FREIGHT CAR
UNDERBODY DETAIL

by

Gene Green

To properly detail the underside of our freight car models we need to understand the three systems; air brakes, foundation brake gear and truck brake rigging. When seen altogether as in Figure 1 below there can be some confusion but when we look at each system one at a time and then go through each system part by part it all becomes simple.

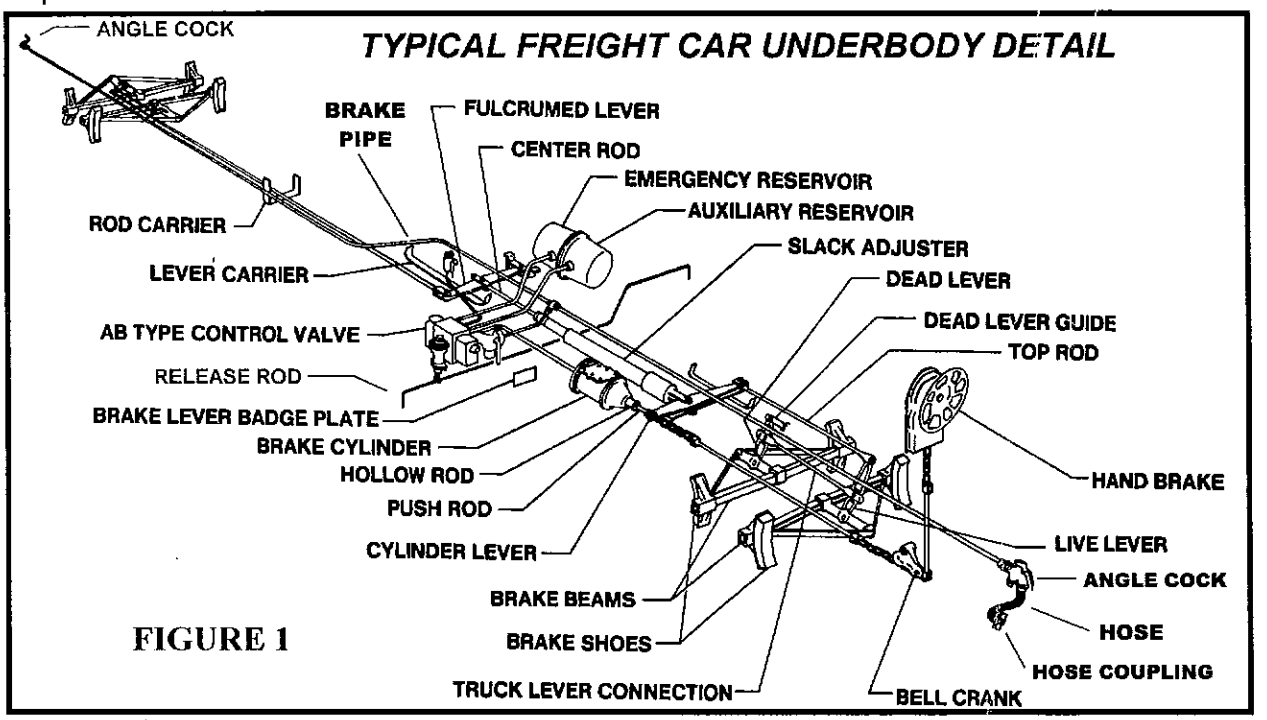


FIGURE 1

Figure 1 gives most of the terminology that will be used in this paper. At some points in this paper it will be possible to give exact dimensions or other specific information. Elsewhere only generalizations are possible. An effort will be made to be as specific as possible and, when it is not possible, to qualify statements so that the reader understands that a generalization is being put forward.

First we will examine the air brake system, then have a look at the foundation brake gear which is the arrangement of rods and levers that transmits the motion of the brake cylinder to the trucks. After considering the truck brake rigging we will have a look at some examples of brakes on HO scale models. A bibliography will be presented at the end of this paper.

AIR BRAKE SYSTEM

First, let's look at the air brake system. The K brake system was installed on most freight cars built from before 1900 to about 1933. After 1933 the AB air brake system was used on all new freight cars. By about 1950 or a little later most freight cars which were originally built with K brakes and still in use in freight service had received

AB brakes. Both the K and AB systems have a number of features in common including location of the angle cock, all pipe diameters and, usually, the location of the brake cylinder. Since the air brake system on a car begins with the angle cock, let's start there.

ANGLE COCK LOCATION

Figures 2 and 2A shows how to locate the angle cock on cars with type D or E couplers. Table 1 shows the dimensions and how they have changed over the years.

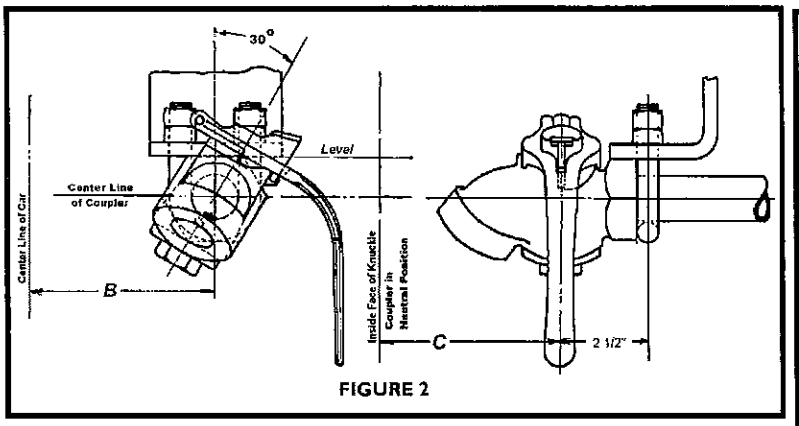


FIGURE 2

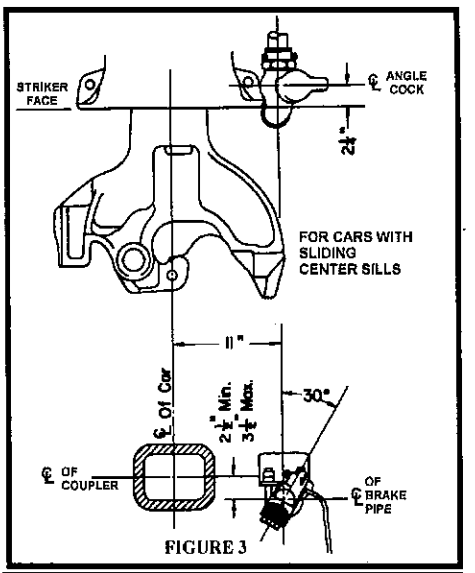


FIGURE 3

TABLE 1
ANGLE COCK LOCATION DIMENSIONS

YEAR	APPLICATION	DIM. B	DIM. C	CENTER LINE
1919	Wood Underframe Cars	13"	13"	Level
1919	Steel Underframe Cars Built after 1916	15"	9"	Level
1922	Cars with Type D Couplers	15.5"	8"	Level
1943	Cars with Type D or E Couplers	12"	15"	Level
1953	Cars with Type D or E Couplers	12"	15"	2.5" Below
1966	Cars with Type D or E Couplers (Minimum) (see Fig 2A)	12"	0"	2.5 to 3.5" Below
1966	Cars with Type D or E Couplers (Maximum) (see Fig 2A)	15.5"	5"	2.5 to 3.5" Below
1966	Cars with Type F Couplers (see Fig 3)	11"	-2.5"	2.5 to 3.5" Below

Figure 2A (below) shows how, in 1966, the location of the angle cock became variable. While the formula C=(B-12) x 1.43 gives the exact relationship between dimensions B and C in Figure 2A, a simpler statement is that as the angle cock is moved away from the car's center line it must also move away from the car's end.

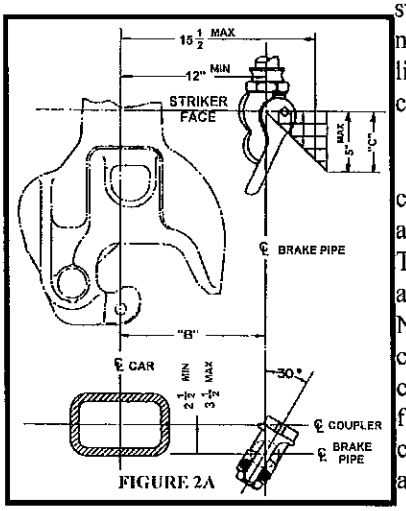


FIGURE 2A

Figures 3 and 3A show the correct dimensions to locate the angle cock on freight cars having Type F interlocking couplers with and without sliding center sills. Notice that , on cars with a fixed center sill the center line of the angle cock is set in 2 ½ inches from the face of the striker and is right of the car's center line by 11 inches. The angle cock is located 2 ½ to 3 ½ inches below the coupler center line.

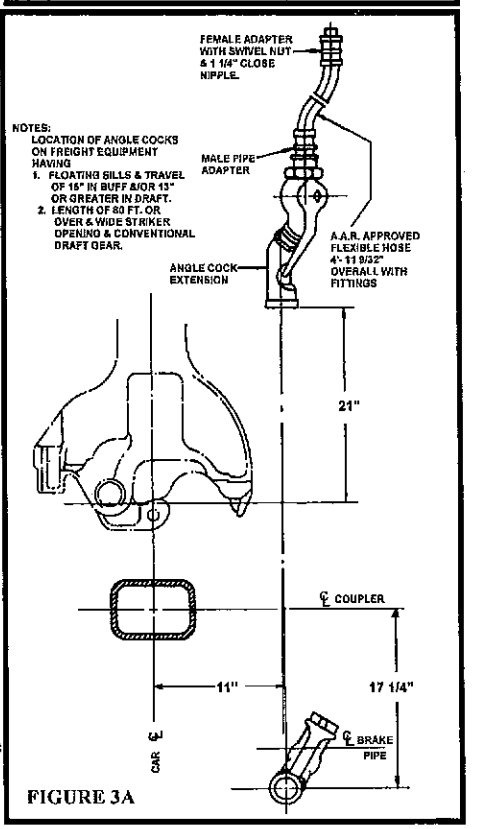
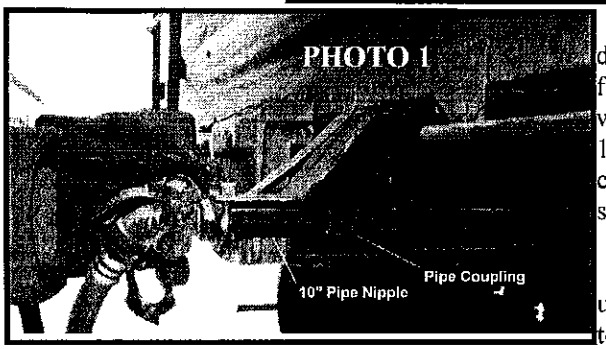
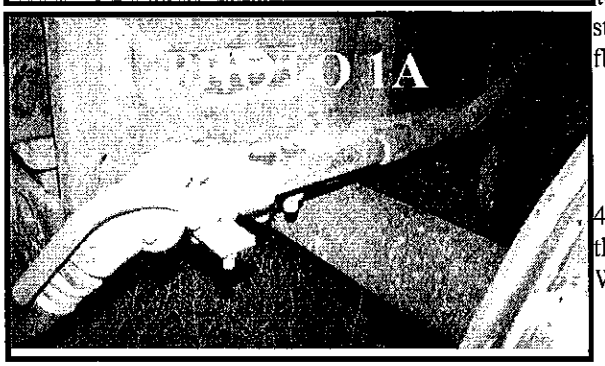


FIGURE 3A

FREIGHT CAR UNDERBODY DETAIL





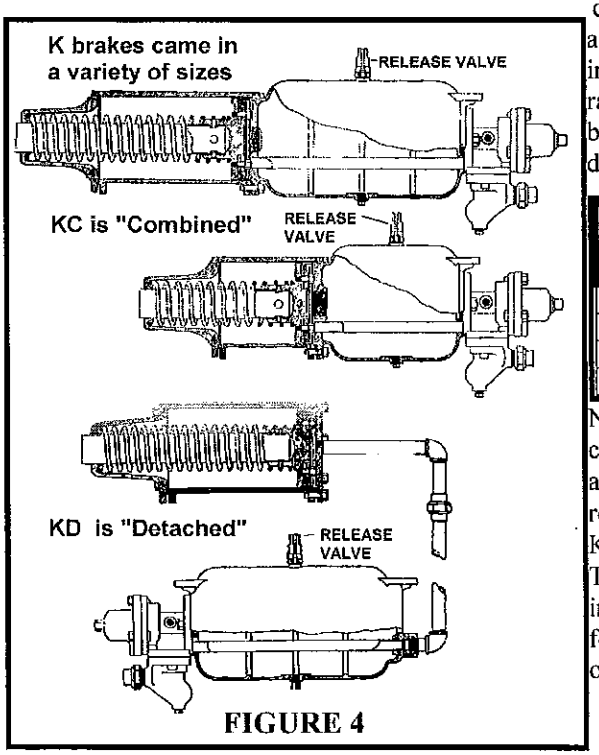


FIGURE 4

HOW TO TELL LEFT FROM RIGHT

Stand facing the end of the car with the hand brake. The hand brake end is the "B" end. The side of the car to your right is the right side; the left is on your left. The far end is the "A" end.

Brackets holding the angle cock vary too widely to be described here but the most common bracket consists of a flat plate to which the angle cock is secured by a "U" bolt which can be seen in Figure 2 above. Freight cars built after 1900 were required to have a 10" pipe nipple and pipe coupling immediately behind the angle cock which is as shown in Photo 1.

The brake pipe (also called train line) usually bends upward somewhat behind the pipe coupling and runs parallel to the center sill, often so close that, when viewed from straight below, the brake pipe is obscured by the bottom flange of the center sill. See Photo 1A.

DESCRIPTION OF K BRAKES

K brakes came in two forms; KC and KD. Figure 4 shows the difference between the two types. KC indicates that the triple valve, reservoir and cylinder are all in one unit. With KD brakes the cylinder is a separate unit.

K brakes came in three sizes (later just two) and two configurations to accommodate different freight car designs and to provide different amounts of force. The top illustration in Figure 4 shows a standard KC brake. See Table 2 for the range of sizes and their uses in freight cars. The short KC brake in Figure 4 is a special brake as might be necessary on a drop bottom gondola or other car with restricted clearances.

TABLE 2
K BRAKE CYLINDER SIZE

CAR LIGHT WEIGHT IN POUNDS	CYLINDER DIAMETER
Less than 15,000	6 inch
15,000 to 40,000	8 inch
More than 40,000	10 inch

Notice the pipe union in Figure 4 between the reservoir and cylinder on the KD brake equipment. This is necessary to allow the removal of either component for repair or replacement without having to remove the other component. KC brakes were removed as a whole unit when necessary. The standard arrangement of pipes for the KC brake is shown in Figure 5. Figure 6 shows a typical arrangement of pipes for the KD brake. The necessary pipe union is incorrectly omitted from this drawing.

The Combined Cylinder and Reservoir is typically placed on the left side of the car. The Piston points toward the hand brake. The Brake Pipe crosses over to the right side of the car after the Brake Pipe passes through the Branch Pipe Tee. Pipe to Retainer emerges from car on the left side of the "B" end.

The KD system differs from the KC mainly by the addition of a pipe between the reservoir and the cylinder. The KD reservoir is normally located on the car's right side.

FREIGHT CAR UNDERBODY DETAIL

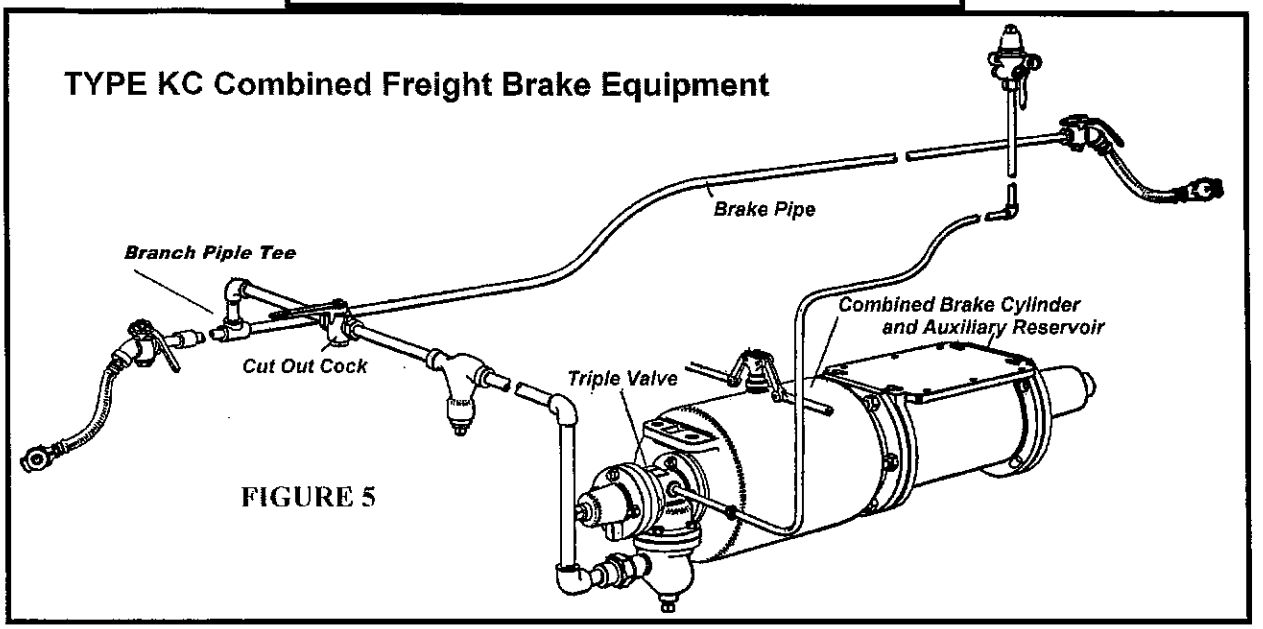


FIGURE 5

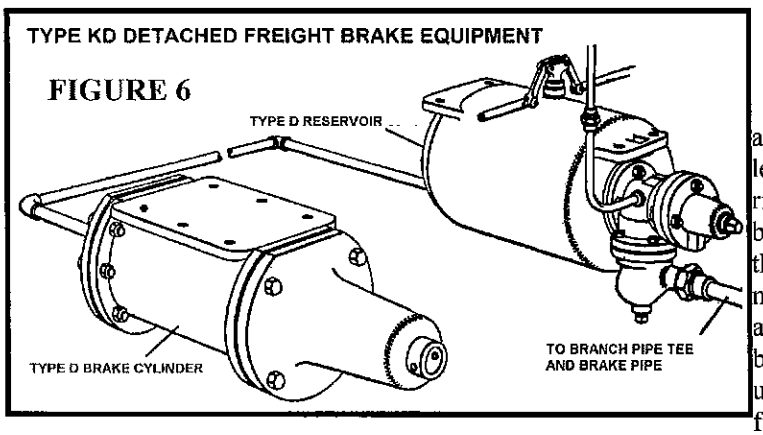


FIGURE 6

DESCRIPTION OF AB BRAKES

The typical AB brake component arrangement has the valve and cylinder on the left side of the car and the reservoir on the right side. Figure 7 shows these components but, in an effort to clearly show all pipes, has the components arranged in an atypical manner. The reservoir is usually straight across from the AB valve. The two pipes between the reservoir and cylinder usually run under a straight center sill or through a fishbelly center sill. Again, a ten inch pipe nipple and coupling is required at each angle cock. In some cases the reservoir and valve are both located on the same side of the car. A photo showing such an arrangement on a box car is included later.

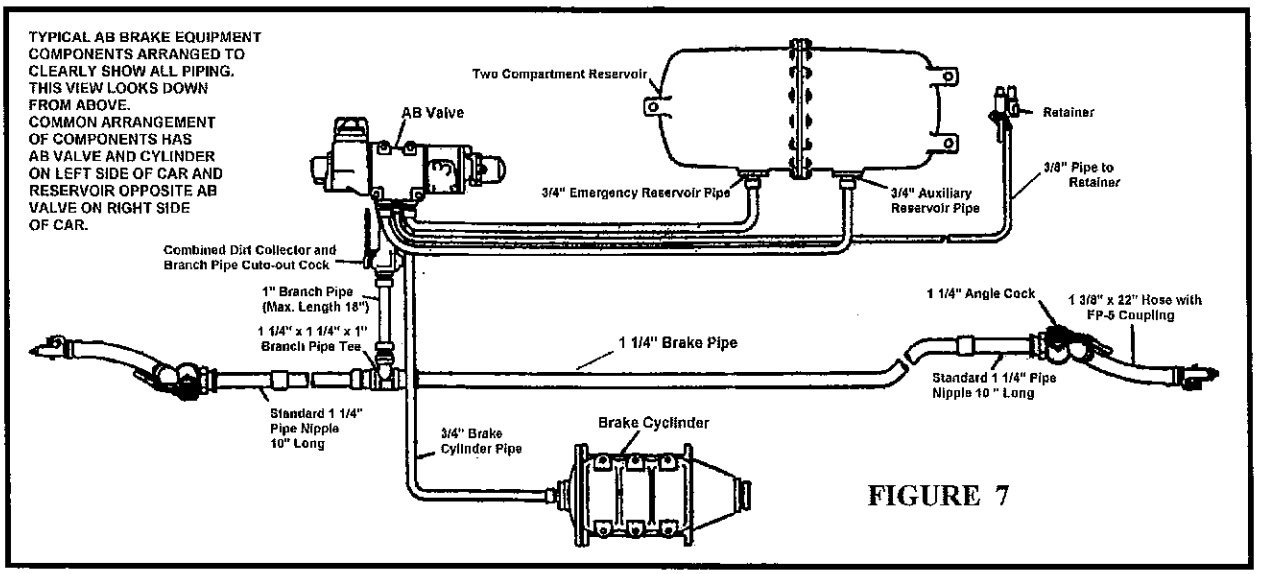


FIGURE 7

FREIGHT CAR UNDERBODY DETAIL

BRANCH PIPE TEES

The brake pipe (train line) is connected to the rest of the air brake system, whether K or AB, through the branch pipe tee. See Figures 8 and 9. Typically the branch pipe tee is supported by one of two bracket types, one supports the brake pipe on one or both sides of the branch pipe tee (Photo 2 and Figures 10 and 11); the other is bolted to the lug on the top of the branch pipe tee as seen in Photo 2A.

