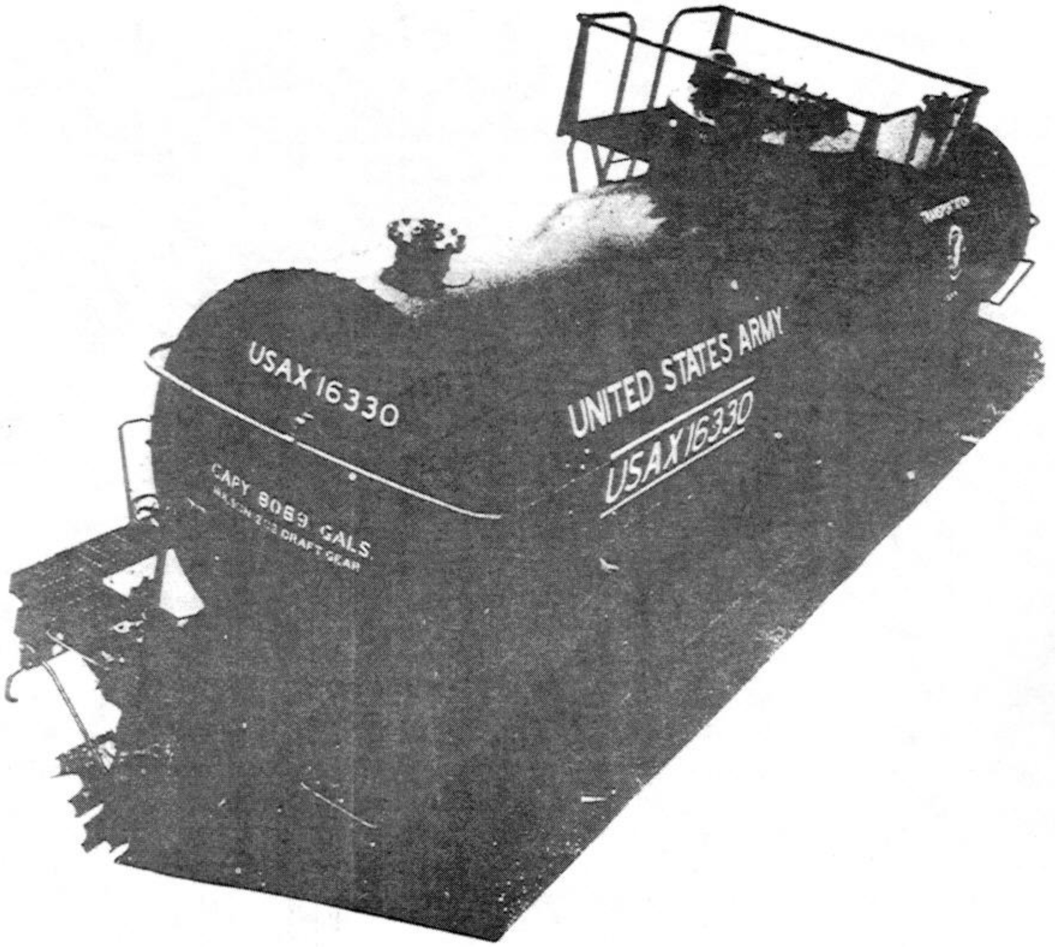


Figure 7.3. Tank Car with Side and End Running Boards.

safety railings are attached to the tank or tank bands, four additional vertical handholds are attached, one over each sill step.

7.7. TANK CAR WITHOUT END SILLS

Tank cars constructed without end sills must have one continuous running board around their ends and sides as shown in figure 7.3. These boards must be at least 10 inches wide on the sides and 6 inches on the ends. When the running boards are attached below the center of the tank, they must extend at least 7 inches beyond the bulge of the tank.

Four side steps are attached to these cars. One is located near each end on each side flush with the outside edge of the running board as near the end of the car as possible. These steps must be no more than 24 inches above the top of the rails, and if they exceed 18 inches in depth, they must have an additional tread and be laterally braced.

7.8. CABOOSE

Cabooses are constructed either with or without platforms. A typical caboose showing the location of the safety appliances is shown in figure 7.4. These appliances for both a caboose with a platform and one without are discussed in the following subparagraphs.

a. With platform. Some cabooses are constructed with platforms at both ends. These cars are equipped with a running board down the center of the roof. Many of these platforms have latitudinal extensions leading to ladders located on sides of the superstructure. On other cars with cupolas, longitudinal running boards extend from the cupola to the ends of the roof. Also on these cars, a wrought-iron or -steel handhold extends around the top of the cupola, 3 inches from the cupola's roof. Four right-angle handholds at each corner may be substituted for the continuous handhold. Cabooses are also equipped with box steps leading to their platforms at each outside corner of the car. The lower tread of these steps must not be more than 24 inches above the top of the rails. Curved handholds are located on the sides at each end of a caboose with platforms. Boarding a caboose from the front, a railroader braces his foot against the side of the step and grabs the curved part of the handhold; as his hand slides up the railing, it helps to pull him up on to the platform.

b. Without platform. Cabooses constructed without platforms are usually equipped with side doors with a step for each. These steps must be at least 5 feet long with a minimum tread thickness of 1 1/2 inches and a backstop height of 3 inches. Again, the bottom tread of the steps must not be more than 24 inches from the top of the rails. The steps are supported by metal brackets with minimum dimensions of 7/8 x 3 inches.

Curved handholds are attached beside each door opposite the ladder from a point not less than 36 inches above the bottom of the car, curving away from the car downward to a point not more than 6 inches above the bottom of the car. Vertical handholds are also located on each side of both doors.