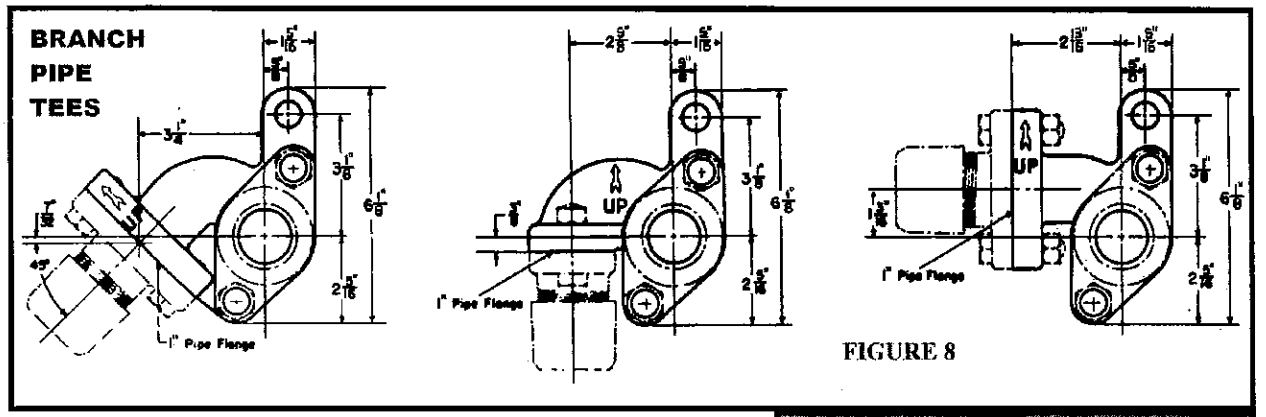


FIGURE 8

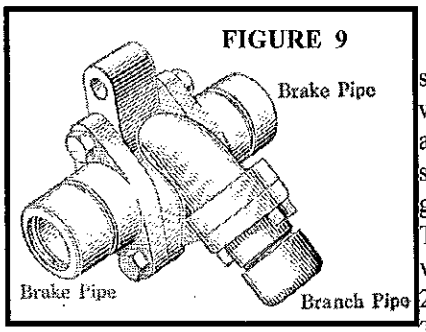


FIGURE 9

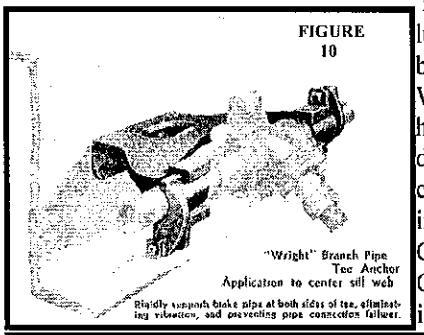


FIGURE 10

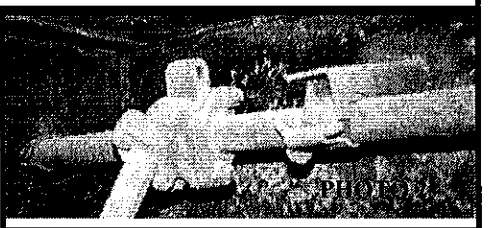


PHOTO 2

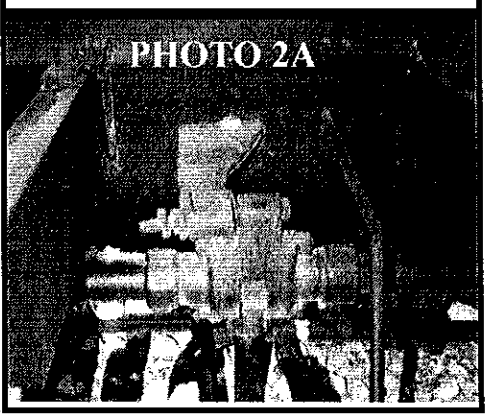


PHOTO 2A

Brackets such as those shown in Figures 10 and 11 would be prominent details on any freight car model without a side sill such as drop bottom gondolas or air dump cars. These brackets are especially visible on tank cars. See Photo 2A which is part of a tank car. These simple brackets utilize the lug shown on the top of all three brackets shown in Figure 8. Whether the branch pipe tee is horizontal, angled or vertical depends on the car's construction. The branch pipe including Combined Dirt Collector and Branch Pipe Cut-Out Cock must be at least 22 inches and not more than 40 inches in length to allow for flexibility for installation, expansion and contraction and to compensate for vibrations. The Combined Dirt Collector and Branch Pipe Cut-Out Cock is a detail usually omitted on commercially available air brake parts in the various scales. Kadee includes the dirt collector but not the cut-out cock in their HO scale PS-1 box cars.

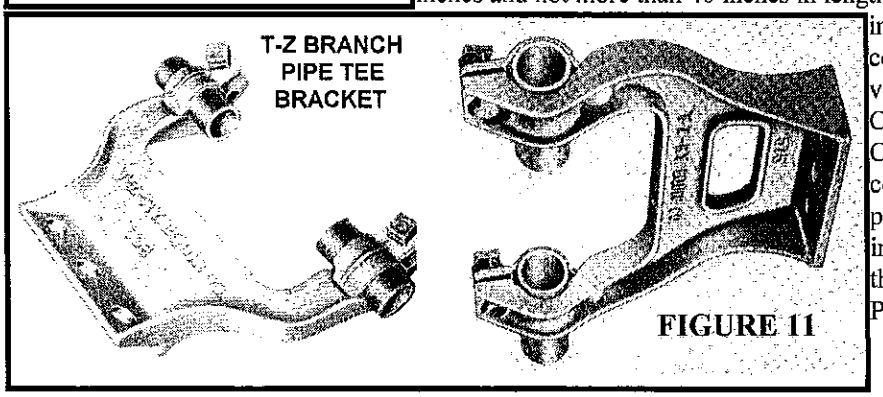
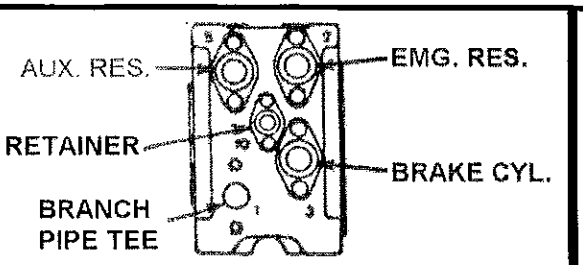


FIGURE 11

PIPE BRACKET

The Pipe Bracket is the center third of the AB valve. The branch pipe connects to the Pipe Bracket through the combined dirt collector and branch pipe cut-out cock as previously stated. As the AB brake and its derivatives have evolved, the pipe bracket

FREIGHT CAR UNDERBODY DETAIL



AB VALVE PIPE BRACKET

FIGURE 12

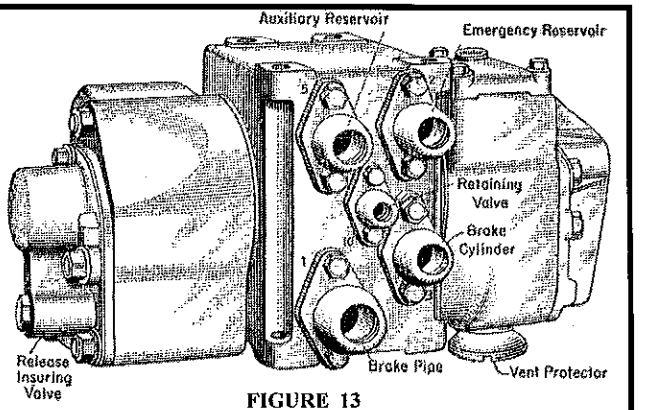
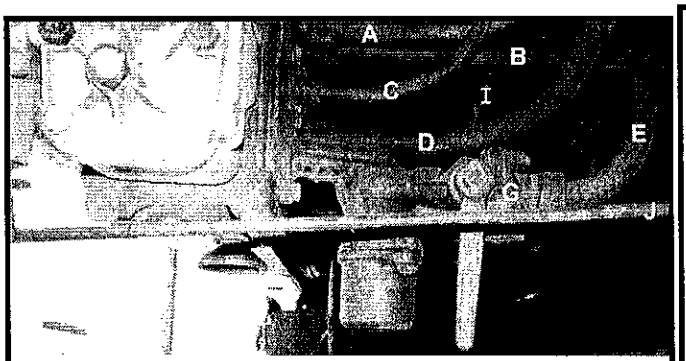


FIGURE 13

has remain unchanged . This means that the pipes connecting to the control valve will connect in the same manner regardless whether the valve is AB, ABC-1, ABD or AB-4-12. Figures 12 and 13 show the pipe connections on the pipe bracket of the typical AB valve. Notice that there are connections for FIVE pipes. The typical model AB valve has "dimples" for two or four pipes. You'll have to add one more. Photo 3 and Figure 13A show the typical arrangement of the pipes coming out of the pipe bracket on the AB valve.



A - TO AUXILIARY RESERVOIR
B - TO EMERGENCY RESERVOIR
C - TO RETAINING VALVE
D- TO BRAKE CYLINDER
E - TO BRANCH PIPE TEE
F - DIRT COLLECTOR
G - CUT-OUT COCK
H - CUT-OUT COCK HANDLE
I - BRAKE PIPE (TRAIN LINE)
J - RELEASE ROD
K - PIPE BRACKET

PHOTO 3

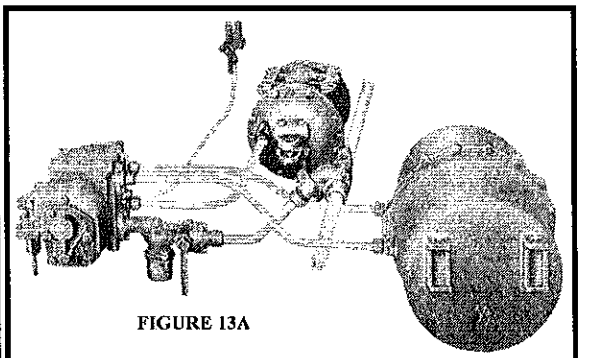


FIGURE 13A

PIPE SIZES

Pipe sizes are the same for either K or AB brakes and are given in Table 2. The actual outside diameters of pipes is somewhat larger than the nominal size. When deciding on a size wire for air brake pipes using the information in Table 2, if the size you need is not available, use the next larger size. It is more often the case that air brake pipes, and other parts under a freight car, are coated with car cement and dirt than that the pipes have rusted away somewhat to a size smaller than they were originally.

When bending wire to make air brake pipes, keep in mind the minimums given in Table 4 which are recommended by the Mechanical Division of the AAR. The use of 90° elbow fittings is prohibited in the brake pipe. In the pipe to the retainer, on the other hand, the use of an elbow fitting is one of five approved methods of bringing the pipe from under the car (horizontal) to go up the end of the car (vertical). More on this later.

TABLE 3: AIR BRAKE SYSTEM PIPE DIAMETERS

USE	NOMINAL SIZE	ACTUAL OUTSIDE DIAMETER	O SCALE	S SCALE	HO SCALE	N SCALE
BRAKE PIPE	1 1/4"	1.660"	.035"	.026"	.019"	.010"
BRANCH PIPE	1"	1.315"	.027"	.021"	.015"	.008"
BRAKE CYLINDER PIPE	3/4"	1.050"	.022"	.016"	.012"	.007"
AUXILIARY RESERVOIR	3/4"	1.050"	.022"	.016"	.012"	.007"
EMERGENCY RESERVOIR	3/4"	1.050"	.022"	.016"	.012"	.007"
RETAINING VALVE	3/8"	0.675 "	.014"	.011"	.008"	.004"

MOUNTING OF MAJOR COMPONENTS

TABLE 4
MINIMUM RECOMMENDED PIPE BEND RADII

PIPE SIZE	MINIMUM RADIUS
1 1/4"	12"
1"	12"
3/4"	6"
3/8"	3"

Mounting the major parts of the K or AB brake system requires more than having them dangle from the car floor on thin styrene rods. The brake cylinder, for example, can develop a force of 4000 to 8000 pounds at 80 psi. It stands to reason, then, that the brake cylinder must be attached to the freight car in a very substantial manner. Photos 4, 5 and 6 show the two most frequently seen mounting brackets for cylinders.

In Photos 4 and 5 two plates are riveted to the frame and are held together at their junction by the three bolts that support the outer edge of the brake cylinder. The three bolts supporting the inner edge of the brake cylinder pass through the bottom plate only.

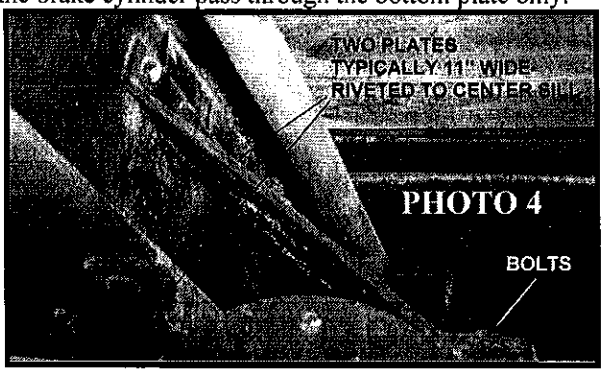


PHOTO 4

Photo 6 shows a typical one-piece brake cylinder bracket. The brackets in Photos 4 and 6 have several features in common. The plates are at least 3/8" thick and on some newer cars, 1/2" thick. The plates are almost always 11" wide because this width fits the top of the brake cylinder. The bolts holding the brake cylinder are always spaced as shown in Figure 14. AB brake cylinders are usually mounted near the center of the car and about 16" to 18" out from the car's center line. K brake cylinders were more typically mounted about 15 inches out from the car's center line. The obvious exceptions for both brake systems would be open and covered hopper cars.

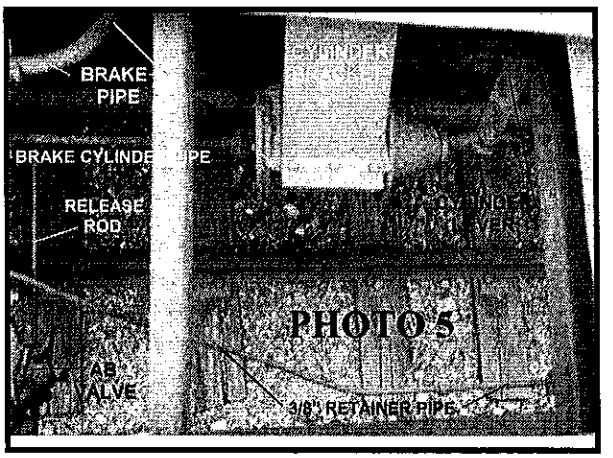


PHOTO 5

The horizontal center line of a brake cylinder, K or AB, is from 3 to 6 inches below the bottom of straight center sills so as to allow sufficient room for the foundation brake gear (those rods and levers) to move freely. For modelers this add some nice detail to the underside of the car when it is seen in profile.

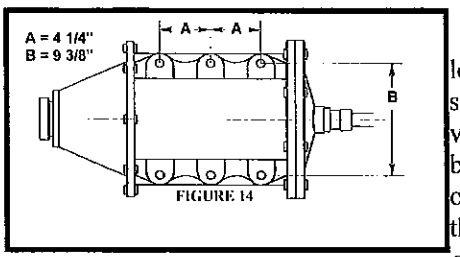


FIGURE 14

The bolt hole locations are the same on almost all varieties of air brake - passenger or freight - and these dimensions are shown in Figure 14. When installing air brake cylinders sufficient clearance must be allowed for lubrication and routine maintenance. Figure 15 shows a K brake cylinder being disassembled while Figure 16 shows the required minimum clearance for AB brake cylinder installations. A Bettendorf 30-ton, refrigerator car underframe, Figure 17, which, when built, received

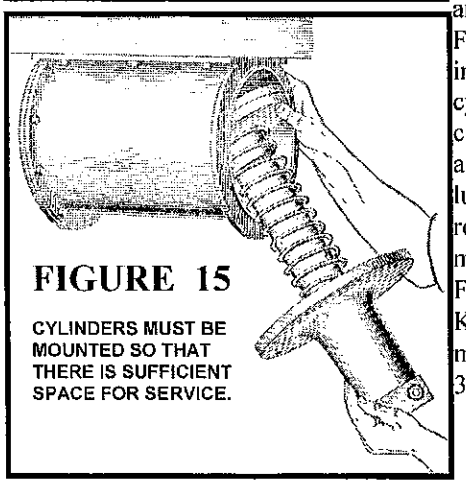


FIGURE 15

CYLINDERS MUST BE MOUNTED SO THAT THERE IS SUFFICIENT SPACE FOR SERVICE.

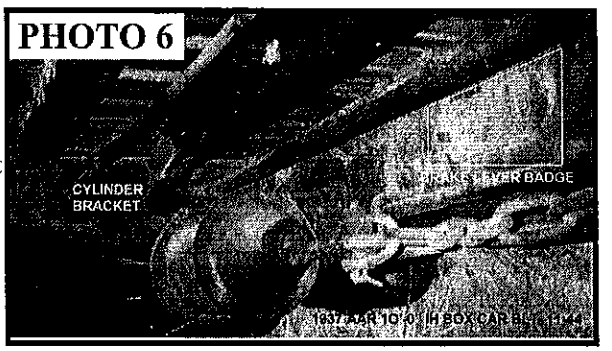


PHOTO 6

FREIGHT CAR UNDERBODY DETAIL

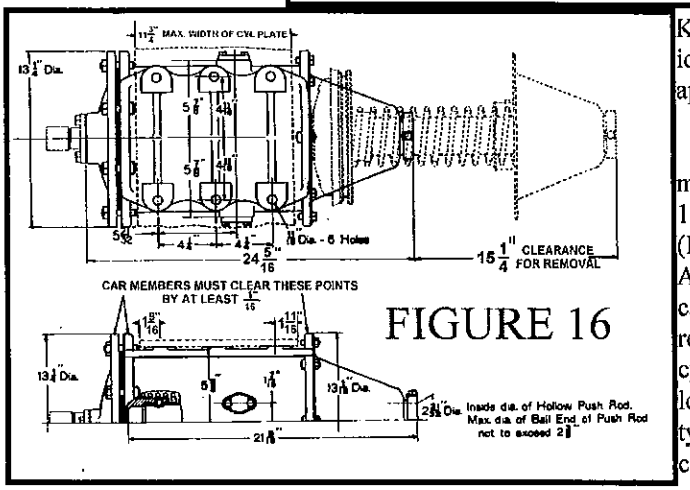
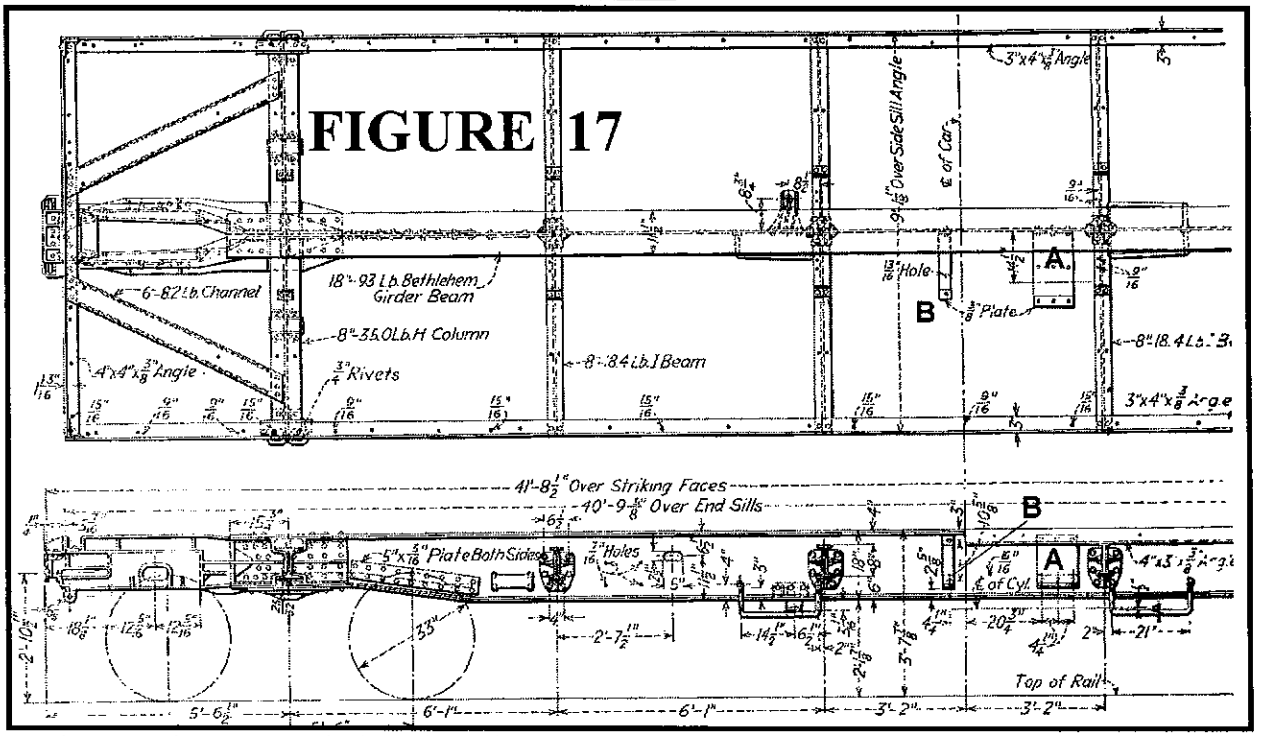


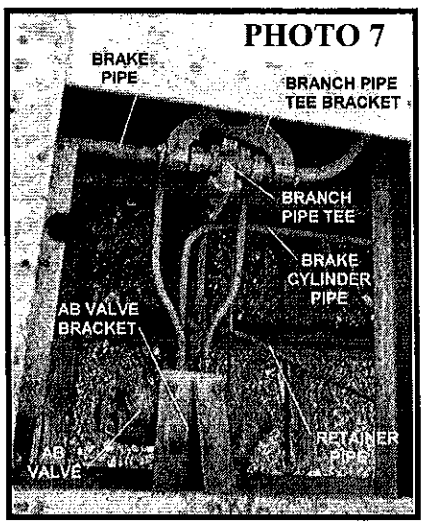
FIGURE 16

K brakes has the mounting brackets for the KC brake identified on the drawings as "A" and "B" and they appear to be the style shown in photos 4 and 5.