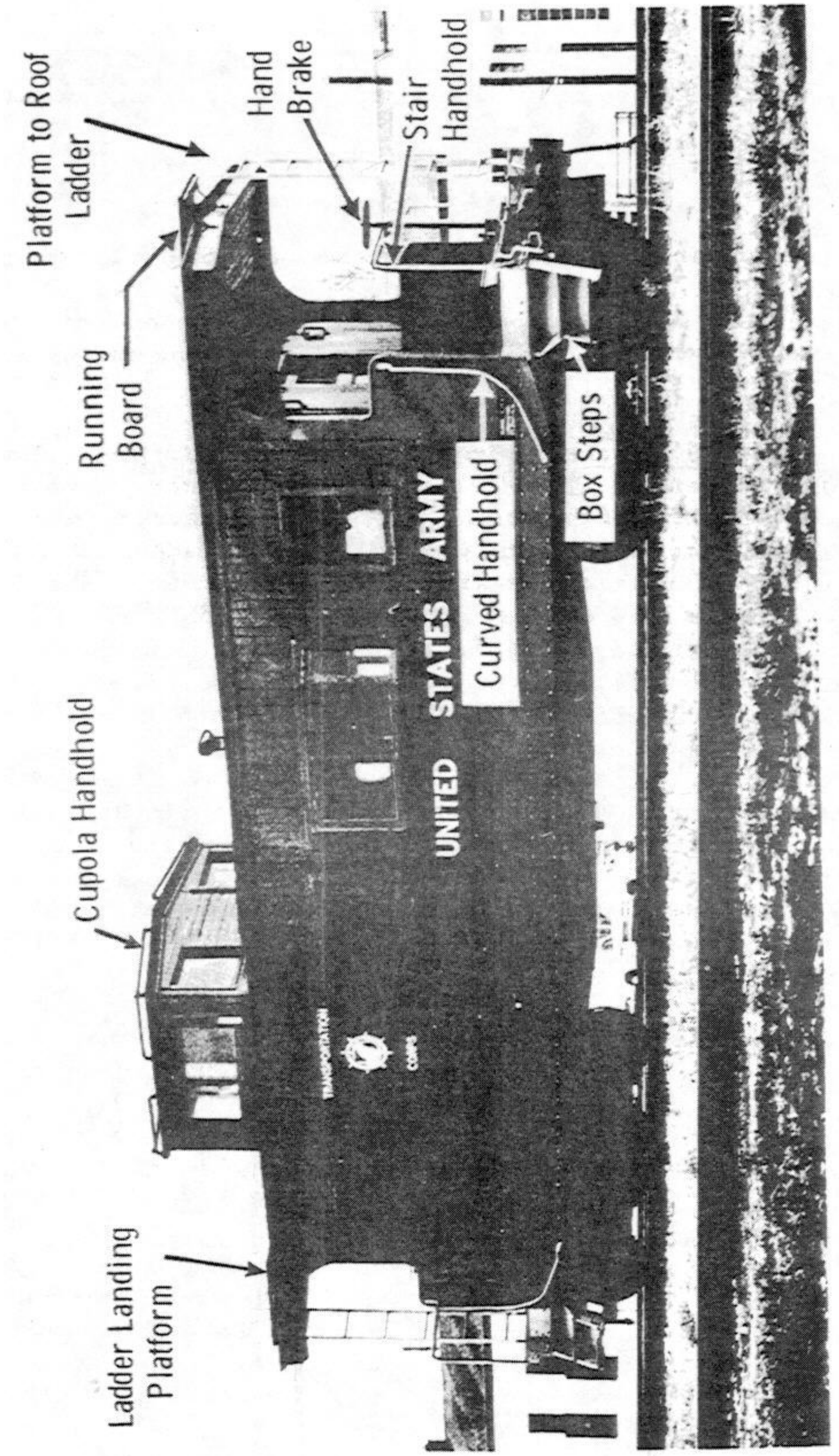
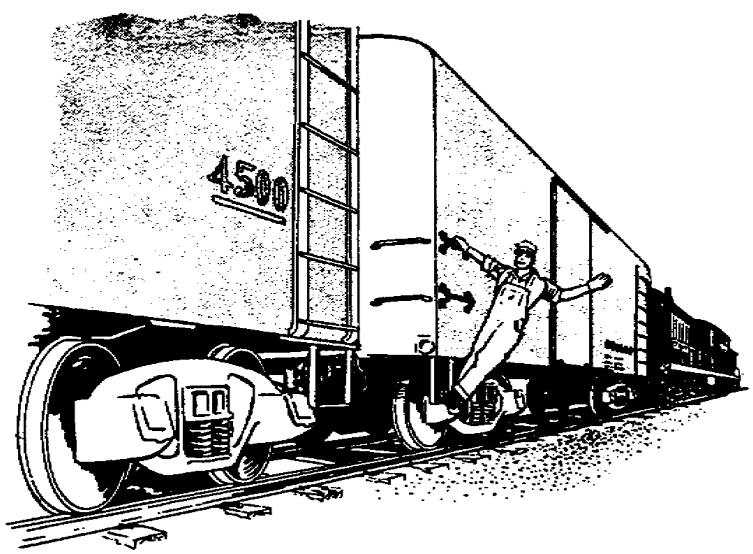


Figure 7.4. Safety Appliances on Caboose.

7.9. SUMMARY

In railway business as in any other industry, the safety of workers is a chief concern. Each piece of rolling stock has many safety attachments to safeguard the people working on it. Regulations establish how many, what kind, and the location of all safety appliances on each type of railway car.

Exact measurements and locations are given for all safety appliances, such as handbrakes, brake steps, uncoupling levers, running boards, ladders, and handholds. Tank cars have additional attachments, depending on their construction; these are also specific in dimension and location.



CORRESPONDENCE COURSE OF THE
U.S. ARMY TRANSPORTATION SCHOOL
SOLUTIONS

TRANS SUBCOURSE 655 Railway Rolling Stock.

(All references are to Reference Text 655.)

LESSON 1

Weight	Exercise	
2	1.	A, true. (par. 1.7)
2	2.	B, false. (par. 1.2)
2	3.	B, false. (par. 1.8)
2	4.	A, true. (par. 1.3b)
4	5.	A, true. (par. 1.3c)
4	6.	B, false. (par. 1.1)
4	7.	A, true. (par. 1.3a)
4	8.	A, true. (par. 1.5)
4	9.	B, false. (par. 1.6)
4	10.	A, true. (par. 1.6)
4	11.	A, true. (par. 1.4)
4	12.	B, false. (par. 1.5)
4	13.	A, true. (par. 1.2)
4	14.	B, false. (par. 1.8)
4	15.	A, true. (par. 1.2)
4	16.	B, false. (par. 1.8)
4	17.	B, false. (par. 1.3b)
4	18.	B, false. (par. 1.3a)
4	19.	A, true. (par. 1.4)
4	20.	E. (par. 1.3c)
4	21.	B. (par. 1.6)
4	22.	A. (par. 1.5)
4	23.	C. (par. 1.7)
4	24.	D. (par. 1.3a)
3	25.	A. (par. 1.7)
3	26.	B. (pars. 1.2, 1.4) Lumber can be transported on flatcars if it is well tied down; flatcars have no sides.
3	27.	A. (par. 1.3c)
3	28.	C. (par. 1.6) Tank cars have one or more domes, depending

All concerned will be careful that neither this solution nor information concerning the same comes into the possession of students or prospective students who have not completed the work to which it pertains.

Supersedes Trans 655, Railway Rolling Stock, August 1969.

Weight	Exercise	
		on the number of internal compartments; a dome is needed for each compartment for filling it.

LESSON 2

Weight	Exercise	
2	1.	B, false. (par. 2.22)
2	2.	A, true. (par. 2.23b)
2	3.	B, false. (par. 2.22)
2	4.	A, true. (par. 2.23a)
2	5.	B, false. (par. 2.22)
2	6.	B, false. (par. 2.23c)
2	7.	A, true. (par. 2.22)
2	8.	B, false. (par. 2.23d)
2	9.	B, false. (par. 2.13; table I)
2	10.	B, false. (fig. 2.22; table II)
2	11.	A, true. (par. 2.17)
2	12.	B, false. (table I)
2	13.	A, true. (par. 2.14)
2	14.	A, true. (par. 2.15e)
2	15.	A, true. (par. 2.15d)
2	16.	B, false. (par. 2.21b)
2	17.	B, false. (par. 2.21b)
2	18.	B, false. (par. 2.21a)
2	19.	A, true. (par. 2.21b)
2	20.	A, true. (par. 2.21a)
2	21.	A, true. (par. 2.5)
2	22.	B, false. (par. 2.6b)
2	23.	A, true. (par. 2.4, 2.5)
2	24.	A, true. (par. 2.6b(2))
2	25.	B, false. (par. 2.5)
2	26.	B, false. (par. 2.5)
2	27.	B, false. (par. 2.5)
2	28.	D. (par. 2.9a)
2	29.	A. (par. 2.9c)
2	30.	C. (par. 2.9f)
2	31.	E. (par. 2.9e)
2	32.	B. (par. 2.9b)
2	33.	C. (par. 2.10a)
2	34.	A. (par. 2.10i)
2	35.	B. (par. 2.10h)

Weight	Exercise	
2	36.	E. (par. 2.10b)
2	37.	D. (par. 2.10e)
2	38.	E. (par. 2.18c)
2	39.	C. (par. 2.18a)
2	40.	A. (par. 2.18h)
2	41.	D. (par. 2.18d)
2	42.	B. (par. 2.18e)
2	43.	A. (par. 2.11; fig. 2.21)
2	44.	A. (par. 2.6b(2))
2	45.	A. (pars. 2.4, 2.6a)
2	46.	A. (pars. 2.24c)
2	47.	C. (pars. 2.5) AAR-1-W wheels have a minimum rim thickness of 1 1/4 inches; those marked AAR-MW have 2 1/2 inches.
2	48.	C. (par. 2.8) The steel-wheel gage is used on wrought-steel wheels; a wheel defect gage is used on slid-flat defects.
2	49.	B. (par. 2.16a) They are found on military freight cars; however, it is because less maintenance skill and exacting inspections are required; axles for roller bearings do wear longer.
2	50.	A. (par. 2.9f)