Notice that in the KC brake cylinder mounting in Figure 17 there are two brackets: one 11" wide (A) to support the cylinder and one 2" wide (B) to support the triple valve end of the reservoir. Air brake cylinders are usually mounted near the car's center line. In the Bettendorf 30-ton refrigerator car underframe shown in Figure 17 the cylinder center line is 14 1/2" from the car's longitudinal center line. For AB brakes a more typical figure would be 18". When cars were converted from K to AB brakes the almost universal



practice was to install the AB brake cylinder right where the K brake cylinder had been. With this method no foundation brake gear needed to be changed. Both K and AB brake cylinder mounting bolt holes matched those in the bracket. Installation of the AB valve and reservoir required additional mounting brackets for those components.

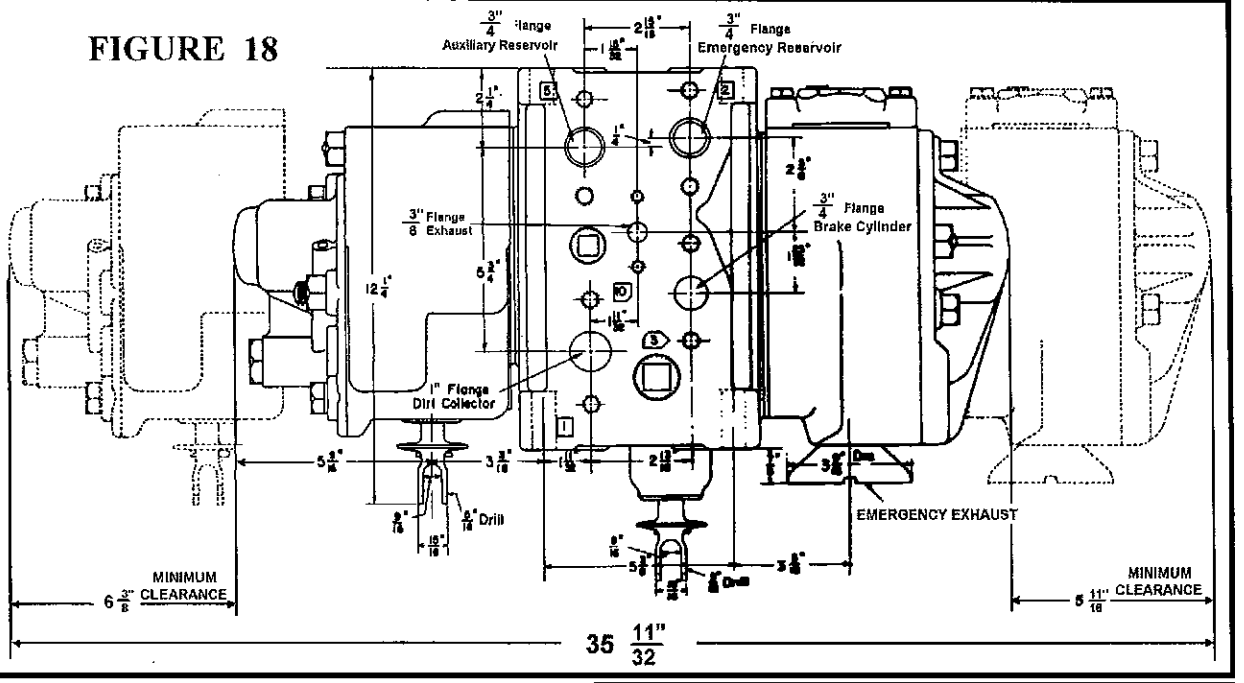


Photos 5 and 7 were made on a flat car that had lost its deck. Both photos are of the same car and the crosstie on the far right of Photo 7 is the same crosstie as is seen in the left third of Photo 5. While the features of the air brake system are completely out of view on a flat car with fishbelly side sills like the one in Photo 7, a flat car with straight side sills will put the air brake components on prominent display.

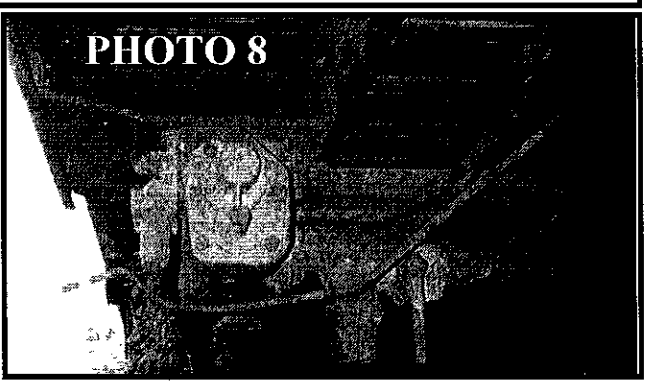
Photo 7 shows one type of mounting bracket for AB valves. Figure 18 shows the clearances necessary to provide for routine service and maintenance. The pipe bracket contains no moving parts and so it seldom

FREIGHT CAR UNDERBODY DETAIL

FIGURE 18



needs to be removed from the car. The only restriction on the location of the pipe bracket for the AB brake valve is that , on boxcars, the pipe bracket must not be installed in line with the doors where there is a possibility of damage from motor trucks backing into the control valve.



The Release Valve Operating Rod is readily visible in Photo 8. The Release Valve is located on the top of the reservoir on K brakes. See Figures 5 and 6. The K brake release valve operating rod runs, in most cases, straight under the freight car just below the stringers and comes out just under or through the side sill. In the case of AB brakes the release valve is position low on the AB control valve and therefore takes quite a circuitous route under the car. Generally the release rod angles upward as seen in Photo 8 and runs through the center sill and across the car to the other side. The Release Rod must be 1/2" in diameter.

Location of the Release Valve Operating Rod must be within 6 feet of the center line of the car towards either the A or B end or as close as possible if car design does not permit a location within 6 feet of the center. Preferably the rods should protrude through the side sill but, where car construction does not permit, it should be suitably bracketed to the side sill or another adjacent member. Release Valve Operating Rod Handles must be at least 18" above the top of the rail and protrude no more than 4" beyond the outside of the side sill. The handle is typically a 90° downward bend about 4" long. The handle for ABDW valves must be a loop with an inner diameter of not more than 1/2". On refrigerator cars the release rod must not be within 15" of the door post to avoid distortion and breakage from misuse as a step.

The KD and AB Air Brake Reservoir can be mounted in a variety of locations while the KC brake can only be attached to the KC brake cylinder. The mounting lugs cast integral to the KD reservoir make it obvious that it is to be suspended from above. AB Brake Reservoir mounting should conform to the following rules unless the car's construction makes it

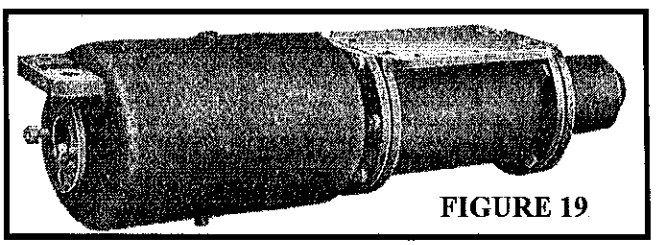


FIGURE 19

FREIGHT CAR UNDERBODY DETAIL

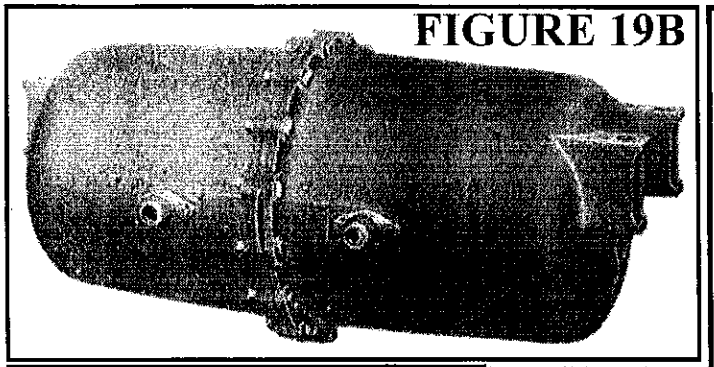


FIGURE 19B

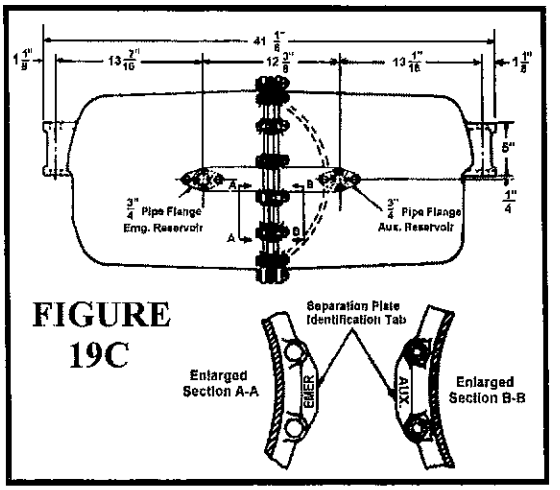
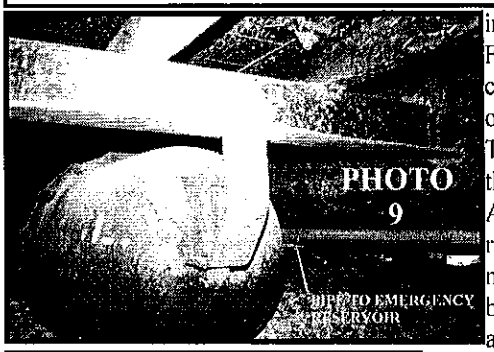
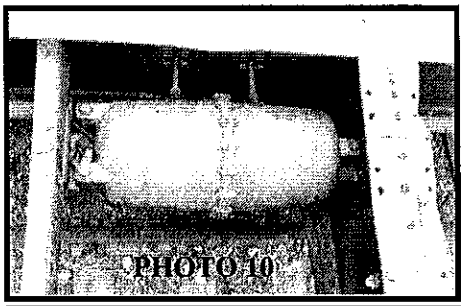


FIGURE 19C



impossible to do so. Figure 19 shows the correct orientation of the reservoir. The side facing the reader is the side normally facing the AB control valve. The reservoir should rest on its mounting lugs and should be so mounted that lugs are above reservoir center line. See Photos 9 and 10. One inch bolts should be installed from the top with nuts on the bottom whenever car design permits. Photo 10 shows just such an exception. Supports should be of sufficient strength to keep the reservoir in place in spite of shocks to the freight car.



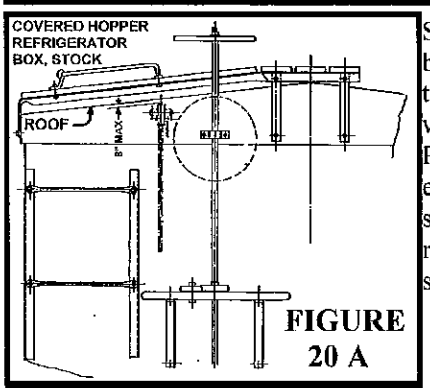
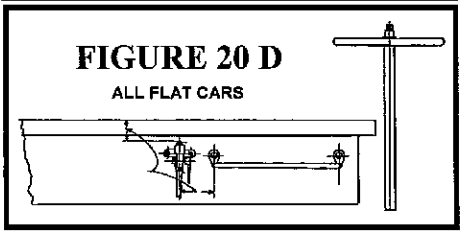


FIGURE 20 A



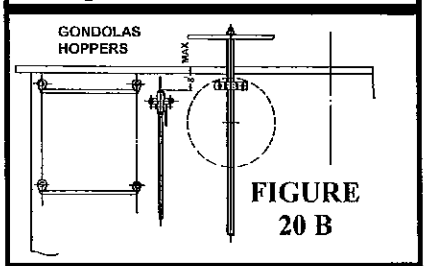
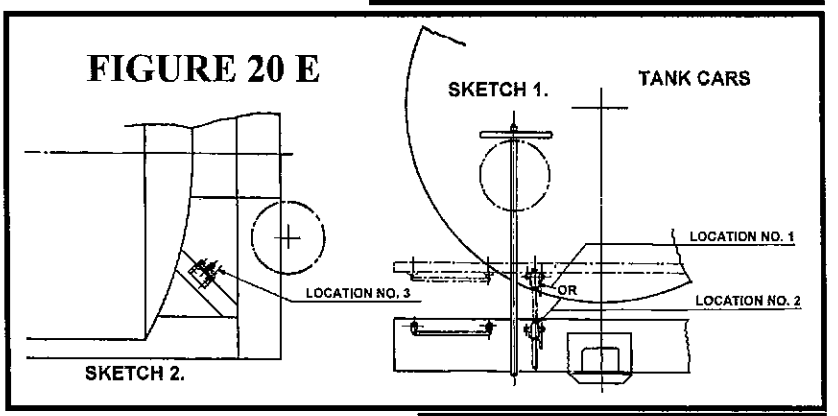


FIGURE 20 B



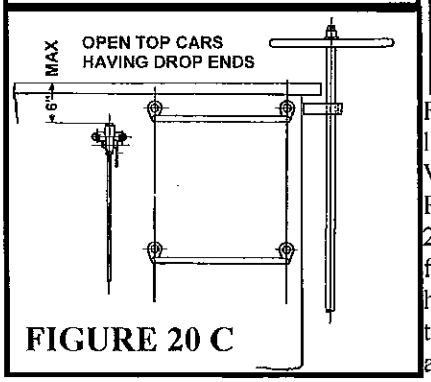
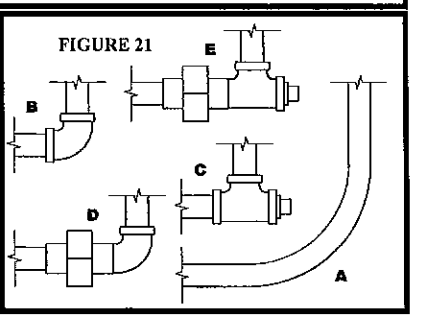


FIGURE 20 C

Figures 20A through 20E show the locations for the Retainer (Retaining Valve) mandated by the American Railway Association in 1933. Figure 21 shows the five acceptable methods for bringing the retainer piper from horizontal under the car to vertical at the end or side of the car. Methods A and B are preferred.



FREIGHT CAR UNDERBODY DETAIL

FOUNDATION BRAKE GEAR

The foundation brake gear begins at the push rod on the air brake cylinder and carries the motion and force of the brake cylinder to each truck where the truck brake rigging carries the motion and force to the brake shoes.

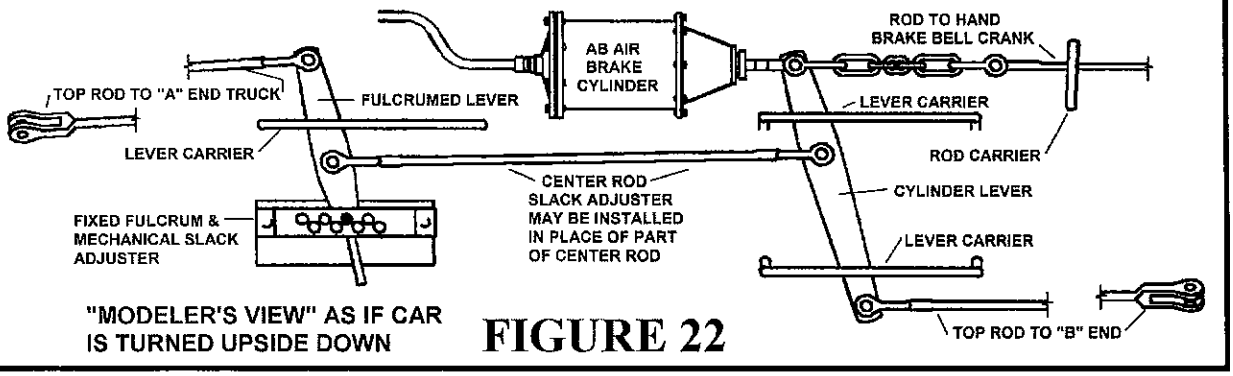
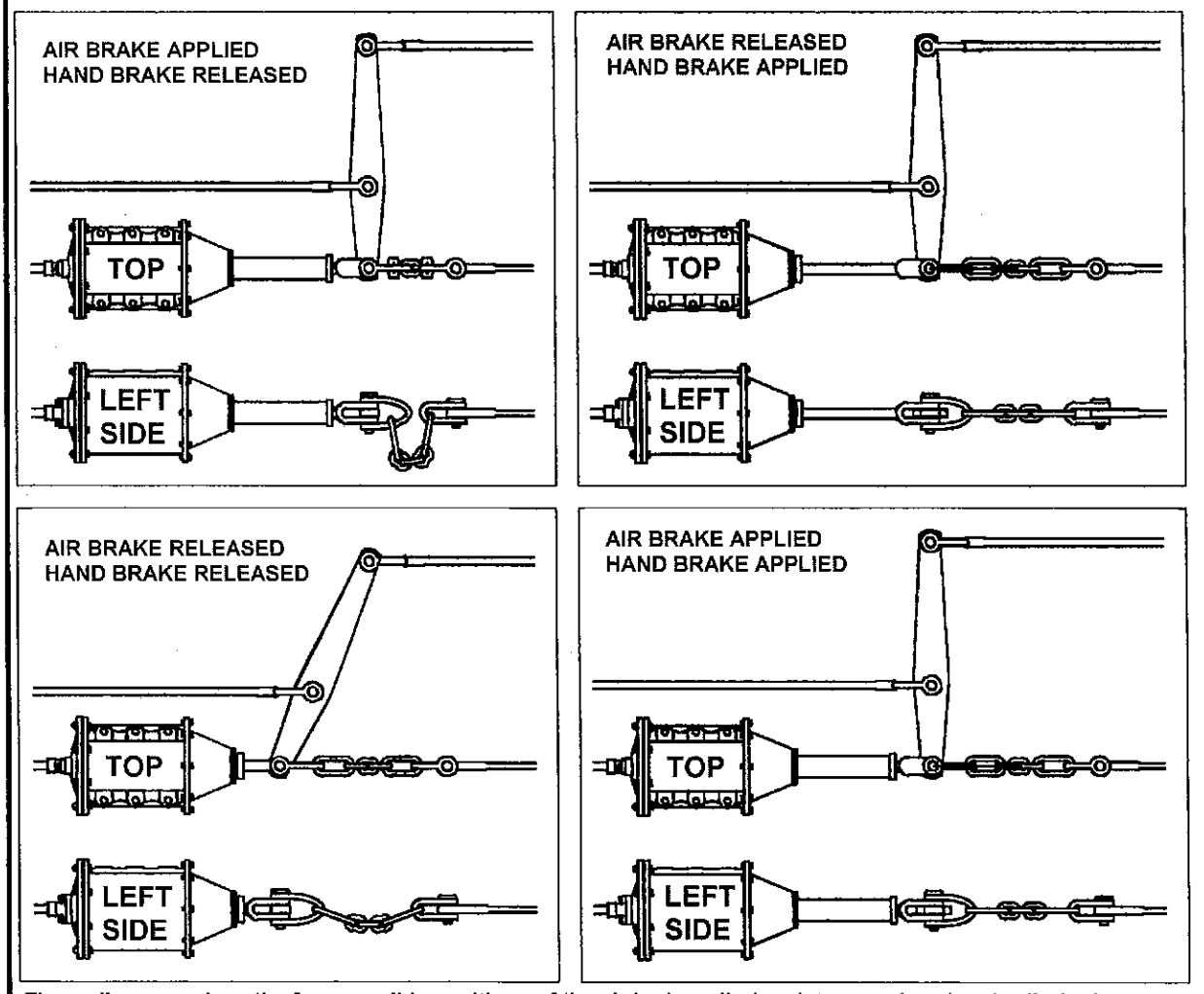


FIGURE 22

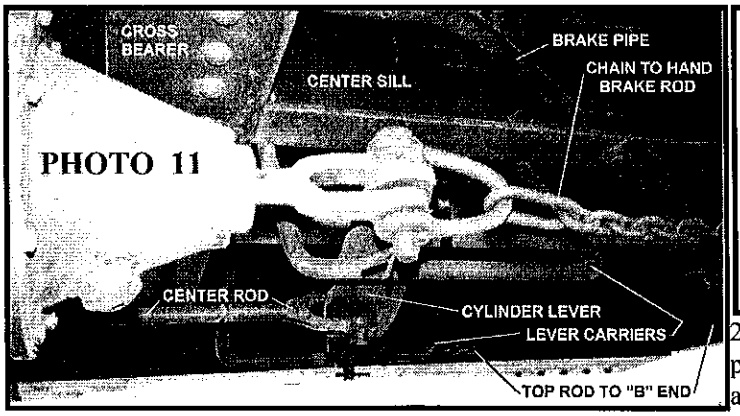
FIGURE 23



These diagrams show the four possible positions of the air brake cylinder piston, push rod and cylinder lever. In each box the upper illustration shows the cylinder viewed as if the car floor was removed. The lower illustration in each box shows the cylinder as viewed from the left side of the car.

FREIGHT CAR UNDERBODY DETAIL

Figure 22 shows the principal parts of the Foundation Brake Gear with both air and hand brakes in the released position. Figure 23 shows the relationship of push rod, cylinder lever and hand brake chain in the four possible positions. The distance from the brake cylinder to the center line of the pin through the brake rod jaw and end of cylinder lever should probably not exceed 6 scale inches. Any distance greater than that would indicate a brake in the applied or partially applied position. [I make the assumption here that modelers will wish to model brakes in the released position which is correct for a car in motion and usually correct for a car at rest. During switching and dropping of cars for loading or unloading the hand brake is set only if absolutely necessary. Leaving a car standing with the air brake applied because the air was "dumped" is common but these brakes sometimes slowly bleed off.] Photo 11 shows these parts with both the air brake and hand brake in the released position. As can be seen in Figure



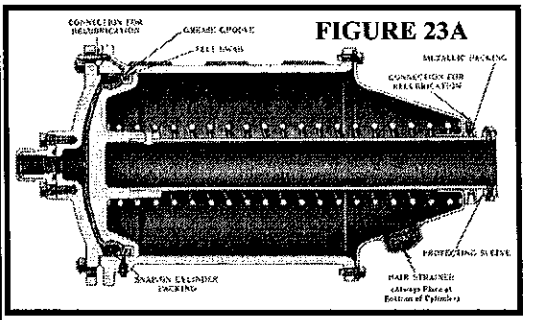


FIGURE 23A

23A, the push rod is free to move inside the push rod tube. If this were not the case, application of the hand brake would require extra effort to pull against and hold the return spring inside the brake cylinder.