LESSON 3

Weight	Exercise	
2	1.	A, true. (par. 3.3b)
4	2.	B, false. (par. 3.7)
4	3.	B, false. (par. 3.7)
4	4.	A, true. (par. 3.7)
4	5.	A, true. (par. 3.7)
4	6.	A, true. (par. 3.7)
4	7.	A, true. (par. 3.1}
4	8.	A, true. (par. 3.3)
4	9.	B, false. (par. 3.1)
4	10.	B, false. (par. 3.6)
4	11.	B, false. (par. 3.1)
3	12.	B, false. (par; 3.5e)
3	13.	A, true. (par. 3.3c)
3	14.	A, true. (par. 3.3b)
3	15.	A, true. (par. 3.3a)
3	16.	A, true. (par. 3.4)
3	17.	B, false. (par. 3.5c)
4	18.	A, true. (par. 3.5a)
4	19.	A, true. (par. 3.5c)
4	20.	A, true. (par. 3.5d)
4	21.	A, true. (par. 3.5b)
4	22.	B, false. (par. 3.5b)
4	23.	D. (par. 3.3)
4	24.	B. (par. 3.4)
4	25.	A. (par. 3.5)
4	26.	E. (par. 3.3c)
4	27.	C. (par. 3.6)

LESSON 4

Weight	Exercise	
3	1.	B, false. (par. 5.8a)
3	2.	B, false. (par. 5.8b)
3	3.	A, true. (par. 5.8a; fig. 5.9)
3	4.	B, false. (par. 5.8a)
3	5.	A, true. (par. 5.8a)
3	6.	A, true. (par. 4.5)
3	7.	B, false. (par. 4.2)
3	8.	A, true. (par. 4.4; fig. 4.1)
3	9.	B, false. (par. 4.1)
3	10.	A, true. (par. 4.3)
3	11.	A, true. (par. 5.2)
3	12.	A, true. (par. 5.2)

Weight	Exercise	
3	13.	A, true. (par. 5.5)
3	14.	B, false. (par. 5.2)
3	15.	B, false. (par. 5.2)
3	16.	A, true. (pars. 4.2a, 5.1)
3	17.	B, false. (par. 4.1)
3	18.	A, true. (par. 4.3)
3	19.	A, true. (par. 4.5)
3	20.	B, false. (par. 4.2b)
3	21.	A, true. (par. 5.3)
3	22.	B, false. (par. 5.4)
3	23.	A, true. (par. 5.2)
3	24.	B, false. (par. 5.3)
3	25.	A. true. (par. 5.3)
3	26.	B, false. (par. 5.7b)
3	27.	A, true. (par. 5.6)
3	28.	B, false. (par. 5.6)
3	29.	B, false. (par. 5.6)
3	30.	A, true. (par. 5.7a)
2	31.	E. (par. 4.2a)
2	32.	E. (par. 4.2a)
2	33.	A. (par. 4.6)
2	34.	D. (par. 4.4)
2	35.	C. (par. 4.3)

LESSON 5

Weight	Exercise	
3	1.	B, false. (par. 6.6e; figs. 6.1, 6.2)
3	2.	A, true. (par. 6.6c; figs. 6.1, 6.2)
3	3.	B, false. (pars. 6.4, 6.5)
3	4.	B, false. (par. 6.6g)
3	5.	A. true. (par. 6.6a)
3	6.	A, true. (par. 6.5)
3	7.	A, true. (par. 6.6h)
4	8.	A, true. (table VI)
4	9.	B, false. (pars. 6.4, 6.5)
4	10.	A, true. (par. 6.1)
4	11.	B, false. (par. 6.6d)
4	12.	A, true. (par. 6.1)

Weight	Exercise	
4	13.	A, true. (par. 6.1)
4	14.	B, false. (par. 6.8)
4	15.	A, true. (par. 6.8)
4	16.	A, true. (par. 6.8)
4	17.	B, false; (pars. 6.9, 6.10)
4	18.	B, false. (par. 6.10)
4	19.	A, true. (par. 6.4)
4	20.	A, true, (par. 6.4)
4	21.	B, false. (par. 6.3)
4	22.	B, false. (par. 6.6)
4	23.	B, false. (par. 6.3)
3	24.	C. (fig. 6.2)
3	25.	A. (fig. 6.2)
3	26.	B. (fig. 6.2)
3	27.	E. (fig. 6.2)
3	28.	D. (fig. 6.2)

LESSON 6

Weight	Exercise	
4	1.	A, true. (par. 7.8b)
4	2.	B, false. (par. 7.8a)
4	3.	B, false. (par. 7.8a)
4	4.	A, true. (par. 7.8a; fig. 7.4)
4	5.	B, false. (par. 7.8b)
3	6.	B, false. (par. 7.6)
3	7.	B, false. (par. 7.4)
3	8.	A, true. (par. 7.8a)
3	9.	B, false. (par. 7.3c)
3	10.	B, false. (par. 7.3b)
3	11.	A, true. (par. 7.3f(2))
3	12.	A, true. (par. 7.3e)
4	13.	B, false. (par. 7.7)
4	14.	A, true. (fig. 7.2)
4	15.	A, true. (par. 7.7; fig. 7.3)
4	16.	A, true. (par. 7.5; fig. 7.2)
4	17.	B, false. (par. 7.6)
4	18.	A, true. (par. 7.3a)
4	19.	B, false. (par. 7.3d)
4	20.	A, true. (par. 7.3f(2))
4	21.	A, true. (par. 7.3f(3))
4	22.	B, false. (par. 7.3a)
4	23.	B, false. (par. 7.3c)
3	24.	A, true. (par. 7.2)

Weight	Exercise	
3	25.	A, true. (par. 7.2)
3	26.	B, false. (par. 7.2)
3	27.	B, false. (par. 7.2)
3	28.	A, true. (par. 7.2)

Appendix I

REFERENCES

Army Regulations

AR 55-255	Railway Equipment
AR 320-5	Dictionary of United States Army Terms
AR 320-50	Authorized Abbreviations and Brevity Codes

Technical Manuals

TM 55-203	Maintenance of Railway Cars

Other Publications

Association of American Railroads:

Manual of Standards and Recommended Practices

Wheel and Axle Manual

Inspection and Maintenance Manual for Couplers, Coupler Parts, and Coupler Operating Mechanism on Freight Equipment Cars

Car and Locomotive Cyclopedia of American Practice, 1966, Simmons-Boardman Publishing Corp., New York, N. Y.

Appendix II

GLOSSARY

A end--in a rail car, end opposite the B end; see B end.

Airbrake--system of braking cars in which the mechanism is actuated by the manipulation of air pressure exerted on different parts of the apparatus.

Angle cock--special type of valve located at both ends of the brake pipe; when a train is made up, all angle cocks must be open except those at the ends of the train.

Axle--cylindrical shaft on which the car wheels are mounted; holds the wheels to gage and transmits the load from the journal boxes to the wheels.

Axle seat--bearing surface of a wheel which comes in contact with the axle; corresponding part of an axle is called the wheel seat; see Wheel seat.

B end--end of car on which the handbrake is located; end toward which the piston rod moves when brakes are applied; opposite of A end.

Bearing--See Journal bearing, Roller bearing, Side bearing.

Black collar--on the early designed solid axle with friction bearings, a collar inside an axle's wheel seat.