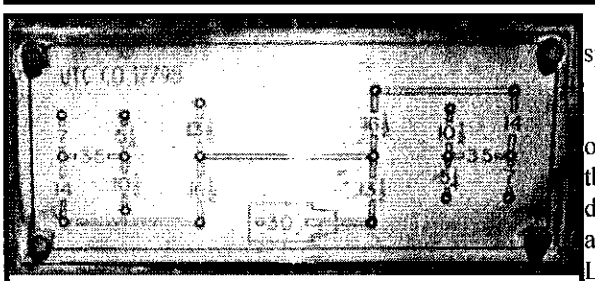
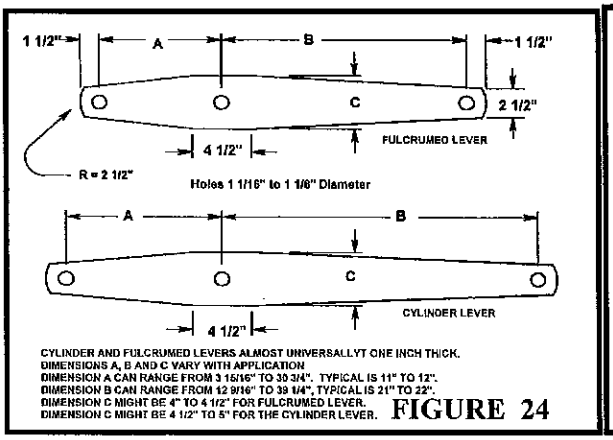


PHOTO 12

Cylinder and fulcrumed levers are almost universally one inch thick, this thickness being dictated by the opening in the push rod jaw. See Figure 28 for a dimensioned push rod drawing. The required strength for a given application is achieved by increasing or decreasing the width of the lever. Length of the lever is dictated by the force needed which is directly related to the empty weight of the freight car. Figure 24 gives some typical lever dimensions but there is no substitute for information from the prototype.

A Brake Badge Plate has been required on new cars since August 1, 1929 and all cars since January 1, 1936. The Brake Badge Plate, Photo 12, gives dimensions A and B from Figure 24 as well as the same dimensions from the two levers on each truck. More on the truck levers later. The brake badge plate is normally located somewhere near the brake cylinder. The plate in Photo 12 on a tank car was easy to see and photograph without getting under the car.



CYLINDER AND FULCRUMED LEVERS ALMOST UNIVERSALLYT ONE INCH THICK.
DIMENSIONS A, B AND C VARY WITH APPLICATION
DIMENSION A CAN RANGE FROM 3 15/16" TO 30 3/4", TYPICAL IS 11" TO 12".
DIMENSION B CAN RANGE FROM 12 9/16" TO 39 1/4", TYPICAL IS 21" TO 22".
DIMENSION C MIGHT BE 4" TO 4 1/2" FOR FULCRUMED LEVER.
DIMENSION C MIGHT BE 4 1/2" TO 5" FOR THE CYLINDER LEVER. **FIGURE 24**

A WORD ABOUT SAFETY

NEVER EVER crawl under a car to take measurements or for any other purpose unless you are absolutely positive that two conditions have been met.

1. You have permission from someone who has the authority to grant permission.

2. Blue flags or blue lights have been placed at each end of the car by someone who has the authority to do so OR the car is in a museum and fixed to prevent any movement.

The width of a lever is a function of a car's light weight. Braking effort must equal 60% of the car's light weight. For most cars of 40 ton capacity the width of the two levers will be somewhere in the 4" to 6" range. Lever width vary in half inch increments. Since freight car designers have been reasonably successful in increasing freight car payloads without increasing light weight by very much, lever widths have remained within a fairly narrow range.

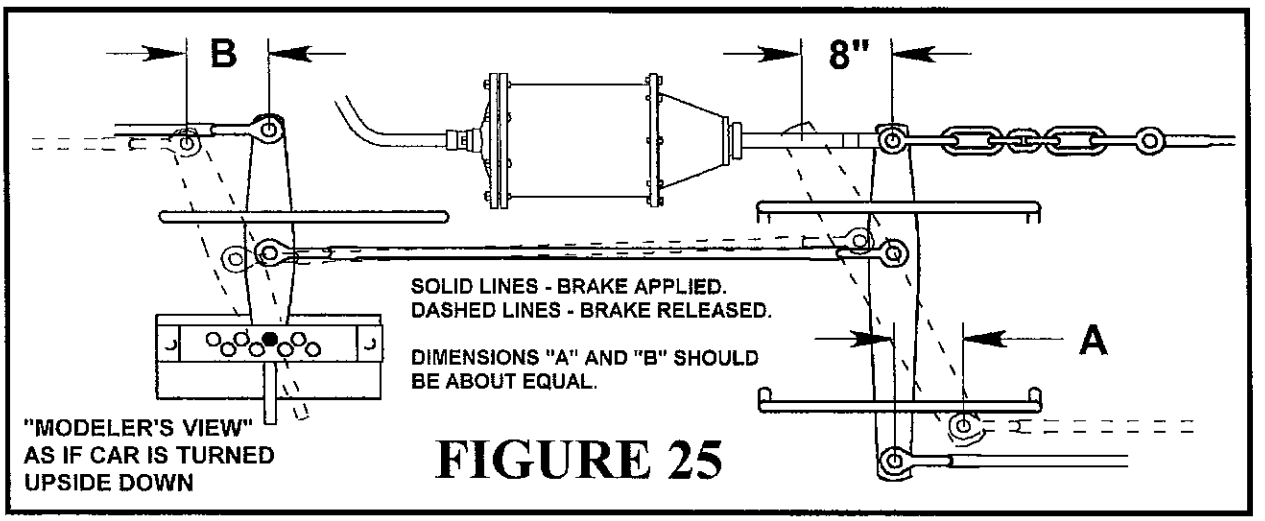


FIGURE 25

All pin holes in brake levers must be on the longitudinal center line. The cylinder lever must be made as long as practicable, and must be located so as to prevent a lateral (side to side) thrust on the push rod when the brake is applied. The cylinder and fulcrumed levers must be substantially at right angles to the rods under a brake application with 7" piston travel. (Some sources say 8" piston travel.) Figure 25 shows the relative positions of the foundation brake gear in the released and applied positions with hand brake but not air brake in applied position.

Center rod and top rod diameters are very typically 7/8" although on cars built before 1930 rods with 3/4" diameter can be found. Lever carriers (refer to Figure 1 and Photo 11) are usually either 1" diameter round rod or 1" square rod. The lever carriers (or lever guides) must permit free movement of the levers in all positions they will assume when the brakes are fully released and when fully applied with the brake shoes removed. This explains why there seems to be unnecessarily long lever carriers as shown in Figure 25, for example.

HAND BRAKES

While hand brakes themselves are not part of this discussion, the motion of the hand brake must be transmitted to the cylinder lever and the foundation brake gear elements that transmit this motion become part of the underbody detail. Since 1911 there has been a requirement to locate the hand brake on the car's end not less than 17" nor more than 22" left of the car's center line. Drop end gondolas and, more recently, piggyback flats, autoracks and some container cars are obvious exceptions to this rule. At the cylinder end the hand brake rod is usually connected to the cylinder lever with a length of chain in order to permit the independent movement of the air brake parts in applying brakes without moving the hand brake rod. See Figure 25. On some older cars, those built before about 1920, this length of chain was sometimes omitted. At the "B" end of the car there is another length of chain which either attaches to the bell crank on geared hand brakes or wraps around a vertical shaft on so-called "Plate A"

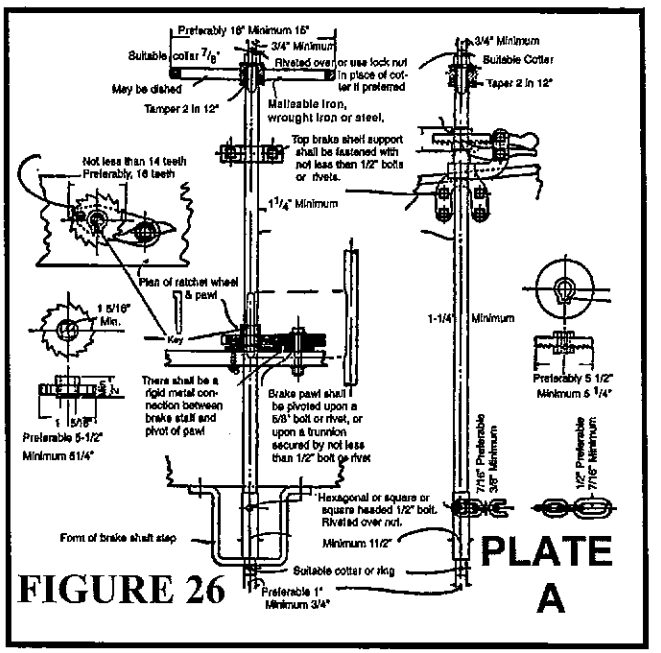


FIGURE 26

hand brakes. See Figure 26 which shows the only hand brake ever required by the ICC or FRA. This drawing can be found in the most recent FRA safety appliance standards.

Geared hand brakes were required by the ARA/AAR on all cars built after January 1, 1937 although some cars received geared hand brakes in the forms we recognize today as early as 1926. Geared hand brakes have been applied here and there since 1912 or so but most of these installations are best described as experimental. The norm before about 1935 was the Plate A hand brake.

In the old days of "Plate A" hand brakes, there were two frequently used methods to increase the hand brake force. Both are shown in Figure 27. These methods could be used in conjunction with one another or just one might be used. The first method - placing a sheave wheel on the hand brake end of the hand brake rod - doubles the power of the hand brake while requiring twice as many turns on the hand wheel to set the brakes. The second method -

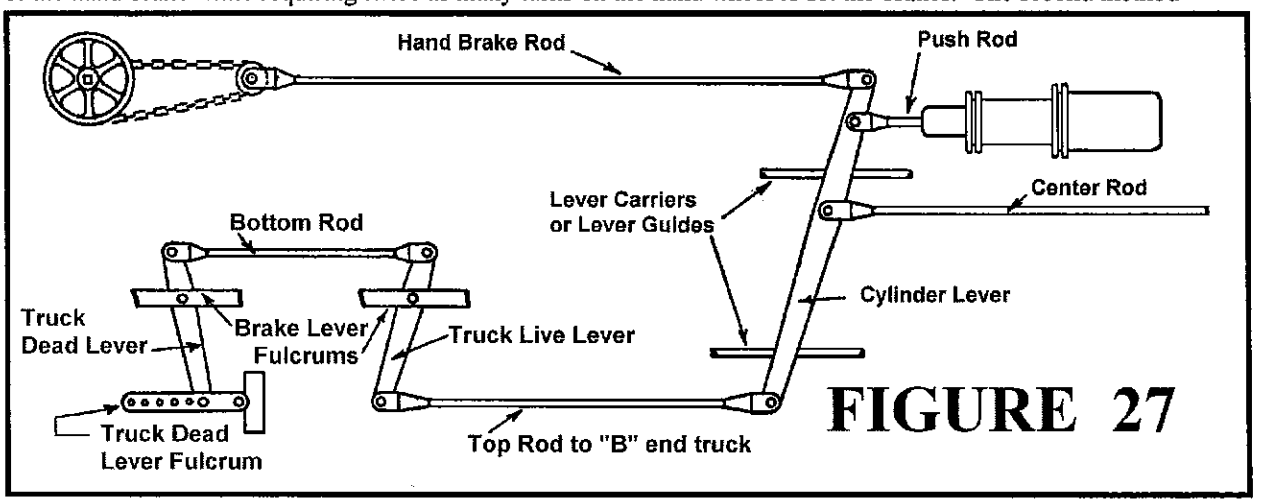


FIGURE 27

lengthening the cylinder lever - gives a more modest increase in power of the hand brake. Because this second method shifts the theoretical pivot point of the cylinder lever there is an uneven application of the hand brakes. In spite of recommendations to the contrary, the second method is often seen on cars with K brakes and a Plate A hand brake.

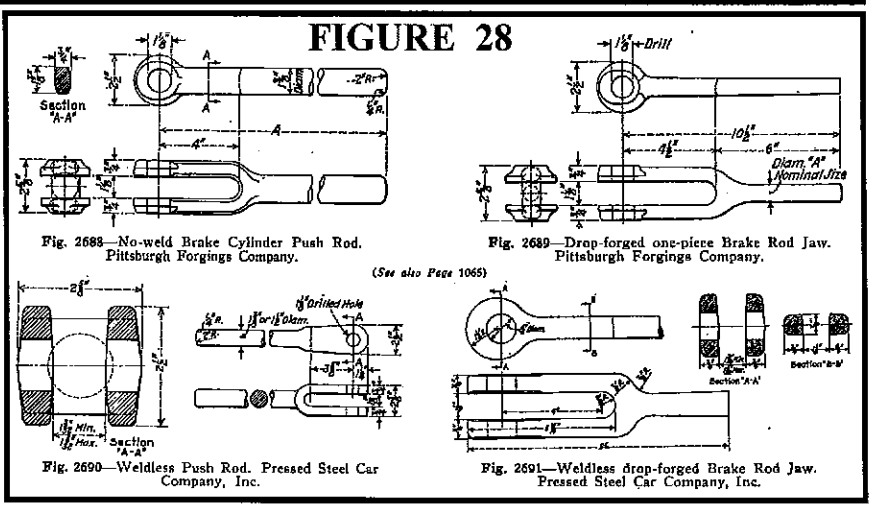


FIGURE 28

Fig. 2688—No-weld Brake Cylinder Push Rod. Pittsburgh Forgings Company.

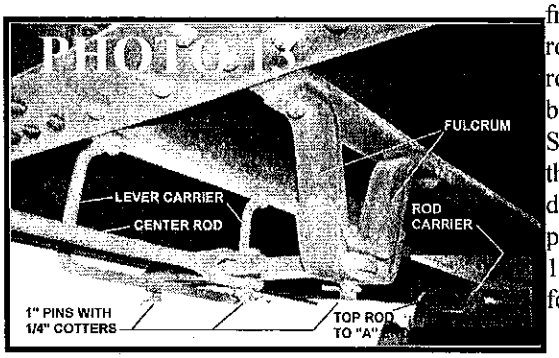
Fig. 2689—Drop-forged one-piece Brake Rod Jaw. Pittsburgh Forgings Company.

(See also Page 1065)

Fig. 2690—Weldless Push Rod. Pressed Steel Car Company, Inc.

Fig. 2691—Weldless drop-forged Brake Rod Jaw. Pressed Steel Car Company, Inc.

Rods always attach to levers with a brake rod jaw so that there is no twisting force applied to the lever. See Figure 28 (taken from the 1940 Car Builder's Cyc) which shows two typical brake rod jaws on the right. The left drawings in Figure 28 show push rods. The fulcrumed lever always has a fixed fulcrum (which may be adjustable) that supports the lever from both above and below. See Photo 13 which shows such a fulcrum, the brake rod jaw on the "A" end of the center rod and the lever carrier. Notice the distance below the bottom of the center sill at which all these parts are located. The lack of adjustment in the fulcrum in Photo 13 indicates the presence of a slack adjuster elsewhere in the foundation brake gear.



FREIGHT CAR UNDERBODY DETAIL

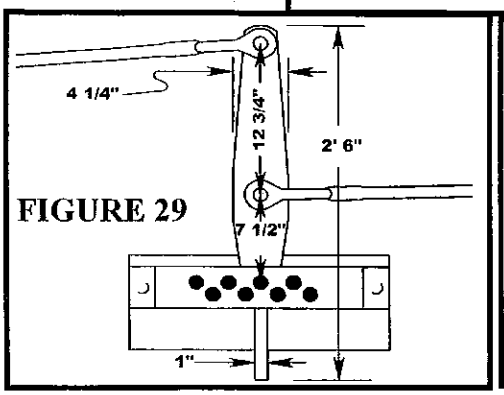


FIGURE 29

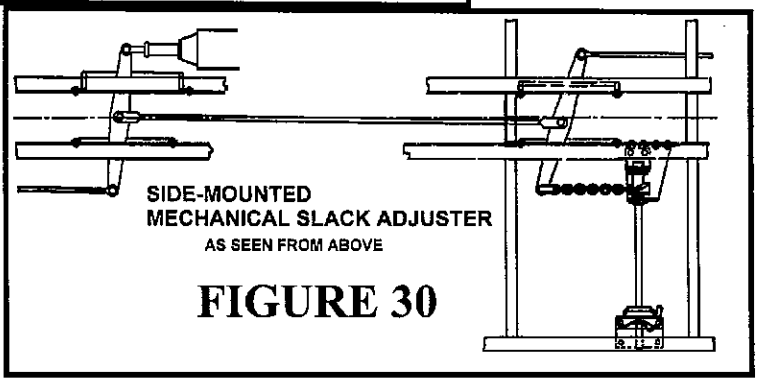


FIGURE 30

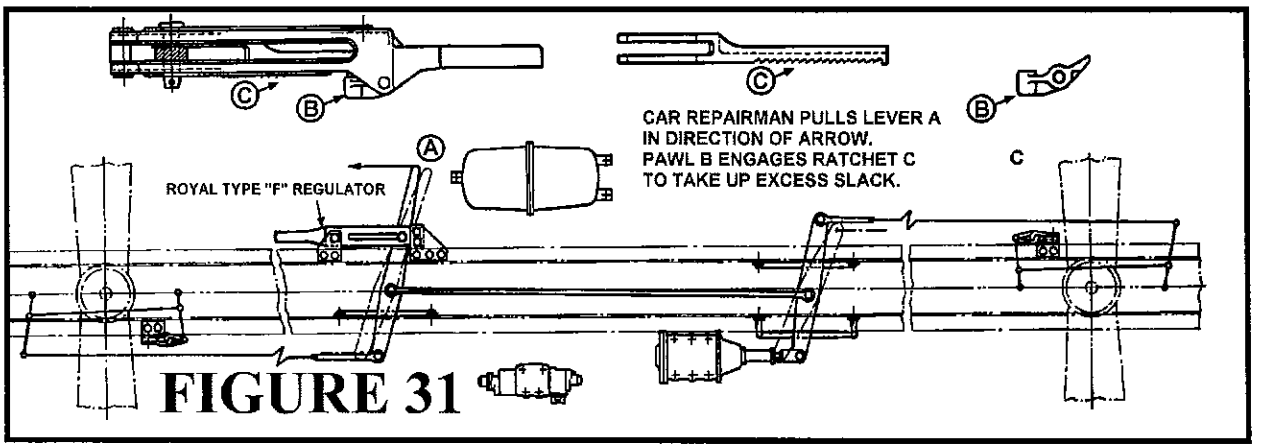


FIGURE 31

There must always be some form of slack adjuster in the foundation brake gear as well as two more; one on each truck. Freight cars with truck mounted brakes are an exception to the requirement for a slack adjuster. More on this later. Figure 29 shows the most common method for foundation brake gear slack adjustment used up through the 1940s, if not later. Figures 30 and 31 show mechanical slack adjusters. There have been various automatic and mechanical slack adjusters for over 100 years but, except for that shown in Figure 29, their use did not become

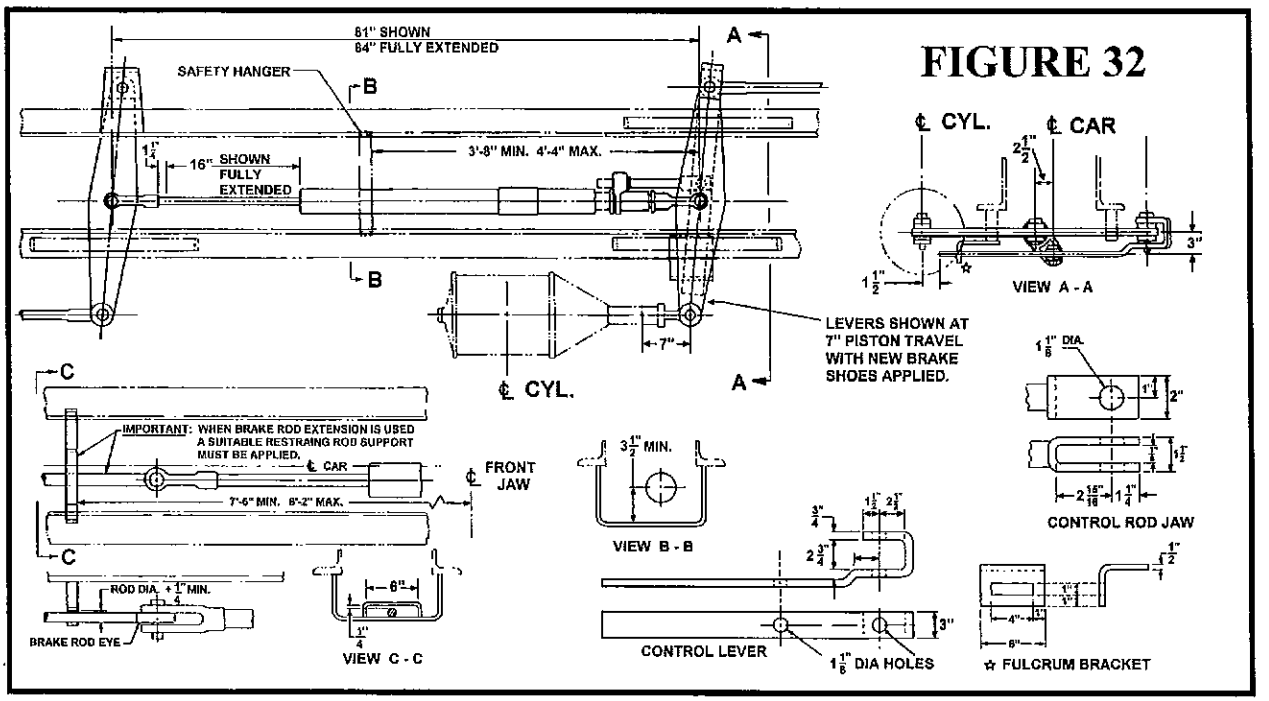


FIGURE 32

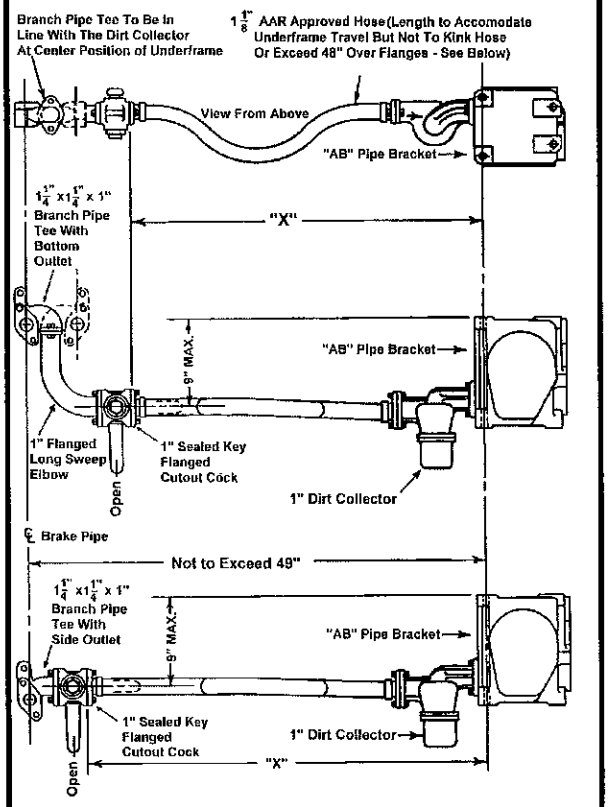
widespread until the 1950s. Automatic slack adjusters since about the 1960s typically take the form shown in Figure 32. These types are usually placed in the center rod of the foundation brake gear but can be placed in one of the top rods. The slack adjuster shown in Figure 32 is a Universal Model 2300DJ but it so closely resembles other slack adjuster is appearance, application and function that it can be seen as a typical example. See Appendix A for more slack adjusters of the same type, general appearance and function.

Cars with sliding center sills as part of a cushion underframe present car designers and modelers with some special considerations. First, the angle cocks and the brake pipe in between must be fixed to the sliding center sill so that they move with the couplers. To do otherwise would mean that the air hoses would separate under some conditions and cause an emergency application of the air brakes. Second, since the trucks and the truck brakes are in a fixed position relative to the car but not the sliding center sill, the foundation brake gear and air brake cylinder must be fixed to the cars underframe, not the sliding center sill. Fixing the air brake control valve and reservoir to the car's body is the standard design. There must, therefore, be a flexible connection between the branch pipe tee and the control valve. See Figure 34 for the correct design of this flexible connection.

The photo at right show a car overturned at a wreck site. This provides an opportunity to see the entire air brake and foundation brake gear system on a car with a sliding center sill. Both top rods were torn loose from the trucks when they separated from the car. Otherwise, everything is pretty much intact here.

FIGURE 33

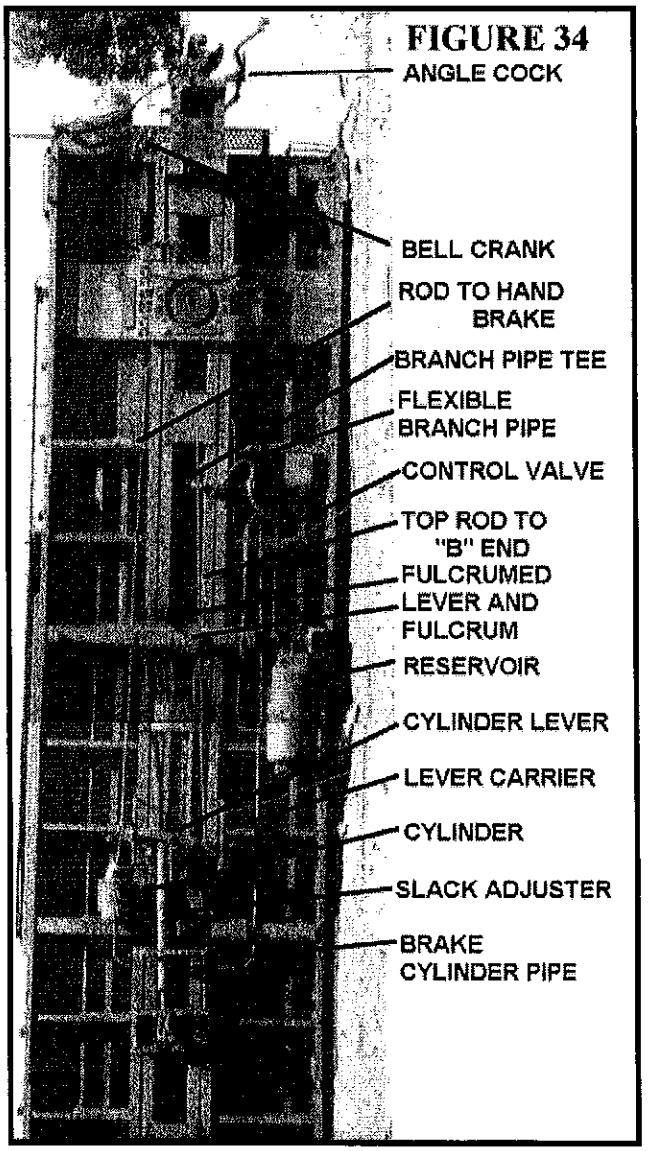
FLEXIBLE BRANCH PIPE ARRANGEMENTS



For Underframe With Maximum Travel (One Way)	Use Hose Of Length Over Flanges No Less Than	Length Of Hose Used		Dimension "X" Must Be Held Between	
		Nominal	Over Flanges	Maximum	Minimum
12"	31"	1 1/8"x 30"	31"	35"	34"
20"	37"	1 1/8"x 36"	37"	37"	36"
24"	43"	1 1/8"x 42"	43"	40"	38"
30"	48"	1 1/8"x 47"	48"	42"	41"

NOTE 1: Length of Brake Pipe Branch From "AB" Valve Bracket Face To Branch Pipe Tee Flange Face Must Not Exceed 60".
NOTE 2: Suitable Support With Renewable Wear Plate Must Be furnished to Prevent Sag In Hose At Center Position Of Underframe.
NOTE 3: Whenever The Left Hand Brake Cylinder Release Valve Adapter IS Used, The "X" Dimension Must Be Increased by 2 3/4".

FIGURE 34

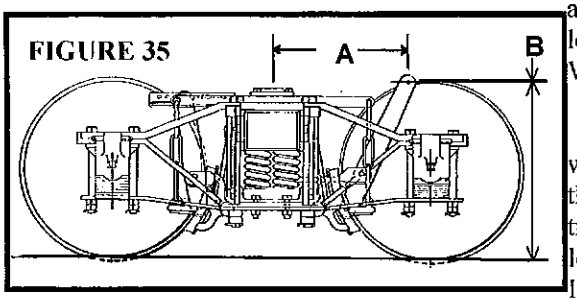


FREIGHT CAR UNDERBODY DETAIL

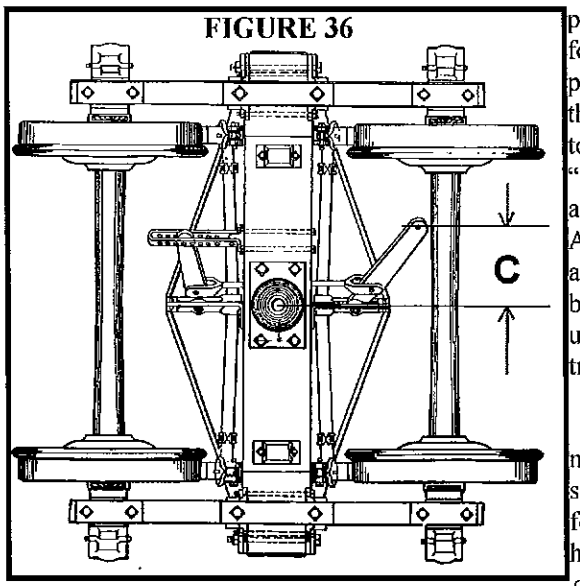
TRUCK BRAKE RIGGING

We look at truck brake rigging mainly to be sure our air brake and foundation brake gear systems are correct. Model freight car trucks in HO scale and larger are improving and, while we are a long way from complete brake rigging on model trucks, there are features of the foundation brake gear that, when modeled correctly, betray the type of truck brake rigging that was on the prototype.

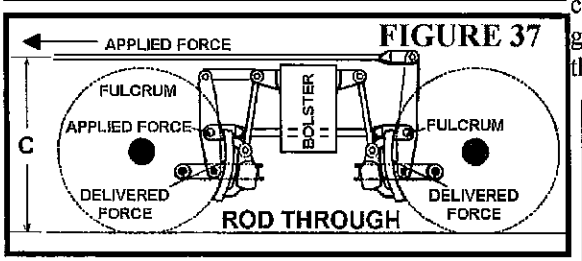
In general, on freight cars built before the 1960s there were basically two forms of truck brake rigging. With the advent of truck mounted brake cylinders about 1966 a third variation came into being. The most obvious way that truck mounted brake cylinders affect underbody detail is that the air brake cylinder and all foundation brake are omitted. Intermountain, to give just one example, has a nice looking roller bearing truck with a very credible model of Wabco truck mounted brake cylinders.

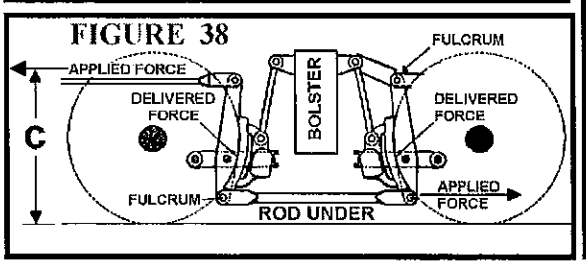


The two most common types of truck brake rigging on any car without truck mounted brake cylinders are "rod under" and "rod through." While we may not model brake rigging on our model trucks, knowing which system was on the prototype allows us to locate the top rod and other elements correctly on our model. If dimensions "A," "B," and "C", Figures 35 and 36, on the prototype are known, the top rod at each end of our model foundation brake gear can appear to be routed to the correct point on each truck even though, if fact, we intend to terminate the top rod short of the model truck. Dimensions A and B tend to be about 11 1/2" whether the truck style is "rod under" or "rod through." Notice, however, that dimension C varies according to whether the truck is "rod under "or "rod through." A fairly simple rule of thumb is that on "rod through" arrangements the level of the top rod is such that it will pass between the car's body bolster and the truck's bolster. The "rod under" rigging has the top rod on a lever below the top of the truck bolster and above the axle.



Since the foundation brake rigging is most efficient when all motion is on one horizontal plane, we know how far below a straight center sill to locate the air brake cylinder and foundation brake gear depending upon whether the prototype has "rod under" or "rod through." Rod through will have the center line of the air brake cylinder and the foundation brake gear on a horizontal plane about 3 inches below the bottom of the center sill; rod under about 6 inches below.





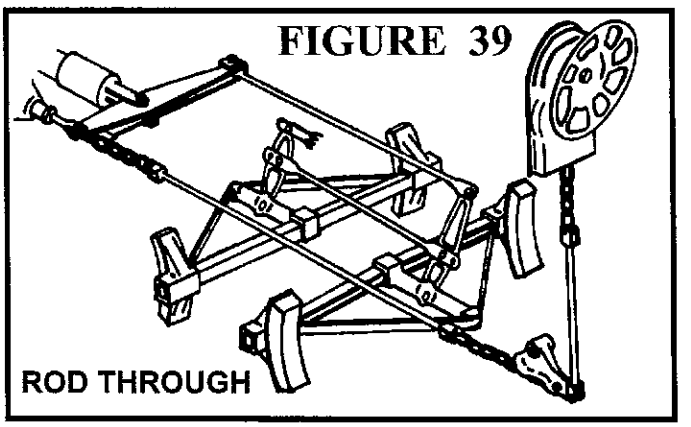
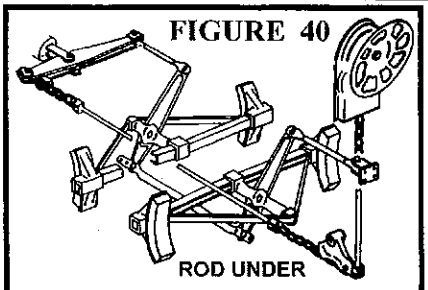


FIGURE 40

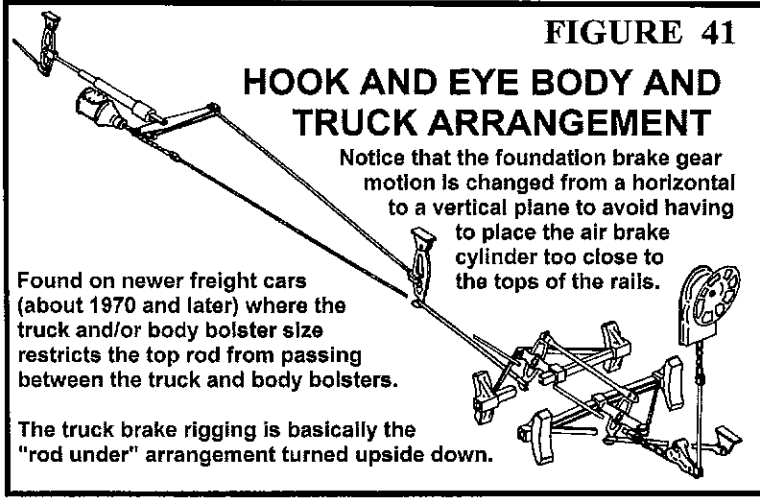


ROD UNDER

FIGURE 41

HOOK AND EYE BODY AND TRUCK ARRANGEMENT

Notice that the foundation brake gear motion is changed from a horizontal to a vertical plane to avoid having to place the air brake cylinder too close to the tops of the rails.



Found on newer freight cars (about 1970 and later) where the truck and/or body bolster size restricts the top rod from passing between the truck and body bolsters.

The truck brake rigging is basically the "rod under" arrangement turned upside down.

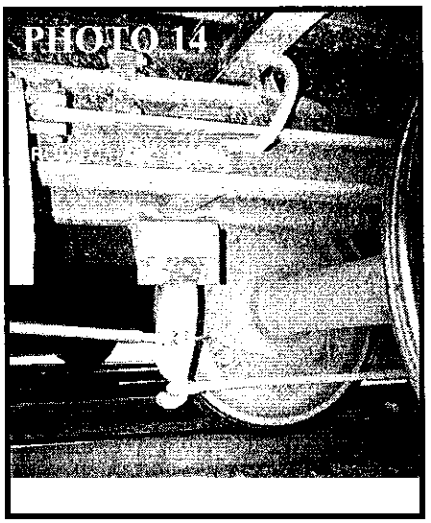


PHOTO 14

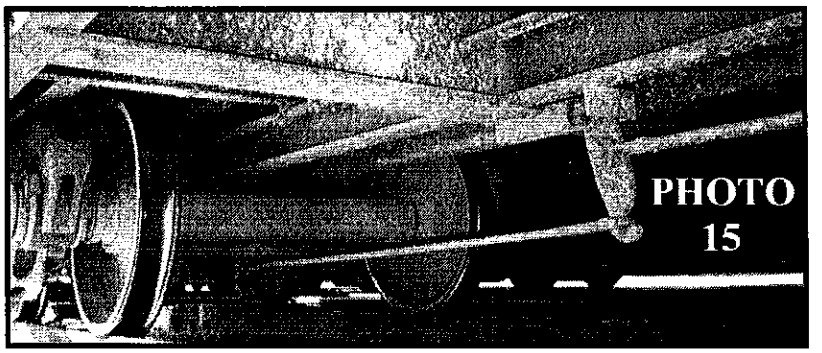
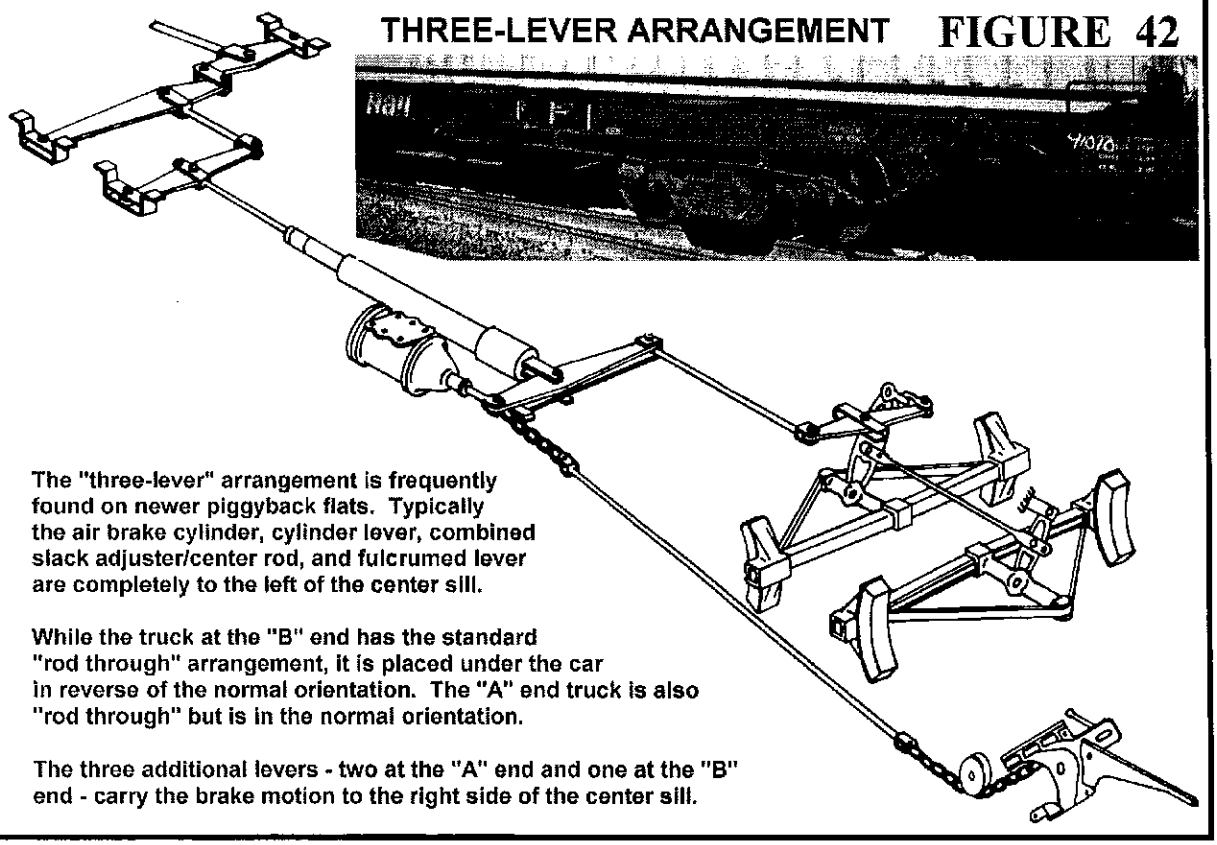


PHOTO 15

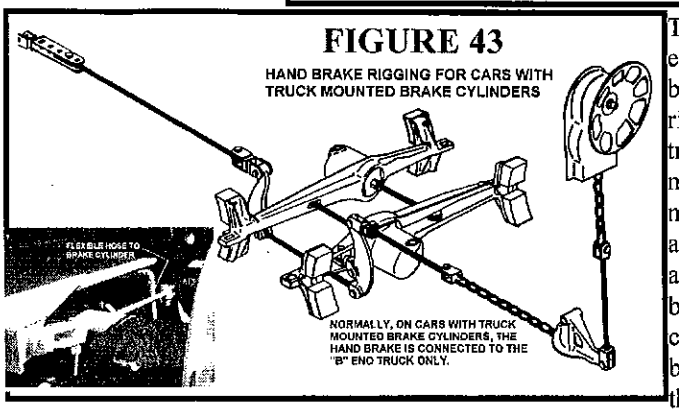
THREE-LEVER ARRANGEMENT FIGURE 42



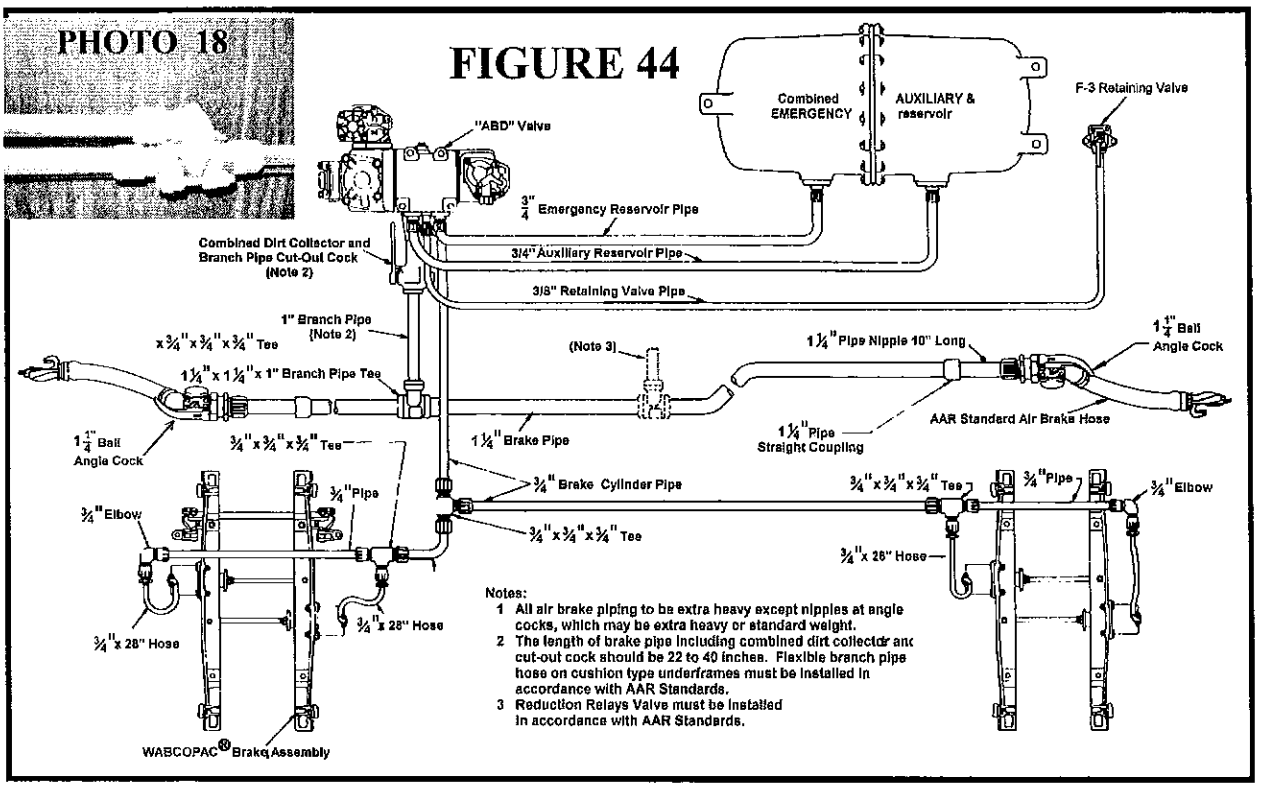
The "three-lever" arrangement is frequently found on newer piggyback flats. Typically the air brake cylinder, cylinder lever, combined slack adjuster/center rod, and fulcrumed lever are completely to the left of the center sill.