Body bolsters--two transverse members of a car's underframe which transmit the load carried by the longitudinal sills to the trucks through the center plates.

Bolster--See Body bolsters, Truck bolster.

Bolster guide (truck)--bar cast as an integral part of the truck frame.

Bore--size of the opening in a wheel's hub through which the axle is fitted.

Boxcar--freight car with sides enclosed and having a roof; doors are built in the sides or sides and ends; used for general service and especially for lading which must be protected from the weather.

Box step--step with sides as distinguished from open steps; used with platforms, as on a caboose.

Brake beam--immediate supporting structure for the two brake heads and brakeshoes acting upon any given pair of wheels.

Brake cylinder--cast-iron cylinder attached to the body frame or truck frame of a car, containing a piston which is forced outward by the compressed air to apply the brakes; when the air pressure is released, the piston returns to its normal position.

Brakeshoe--piece of metal with curved inner surface held against a wheel to produce braking action.

Brake step--small shelf or ledge on the end of a freight car near the top on which the brakeman stands when applying the handbrake.

Branch pipe--pipe extending from the brake pipe to the triple valve in the airbrake system.

Branch-pipe tee--tee used to connect the branch pipe to the brake or train pipe.

Buffer plate--plate fastened to the end of the buffer stem which bears against the opposing plate of the next car in the train; used with the couplers found in foreign countries.

Caboose--car attached to the rear of freight trains to accommodate the conductor and trainmen with office and quarters while in transit and to carry stores, tools, etc., required on freight trains.

Center plate--one of a pair of plates which fit one into the other and support the car body on the truck, allowing it to turn freely under the car.

Center sill--central longitudinal member of a car's underframe which forms, as it were, the backbone of the underframe and transmits most of the buffing shocks from one end of the car to the other.

Coil spring--spring made of bar steel bent in the form of a helix or spiral; a helical spring.

Collar (axle)--rim or enlargement on the end of a car axle which takes the end thrust of the journal bearing.

Crossbearer--transverse member of a car's underframe, placed between the bolsters, acting as a tie between the side sills and helping to distribute the weight of the car.

Crosstie--transverse member of a car's underframe applied to those members which tie the center and side sills together but do not extend from side sill to side sill as does the crossbearer.

Cupola--raised part of the roof of a caboose to afford a lookout for the train crew.

Cut-out cock--valve in airbrake piping which can be closed to make the brakes on one particular car inactive if they are not working properly.

Dead lever guide--loop attached to a truck or car frame which holds the upper end of the fixed dead brake lever.

Dead truck lever--See Truck lever.

Dirt collector--device connected in the branch pipe between the brake pipe and triple valve and constructed to eliminate dirt and foreign matter from the air flowing through.

Dome (tank)--vertical cylinder attached to the top of a tank car, permitting the tank proper to be filled to full cubic capacity.

Draft gear--unit that forms the connection between the coupler rigging and the center sill of the car's underframe.

Dust guard (truck)--thin piece of wood, leather, felt, asbestos, or other material inserted in the dust guard chamber at the back of the journal box to exclude dust and to prevent oil leakage.

End sill--transverse member of a car's underframe, extending across the ends of all the longitudinal members.

Flange (wheel)--projecting edge on the periphery for keeping the wheel on the rail.

Flatcar--freight car having a floor laid over the sills, without any housing or body above.

Floor stringer--longitudinal member of a car's underframe, occupying the space between the center and side sills.

Gondola--freight car with sides and ends but without a top covering; the floor or bottom is level or approximately so and may be solid or have bottom doors.

Handbrake--braking apparatus with which all cars are equipped, permitting the application of brakes by hand.

Hatch--opening through which ice is placed in refrigerator car bunkers and other products are placed in covered hopper cars.

Heater car--freight car equipped with heating apparatus for carrying perishable products during cold weather.

Heat number--number identifying a particular ladle of molten steel.

Hopper--freight car with the floor sloping from the ends and sides to one or more hoppers which will discharge entire load by gravity through the hopper doors.