While the truck at the "B" end has the standard "rod through" arrangement, it is placed under the car in reverse of the normal orientation. The "A" end truck is also "rod through" but is in the normal orientation.

The three additional levers - two at the "A" end and one at the "B" end - carry the brake motion to the right side of the center sill.



Truck mounted brakes, in use since about 1966, eliminate the need for foundation brake gear and the body mounted air brake cylinder. The hand brake rigging stays about the same but is applied only to the truck on the "B" end. See Figure 43 for truck mounted brake hand brake rigging used on the two most commonly used truck mounted brakes; Nycopac and Wabcopac. Compare Figure 44, which shows the air brake systems pipes on a car with truck mounted brakes with Figure 7 on page 4 which shows the more conventional air brake system with body mounted brake cylinder. There is very little difference except that there are extra pipes to each truck. Because the



lengths of the brake cylinder pipes to the trucks must be of equal length, the tee in the middle of the brake cylinder pipe must be at the middle of the car. Pipes then go to each truck. See Photo 18 in Figure 44. Westinghouse's Wabcopac is not the only truck mounted brake cylinder but air brake pipes and hand brake rigging are the same for all. Appendix D has illustrations of a few of the other truck mounted brakes that have been available over the years.

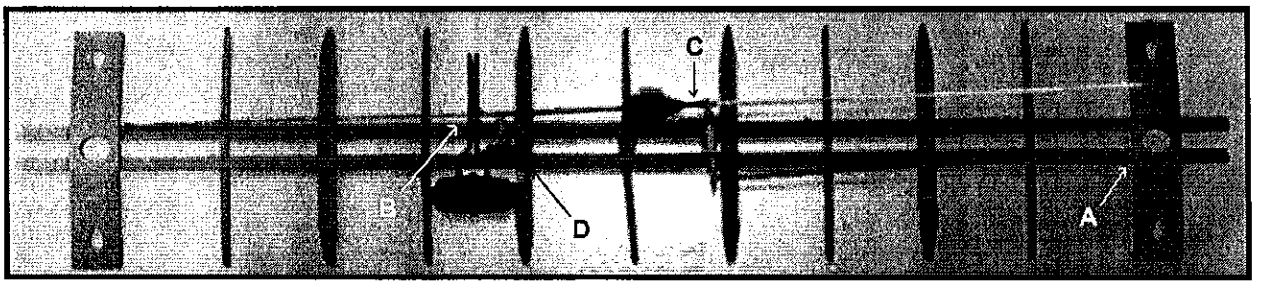
The air brake system and its piping as well as the foundation brake gear on hopper cars, whether covered or open, must be adapted in a number of ways in order to avoid interference with the operation of the hopper outlets. Appendix E will examine both systems on hopper cars in detail. The truck brake rigging, on the other hand, is virtually identical to that of more conventional cars. The typical trucks have either "rod under" or "rod through" rigging or, more recently, the truck mounted brakes.

Traditionally, tank cars had air brake systems and foundation brake gear arranged very much the same as box, stock, refrigerator, flat and gondola cars. With the appearance, or more correctly the reappearance, of frameless ank cars some adaptations to the air brake systems have been made. Some of the principle changes have been the relocation of the air brake control valve and reservoir to the end of tank cars. Foundation brake gear and truck mounted brakes differ little from any other freight car designs.

MODEL CRITIQUE

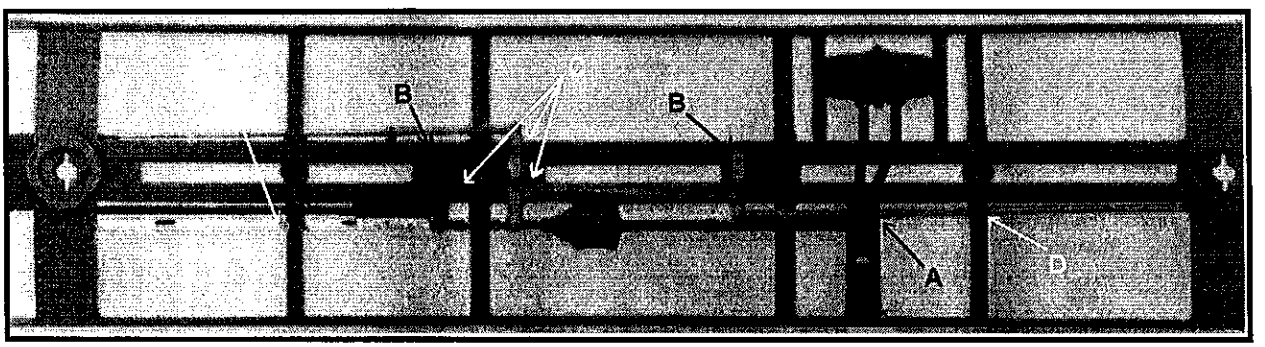
Many models share a number of errors, most of which can be corrected without much effort. First, on many models, the cylinder lever is at right angles to the car's and air brake cylinder's center line indicating a brake in the applied position. This is only an error only if you want your car modeled with the brakes released. I suppose so many models appear to have the brakes applied because that is the way the prototype car was found - hand brake applied to keep the car safely in place. Second, the foundation brake gear is attached tightly to the under side of the center sill on many model cars with straight center sills. On cars with conventional foundation brake gear there should be a gap between the bottom of the center sill and the horizontal plane of the foundation brake gear of about 3 inches on cars with "rod through" truck brake rigging and about 6 inches on cars with "rod under" truck brake rigging. The top rods to each truck should be about parallel to the center sill but on many models these angle in towards the cars center line more than they should. Rod carriers are rare on models; common on the prototype.

BRANCHLINE 50' RBL



Overall pretty good. All essential parts are here. Maybe, on a car this modern, there should also be an automatic slack adjuster. This view of the Branchline 50' RBL, as is the case with all the following models, shows the underframe upside down. The following points apply:

- A - The top rods should not terminate on the underframe. They should be nearly parallel to the underframe.
- B - The pipes to the reservoir should be between the underframe and the top rod. I assembled this car wrong.
- C - The brakes are in the applied or partly applied position.
- D - This model has a proper fulcrum for the fulcrumed lever. Not all models do.



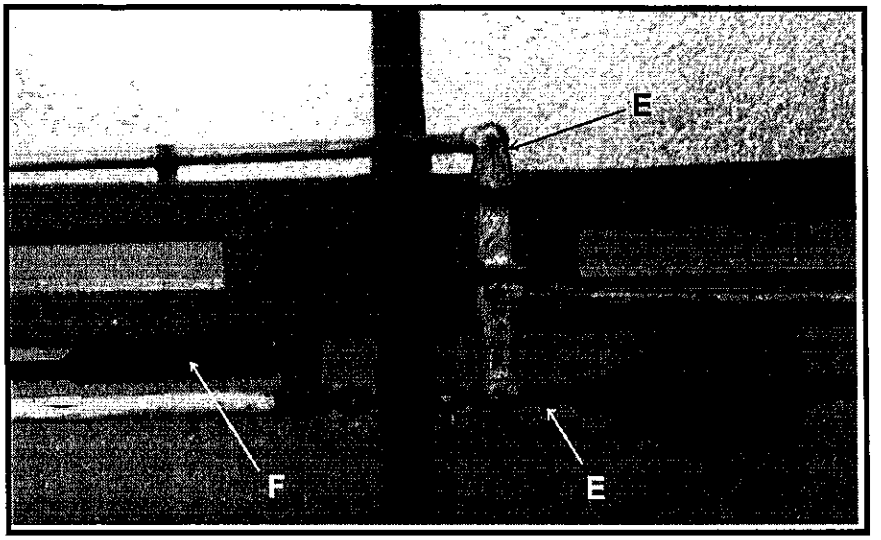
CENTRAL VALLEY STOCK CAR

Good, especially for something cast all in one piece. The lever guides or lever carriers are too tight but these should be replaced with wire anyway. It would be easy to do. This brake appears to be in the applied position judging by lever angles.

- A - Pipes between reservoir and control valve should be next to underframe and top rod below that.
- B - Fulcrums are probably wrong. Should support lever both above and below.
- C - Lever guides too tight. Levers can't swing enough for both applied and released positions.
- D - Rod carriers are included. These are seldom seen on models but essential on the prototype. Nice touch!

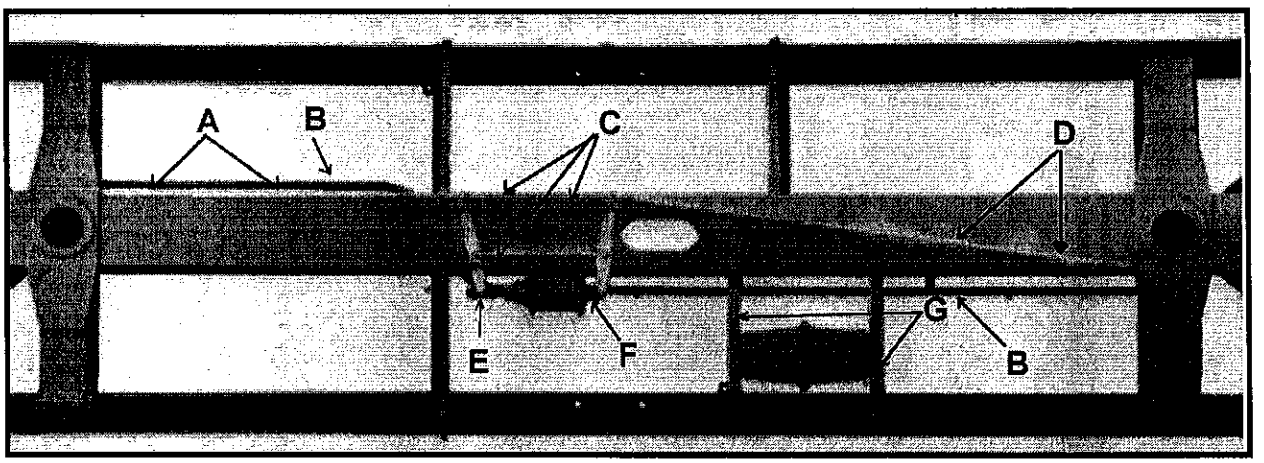
In the inset on the following page the detail in the vicinity of the cylinder lever can be seen more clearly. Notice that the three rods attached to the cylinder lever have fairly nice representations of a brake rod jaw.

FREIGHT CAR UNDERBODY DETAIL



- E - The cylinder lever at right angles to the cylinder center line and the exposed length of push rod suggest that the hand brake is applied. Notice that the chain between the cylinder lever and rod to hand brake is taunt.
- F - Although the extra lever for the hand brake rod is fairly common, especially on cars of this vintage, research did not reveal the function of the spring-like device at F. I don't think its wrong; I just don't know what it is.

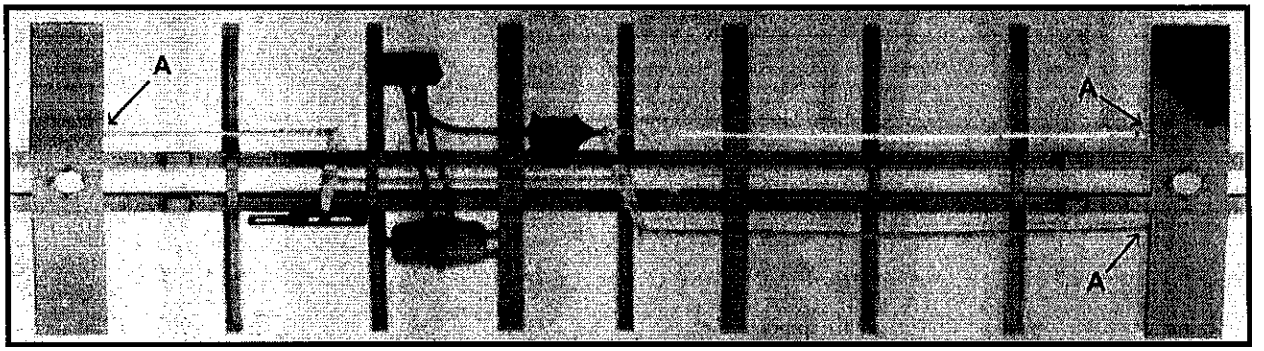
INTERMOUNTAIN TANK CAR



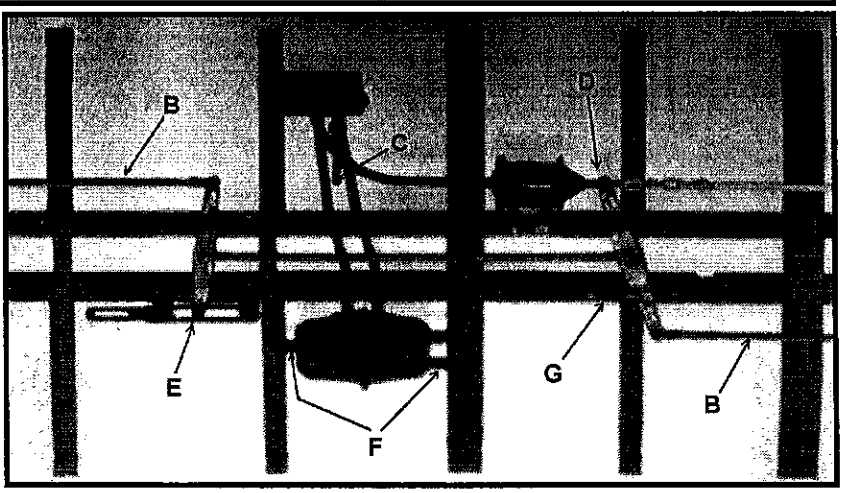
The foundation brake gear and air brake system appear to be essentially correct. Unfortunately the detail is all cast onto the underframe is such a way that there is very little relief. Intermountain's tank car is a model of the ACF type 27. When introduced these cars would have been equipped with K brakes. Type 27s built after about 1933 would have been equipped with AB brakes. Apparently this latter arrangement is what Intermountain is replicating. Since the bottom of the Intermountain underframe is incorrectly bereft of rivets, it would be easy to shave all the foundation brake gear off and start over with wire and styrene strips.

- A - The top rod to the B end is correctly parallel to the center sill
- B - The brake pipe passes over the top of the center sill on this model. Typical is to pass through the center sill. I can't tell from drawings in the Car Builders' Cyclopedias which is correct for this car.
- C - The lever carriers appear to be correctly located and long enough to allow free movement of all foundation brake gear elements. When viewed from the side, one should be able to see daylight between the bottom of the center sill and the inside of the lever carrier.
- D - Apparently this is also correct even though it may not be the best practice. The top rod to the "A" end angles across the center sill so that it attaches to the truck in the same manner as at the "B" end.
- E - Position of push rod and cylinder lever is correct for a brake in the released position. I like this.
- F - When installing AB brakes on Type 27 tank cars, ACF seems to have preferred the air brake cylinder with a bracket attached to the pressure head. Such a pressure head is seen frequently on steam locomotive tenders and passenger cars but less often on freight cars.
- G - I could find no evidence to support the placement of two cross ties to support the reservoir. The end of the reservoir nearest the car's center should be the "two-lug" end and should rest on a cross tie directly opposite the

one on the other side of the car. The cross tie arrangement should be the same as the cross ties near the cylinder lever. The "one-lug" end of the reservoir should be supported on a stub bracket extending out from the side of the center sill. This would move the reservoir closer to the car's "A" end.



KADEE PS1 40' BOX CAR



Best of the lot! Brake pipe (not shown above) passes through the center sill as is most typical. Since the parts for the foundation brake gear are applied separately it is possible to install them so that one can see a little daylight between the bottom of the center sill and the top of the foundation brake gear. Even the centrifugal dirt collector is represented on the branch pipe. The chain between the cylinder lever and hand brake rod is nicely done but that is also true on Branchline's 50' RBL and Life-Like's Mather stock car.

- A - The top rods and hand brake rod should be below the body bolster, not through the body bolster; easily changed by the modeler.
- B - Both top rods are parallel to the center sill as is most typical.
- C - The branch pipe is seldom modeled but always needed. Dirt collector is also represented.
- D - Brake is modeled in the released position as shown by angle of cylinder lever and very short length of exposed push rod.
- E - Nice representation of a mechanical slack adjuster. See Figure 31 on page 15. This slack adjuster is correct for this car's era if not for any particular car. Railroads specified many different appliances for each freight car order. Some PS1s were delivered with a fulcrum with several holes to allow adjustment instead of a mechanical slack adjuster. See Figure 25 on page 13. Other PS1s may have been delivered with slack adjusters from a different manufacturer and therefore have a different appearance.
- F - The lugs on an air reservoir shouldn't project that far. There should be evidence of a bracket on each side but especially the "two-lug" side. See Figures 19B and 19C and Photos 9 and 10 on page 10.
- G -Nice lever carriers although those made of either 1 inch round or 1 inch square rod are more typical.
-

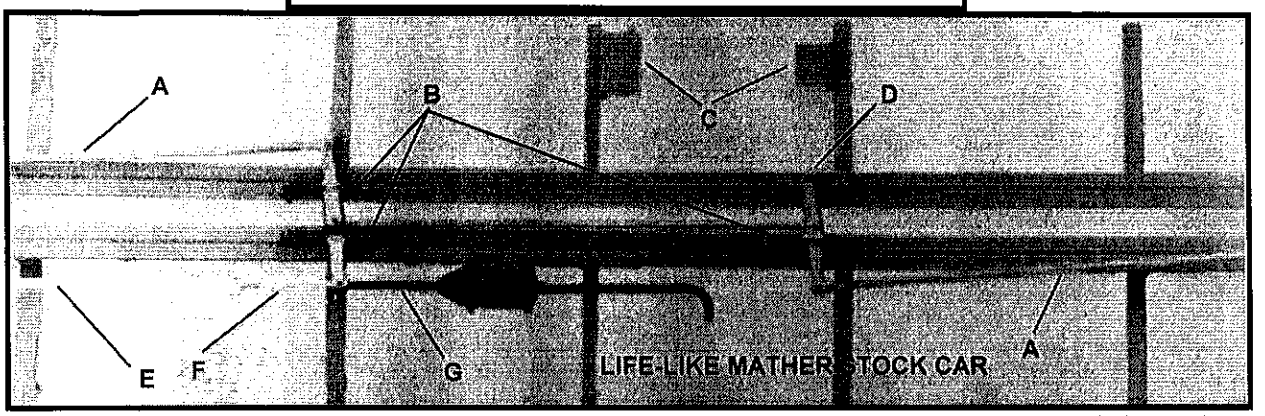
LIFE-LIKE MATHER STOCK CAR

A - Top rods should be parallel to center sill.

B - Nice lever guides or lever carriers. One can see daylight through them.

C - Reservoir is supported by brackets. Typical reservoir support brackets are formed of 1/2" thick steel plate, bent to shape and riveted to car. Round the outside corner of the bend and these look really nice.

FREIGHT CAR UNDERBODY DETAIL

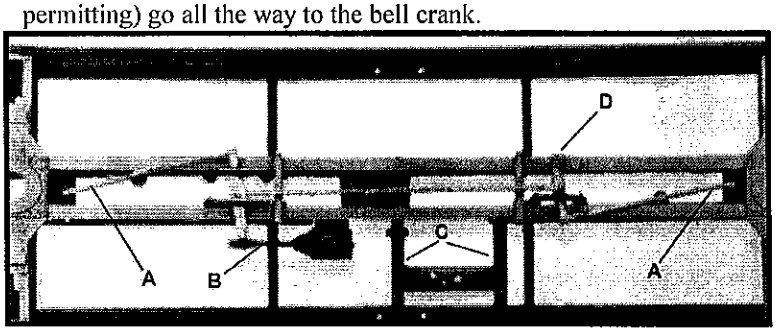


D - Fulcrum lacks member below lever. T should probably be provisions for slack adjustment here similar to that shown in Figure 29 on page 15.

E - Hand brake rod is correctly approximately parallel to center sill and ends on body bolster. If your minimum radius permits this rod should go straight through between body and truck bolsters and terminate at bell crank.

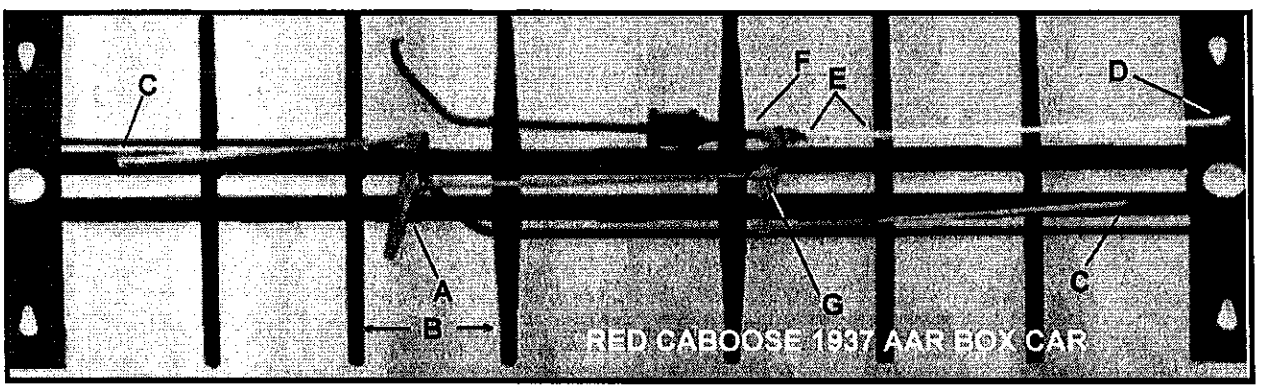
F - Nice chain detail when seen from below. Too flat for side view.

G - Push rod protrudes waaaaay too far. This is impossible. There is not sufficient space inside cylinder for a push rod that long. Either the cylinder should be moved toward the "B" end or, more likely, the cylinder lever and lever guides should be moved 18 scale inches closer to the cylinder. Cylinder lever angle indicates these brakes are applied. Moving the cylinder lever would require new top and hand brake rods made of wire but that gives an opportunity to have these parts parallel to the center sill and all the hand brake rod (your minimum radius permitting) go all the way to the bell crank.



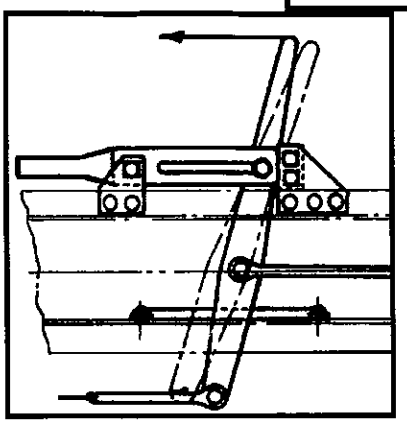
LIFE-LIKE TANK CAR

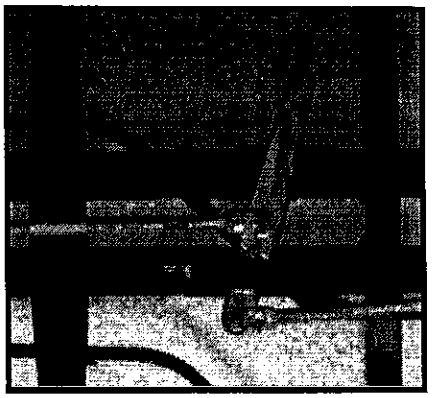
- A - It is not possible that terminating the top rods in the center of the body bolster is correct. They need to be parallel to the center sill.
- B - Push rod is a little too long even if the brakes are set.
- C - Life-Like's ACF type 21 tank cars represent prototypes first built before the introduction of AB brakes and would have originally had K, probably KC brakes, installed where the air brake cylinder is on this model. The brackets for support of the AB control valve on top and reservoir below are an entirely plausible addition to allow conversion to AB brakes. It is possible that ACF type 21 tank cars could have been converted differently by different owners. If you have good photos, work from those.
- D - This fulcrum has the same problem mention frequently above; no support below the lever.



RED CABOOSE 1937 AAR BOX CAR

FREIGHT CAR UNDERBODY DETAIL



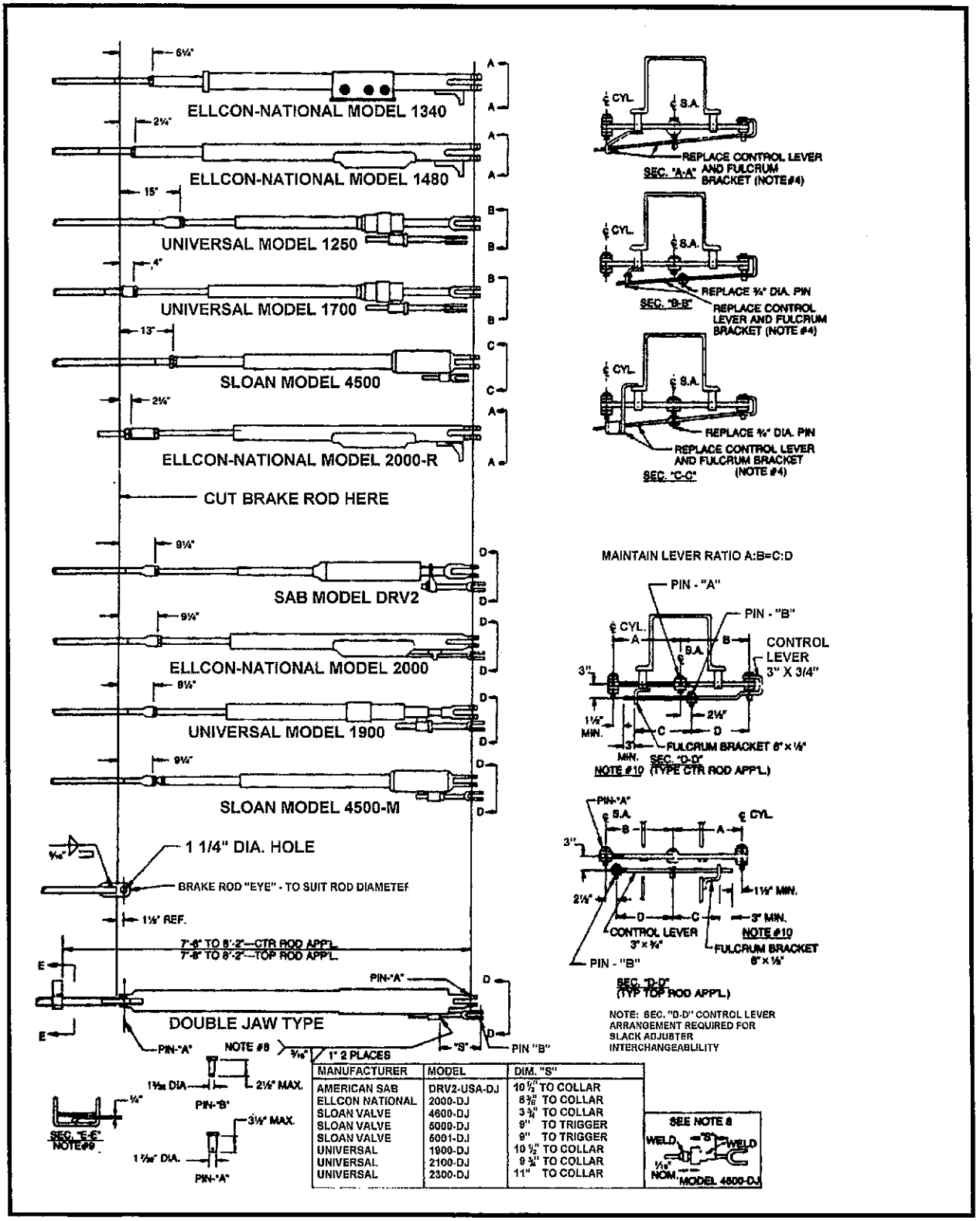


- A - Fulcrum completely missing. See details in Appendix C. Intermountain's R-40-23 reefer and 60' PS-1 box car have all the same faults as this Red Caboose car. The foundation brake gear is essentially identical on all three models. Compare the drawing at left with the enlarged photo of the fulcrumed lever at right. Remember, the drawing's perspective is looking down from the top as if the car's floor is transparent; the photo up from the bottom as if the car is turned upside down. Notice that nice brake rod jaws are modeled here.
- B - The AB control valve and reservoir are installed in this space; the control valve on same side as cylinder and the reservoir opposite. That is usually the correct location for these two components but then the "S" curve of the brake pipe where it passes through the center sill is in the wrong place. See Appendix C for more information. When assembling this model notice that the notches in the top of the center sill to accommodate the brake pipe are in the wrong place. Make two notches above the cylinder lever so the brake pipe can be installed in a reversed position. The branch pipe, missing on this model, needs to be attached to a straight section of pipe, not a curved.
- C - Top rods should be longer and more parallel to center sill.
- D - If the top rods ended on the body bolster like this hand brake rod, the model would be more accurate.
- E - Length of 9/16" chain needed here.
- F - Brake modeled in applied position. Push rod may be extended a little beyond what is physically possible.
- G - A cylinder lever at this angle when brakes are applied indicates an extreme amount of excessive slack somewhere in the foundation brake gear or truck brake rigging or both. Maybe all the brake shoes are missing.

FREIGHT CAR UNDERBODY DETAIL APPENDICES

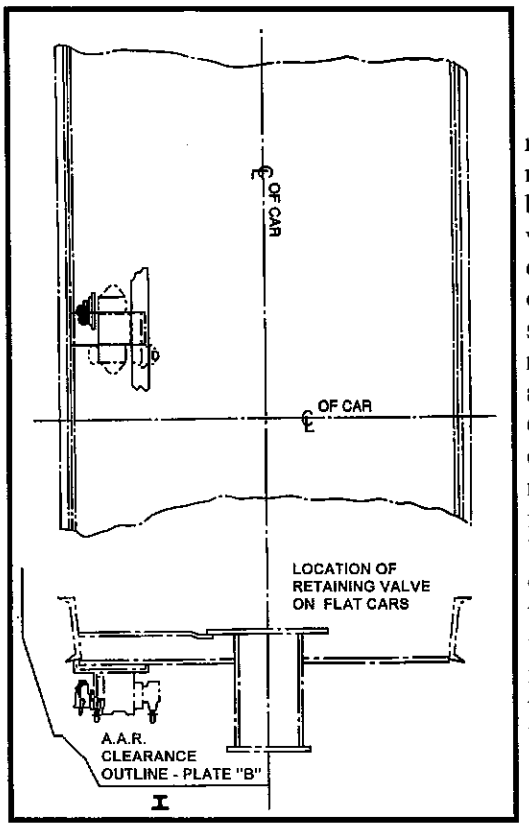
APPENDIX A

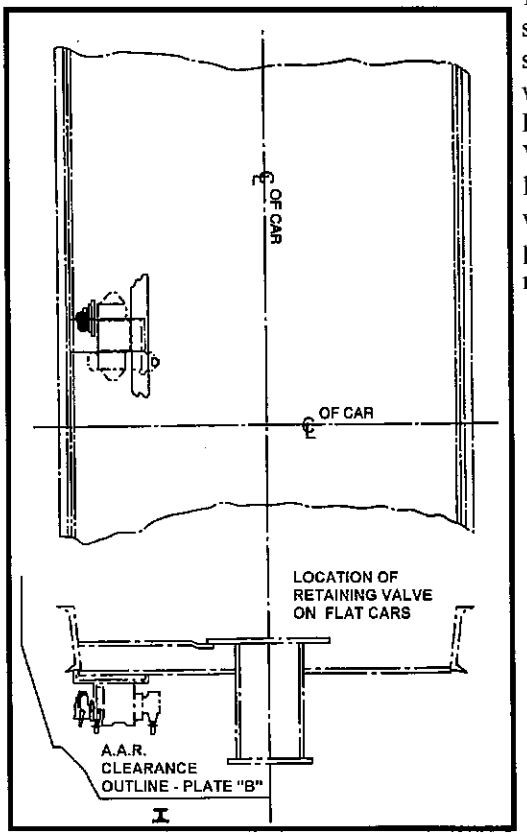
SLACK ADJUSTERS OF TYPE APPLIED IN THE 1970s, 1980s AND 1990s.



MANUFACTURER	MODEL	DIM. "S"
AMERICAN SAB	DRV2-USA-DJ	10 ½" TO COLLAR
ELLCON NATIONAL	2000-DJ	8 ⅜" TO COLLAR
SLOAN VALVE	4600-DJ	3 ¾" TO COLLAR
SLOAN VALVE	5000-DJ	9" TO TRIGGER
SLOAN VALVE	5001-DJ	9" TO TRIGGER
UNIVERSAL	1900-DJ	10 ½" TO COLLAR
UNIVERSAL	2100-DJ	9 ¾" TO COLLAR
UNIVERSAL	2300-DJ	11" TO COLLAR

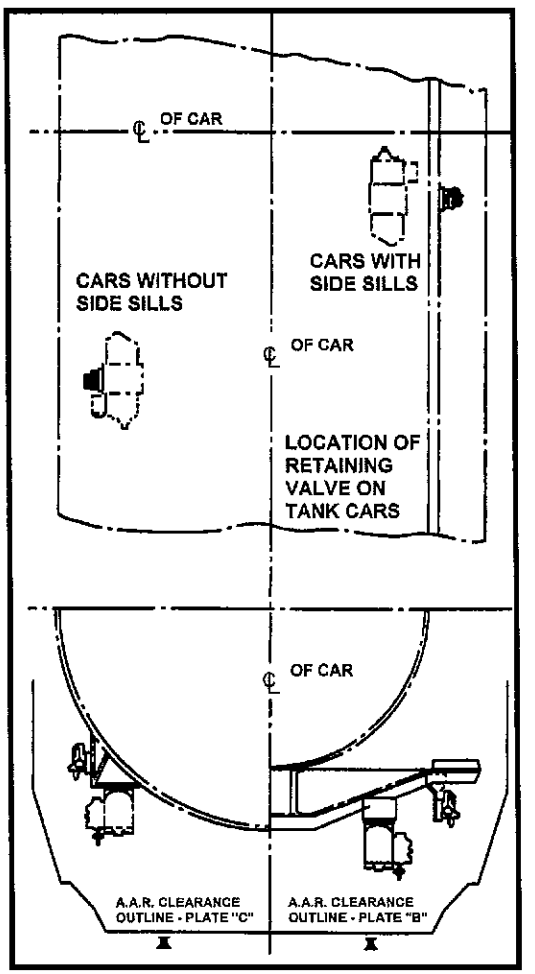
APPENDIX B

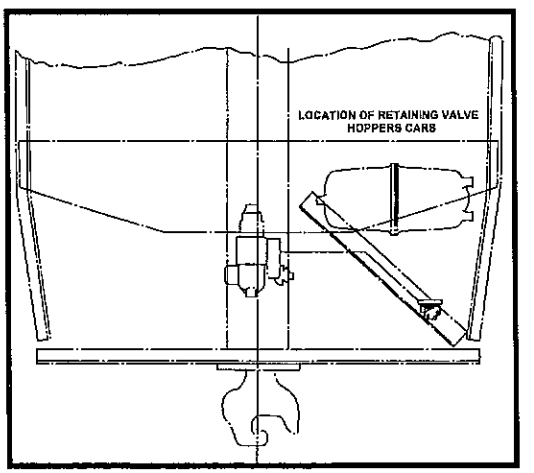




MODERN RETAINING VALVE LOCATIONS

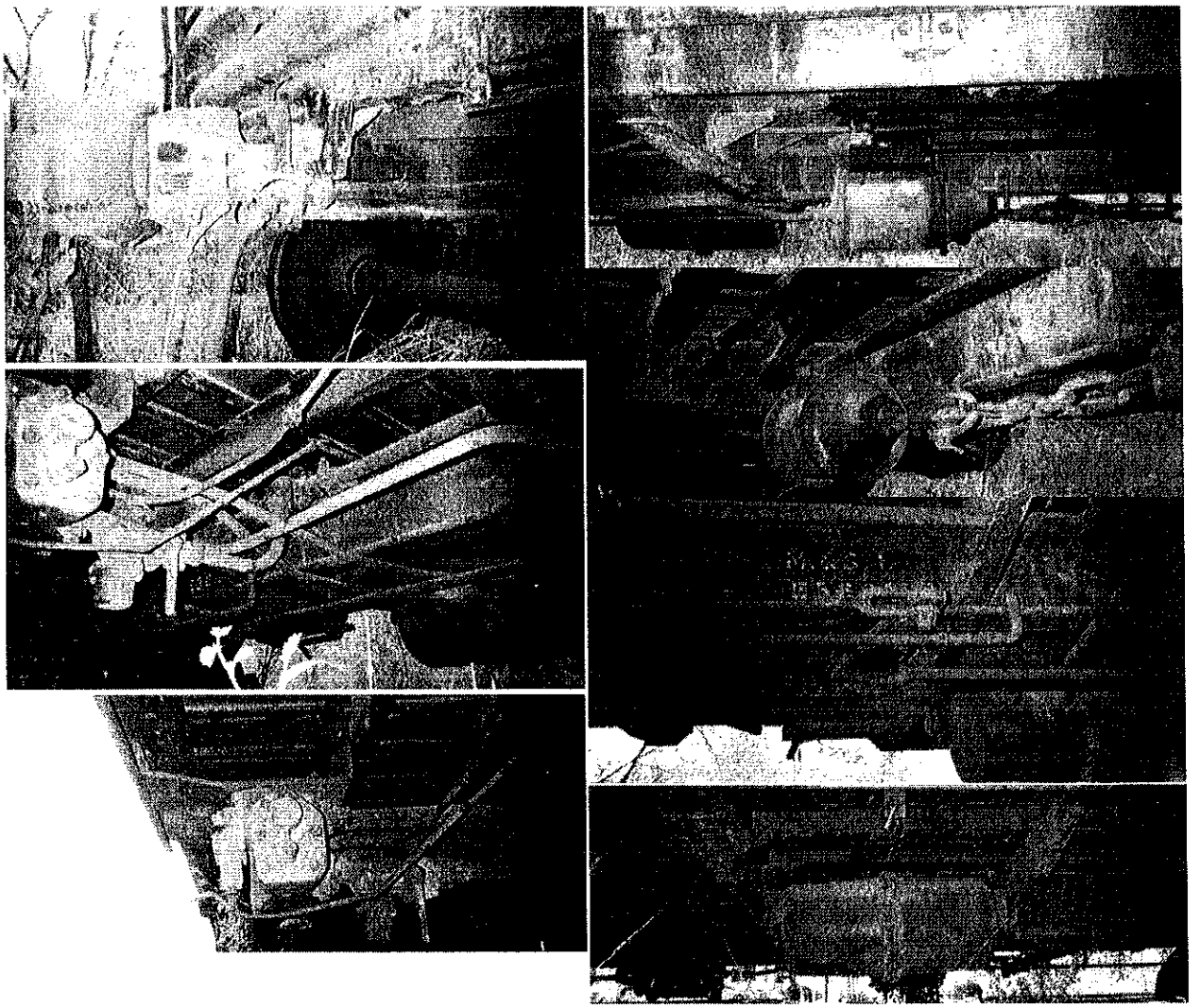
These four diagrams show the most common location for retaining valves on freight cars built after about 1965. The retaining valve should be close to and on the same side as the air brake control valve. The centerline of the operating handle should be a minimum of 12" and a maximum of 60" above the top of the rail and no more than 12' in from the side sill. Where the location of the retaining valve is such that it is not readily seen from the side of the car, such as beneath the low side sill on box or gondola cars, the location should be shown by stenciling the words RETAINING VALVE in 2" letters on side sill with arrow pointing to the retaining valve.

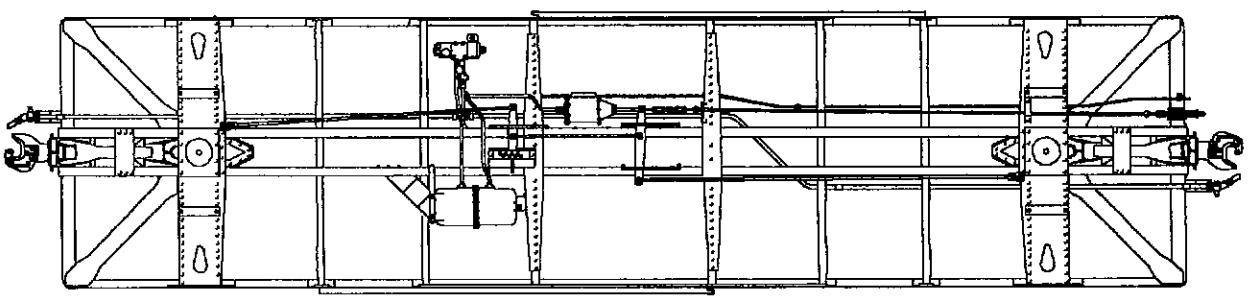




APPENDIX C
1937 AAR Box Car

The photos and drawing below show the underbody detail on a 1937 AAR box car. The photos show one built in November 1944 while the drawing shows one built in October 1941. The principle difference, as the design evolved, is how the reservoir is attached.