Horizontal handbrake--handbrake with wheel set horizontally at right angles to the side of the car; see Handbrake.

Hotbox--overheated journal caused by excessive friction between bearing and journal, lack of lubricant, or foreign matter.

Hub (wheel)--central portion into which the axle is fitted.

Journal--part of an axle on which the journal bearing rests.

Journal bearing--combination of rollers and races or a block of metal, usually brass or bronze, in contact with a journal, on which the load rests.

Journal bearing wedge--device used to hold the journal bearing in place, to distribute the load evenly over the bearing, and to allow the bearing to be removed easily.

Journal box--metal housing which encloses the journal of an axle and the journal bearing and wedge, and holds the oil and packing for lubricating the journal.

Journal box lid--door or lid covering an opening in the end of the journal box by which oil and packing are supplied and journal bearings are inserted or removed.

Knuckle--rotating coupling hook by which coupling is completed when the knuckle is locked by the catch or lock.

Lock lifter--part of the mechanism inside the coupler head which is moved by the uncoupling rod and, in moving, lifts the knuckle lock so that the knuckle can open.

Pinion--smaller of two gears making up a set of gears.

Plate (wheel)--central portion connecting the hub and tread.

Platform--floor at the end of a car (passenger car and caboose), supported by projecting frame members below the car body, to facilitate entering and leaving; a narrow platform is sometimes added to freight cars for convenience of trainmen.

Press--See Wheel press.

Refrigerator car--specially constructed boxcar for carrying commodities that need icing in transit.

Rim (wheel)--that portion outside the plate.

Roller bearing--general term applied to a bearing which depends upon the rolling action of a set of rollers to reduce friction.

Running board--plane surface, made of boards or a special metal structure, for trainmen to walk on; placed on the roof of enclosed cars, cabooses, and covered hoppers, and at the sides of tank cars.

Side bay--windows set in the side of a caboose protruding outward as a bay window, used instead of a cupola; permits train crew to look along the side of a train, especially when rounding curves, to detect hotboxes or other trouble.

Side bearings--bearings attached to the bolsters of a car body and truck on each side of the center plate to steady the car and prevent excessive rocking while going around curves.

Side frame (truck)--longitudinal part of a truck's structure, on the outside of the wheels, which extends from one axle to the other and to which the journal boxes and bolsters are attached or form a part.

Side sill--outside longitudinal members of a car's underframe.

Sill--See Center sill, End sill, Side sill.

Sill step--U-shaped iron attached to the sill of a car as a step for trainmen.

Spring plank (truck)--transverse member underneath a truck bolster on which the bolster springs rest.

Striker plate--member placed on the ends of a center sill of freight cars against which the horn of the coupler strikes, preventing damage to the draft gear and center sill.

Tank car--freight car whose body consists of a tank for carrying liquids, compressed gases, and granular solids.

Train line--complete line of the airbrake system, including the rigid piping secured under the cars and the flexible connections between cars and the locomotive.

Tread (wheel)--exterior cylindrical surface next to the flange which comes in contact with the rail.

Truck bolster--cross member in the center of the truck on which the car's body rests.

Truck lever--that part of the foundation brake rigging which applies the power of the brake cylinder at the brake beams.

Uncoupling lever--rod with a bent handle forming a lever, usually attached to the end sill, by which the lock of the automatic coupler is opened and the cars uncoupled without a trainman going between them.

Vertical handbrake--handbrake with wheel set vertically parallel to the end of a car; see Handbrake.

Waste packing--material that is saturated with lubricating oil and placed in a journal box so that it comes in contact with the lower half of the journal.

Wedge--See Journal wedge.

Well-hole car--flatcar with a depression or opening in the center to allow the load to extend below the normal floor level when it could not otherwise come within the overhead clearances.

Wheel press--machine for pressing wheels on car axles or for dismounting them.

Wheel seat--part of the axle which is inserted in the hub of a wheel.

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