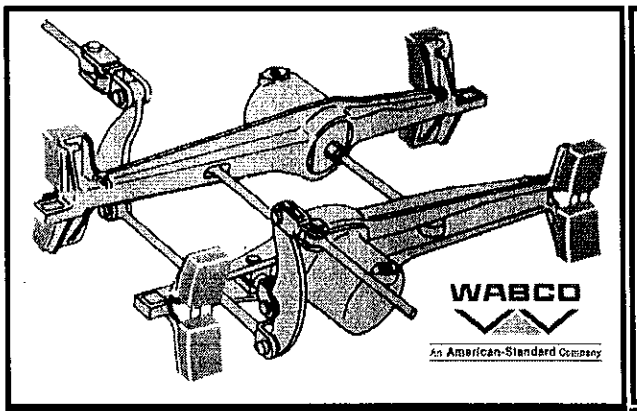


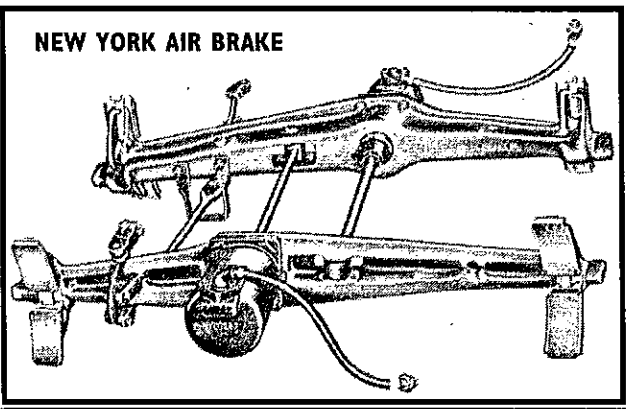


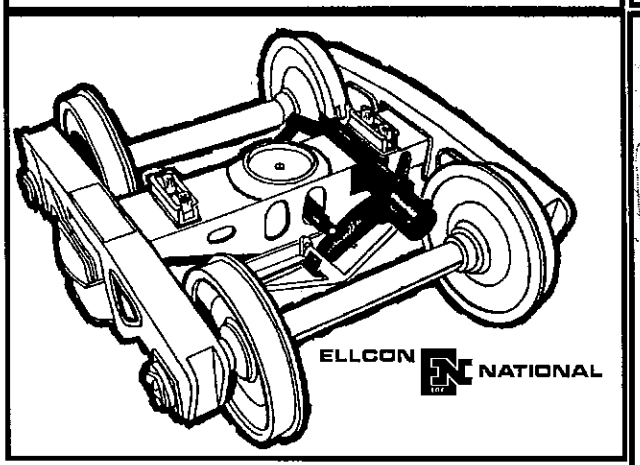
APPENDIX D

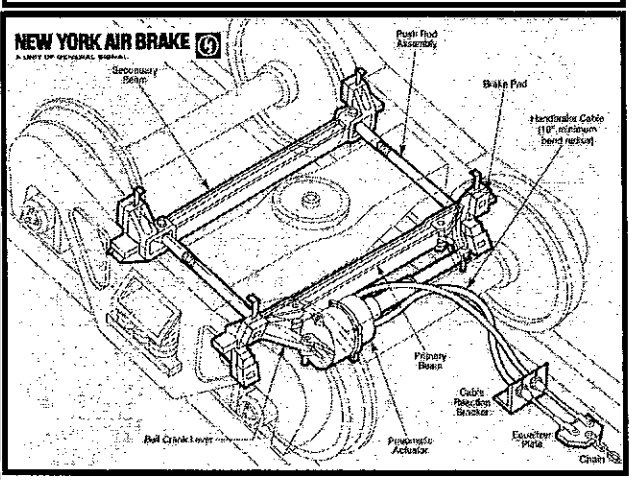
EXAMPLES OF TRUCK MOUNTED BRAKES

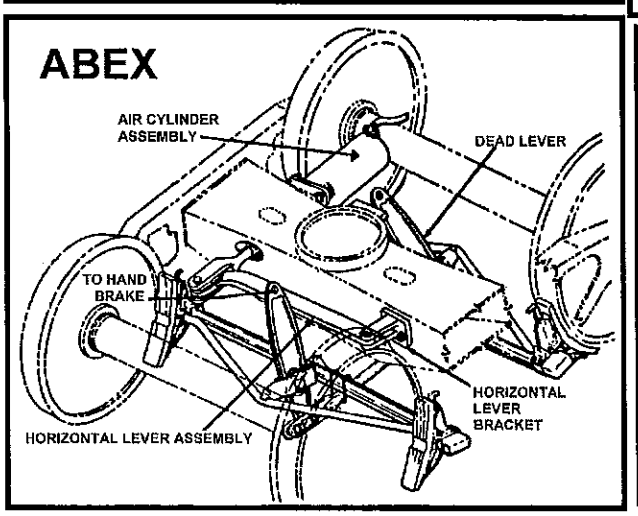
Below are a few examples of truck mounted brakes introduced by various manufacturers since the late 1960s. Westinghouse and New York Air Brake continue to supply truck mounted brakes which are the most commonly seen; the similar Wabcopac/Nycopac and Wabcopac II/Nycopac IIA. Compare the top two illustrations. In 2002 the following truck mounted brakes were still permitted in interchange; Abex, Ellcon-National, Thrall/Davis, Wabcopac/Nycopac and Wabcopac II/Nycopac IIA, Wabco TMX, TTX-TMB (Misner), TTOX, and NYAB TMB-60 although some of the manufacturers were no longer in business. Notice that the Ellcon-National, Abex and TTX make use of standard brake beams.

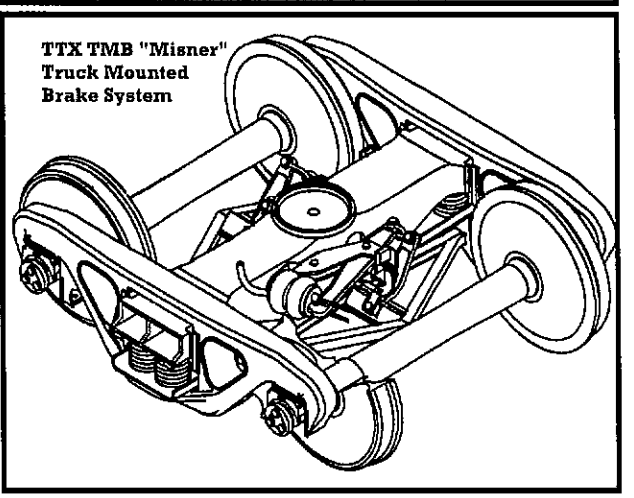










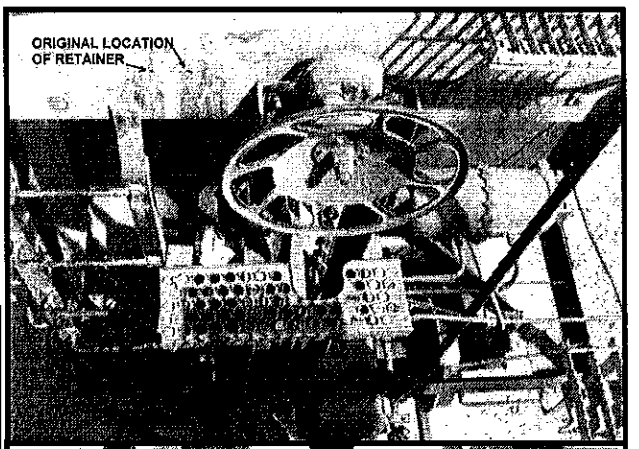


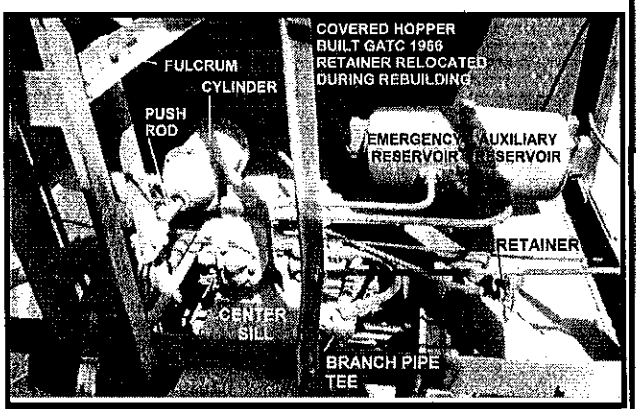
APPENDIX E

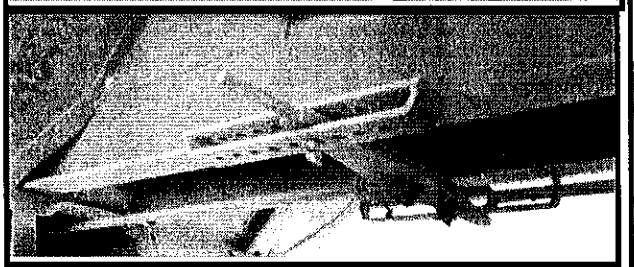
HOPPER CARS

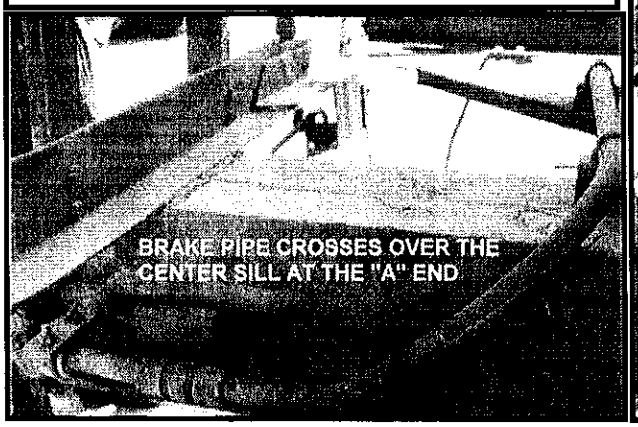
While hopper cars, both covered and open, present some special considerations and exceptions to the bulk of the material presented here, in most respects the requirements for other cars also apply to hopper cars. Beginning with the air brake system we find that the angle cocks must be located using the same criteria as for other cars. All air brake pipes are the same size as presented on page 6. The same elements - control valve, reservoir, cylinder, branch pipe tee, retaining valve and so on - are found on hopper cars and they are connected together in the same relationship to one another. The obvious exceptions are that the reservoir, cylinder and control valve are typically located under the slope sheet on the "B" end of the car.

The series of photos below show the air brake parts on a PS-2 covered hopper built in the mid-1950s. The retainer has been relocated during rebuilding to conform to post-1965 requirements. See page 10 figure 20B for the original location. The pipe from control valve to retainer often ran unsupported, diagonally from control valve to the space between the ladder and hand brake. This pipe was typically a very visible feature.



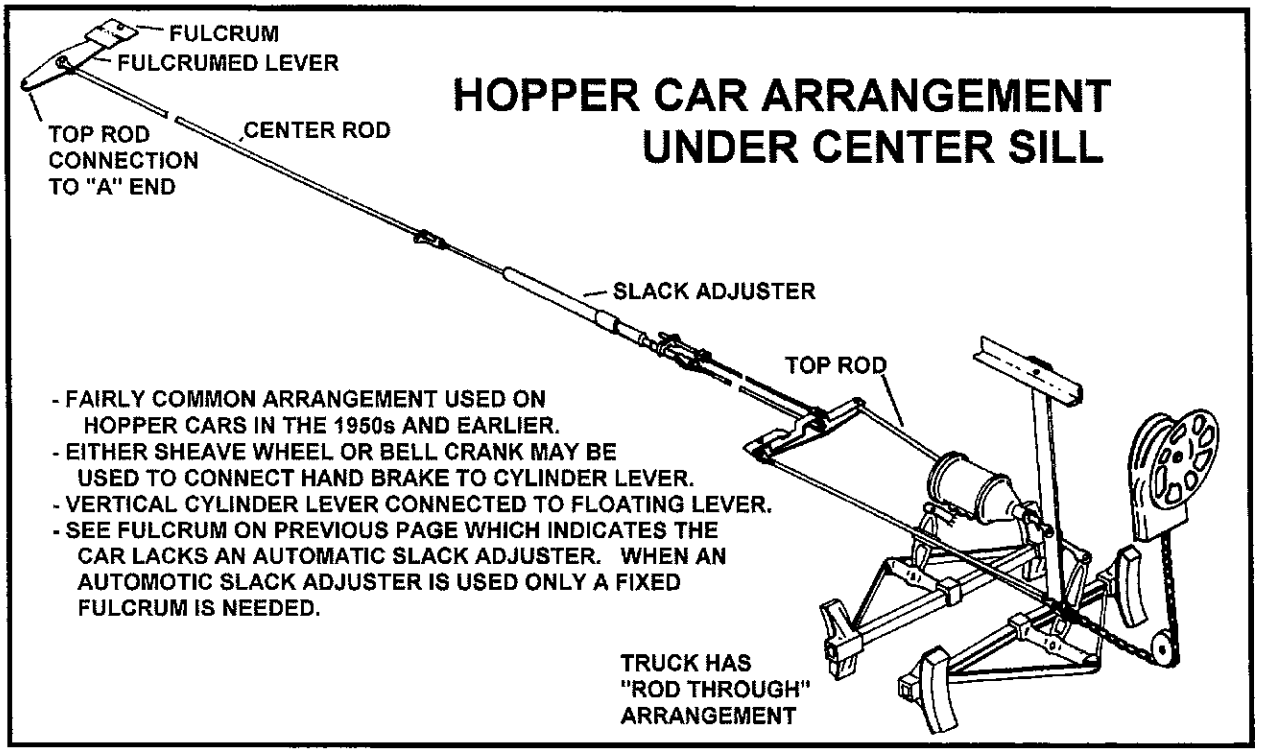


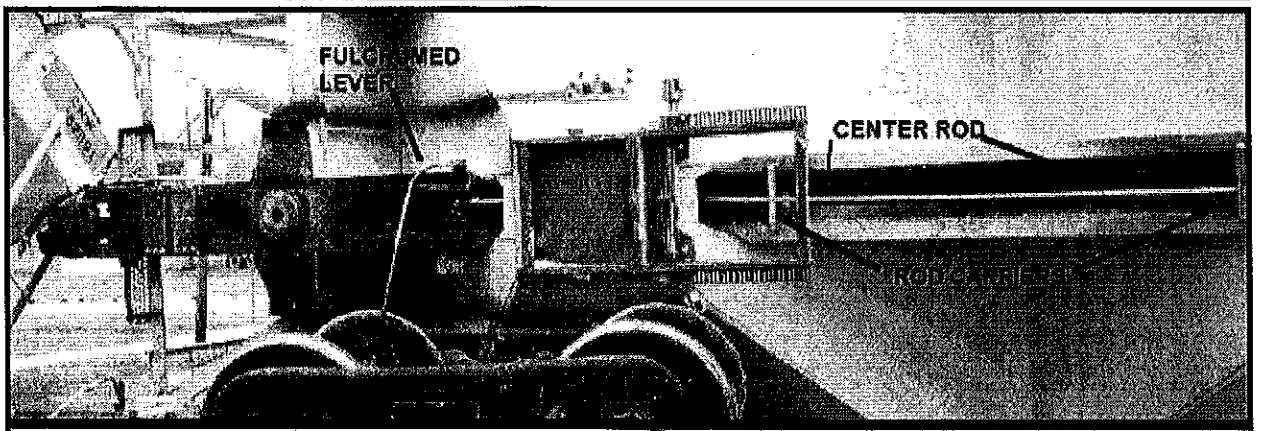


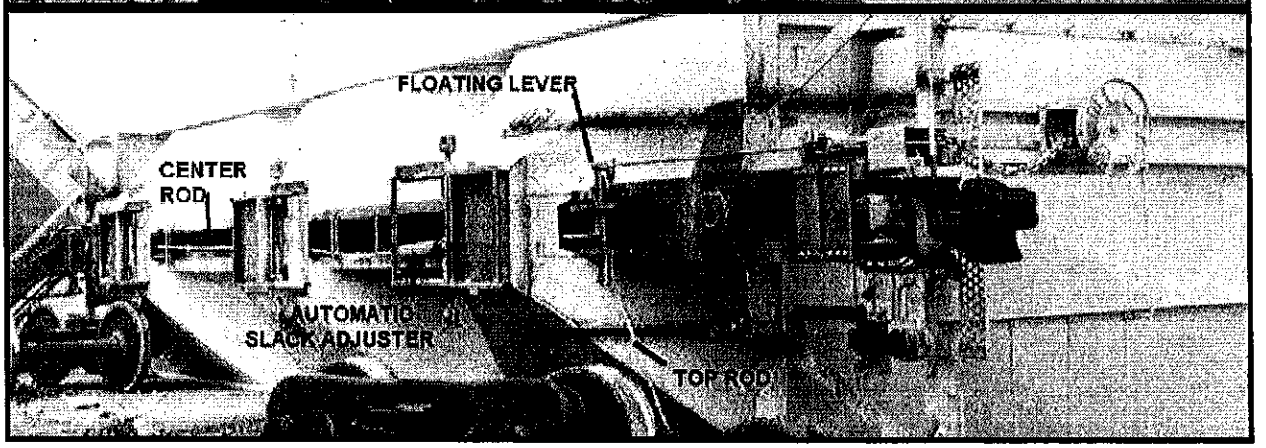


FREIGHT CAR UNDERBODY DETAIL APPENDICES

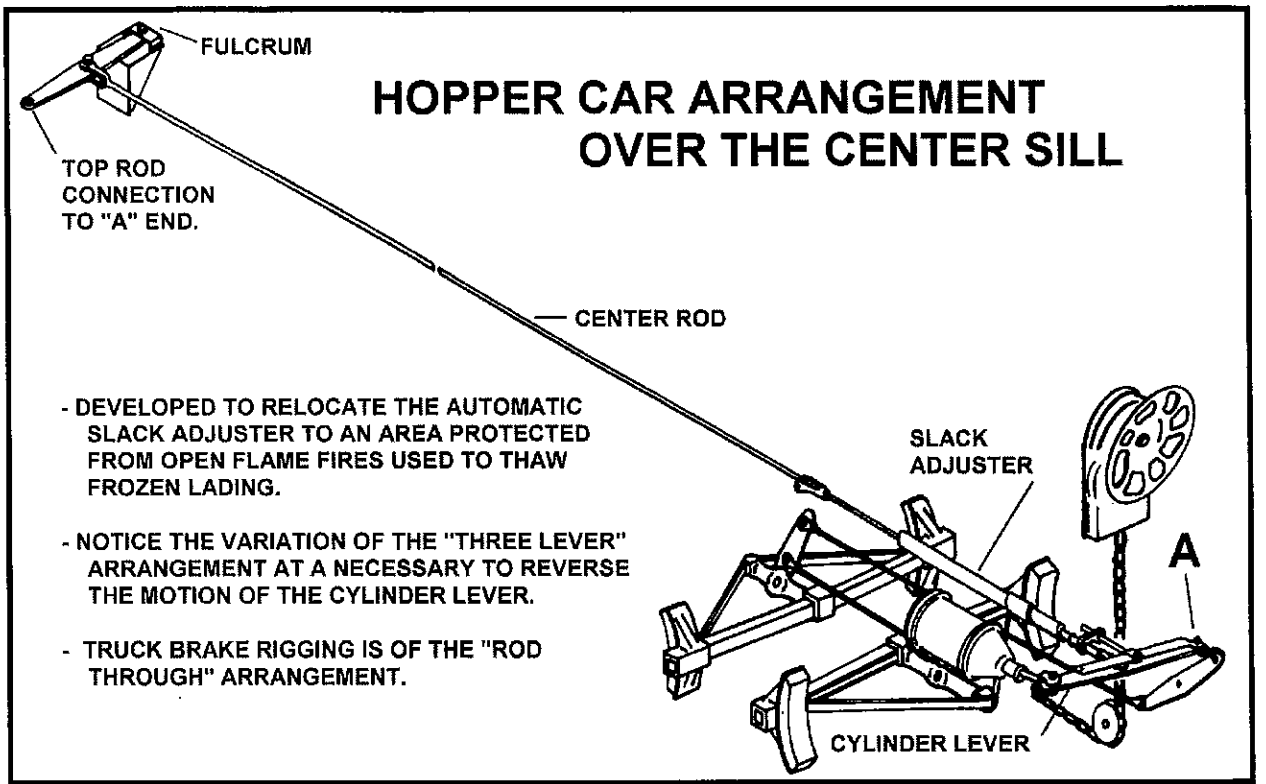
The foundation brake gear is usually relocated somewhat to avoid interference with the hoppers. The diagrams below show the two most typical arrangements. Compare this diagram with the photo of the cylinder lever on the preceding page. Notice that the lever fulcrum is supported by an angle iron. The lever guides, not shown here, are a pair of angle irons. All three angle irons are typically 4"x 4"x 3/8".

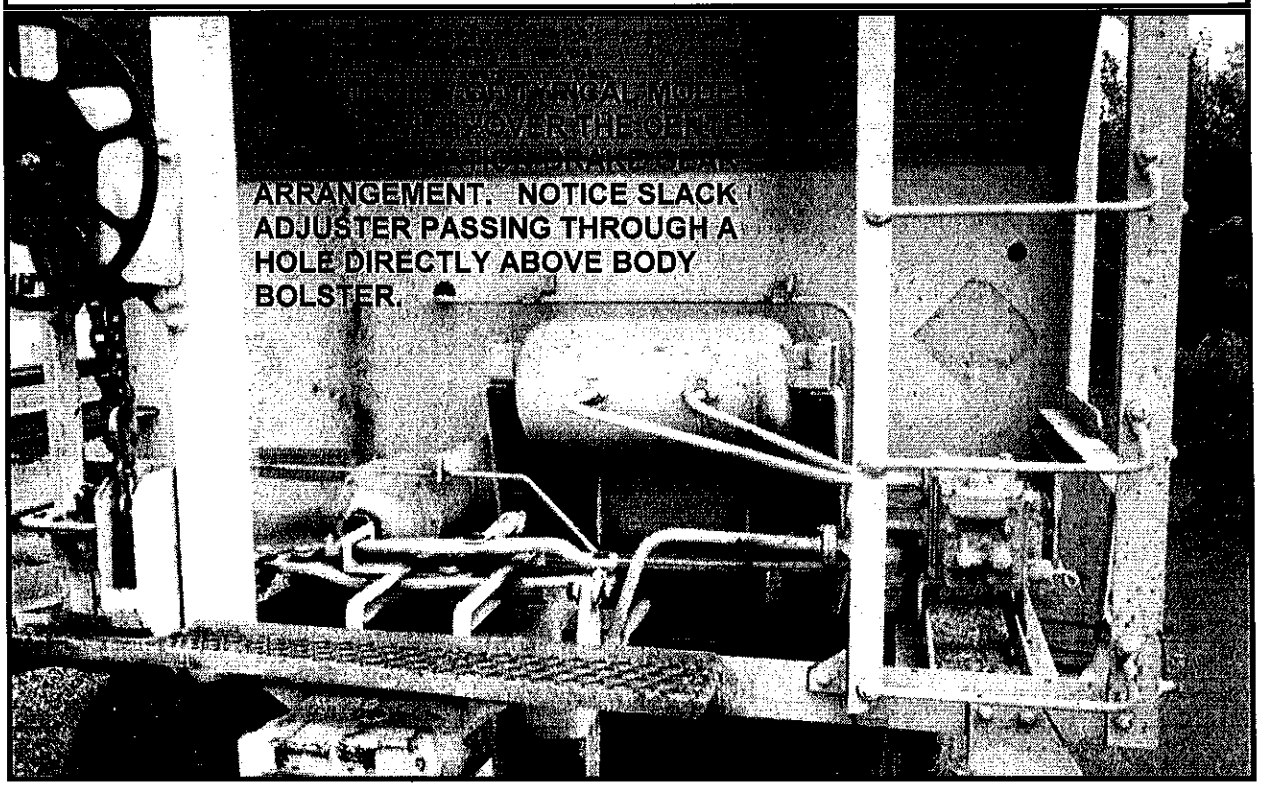






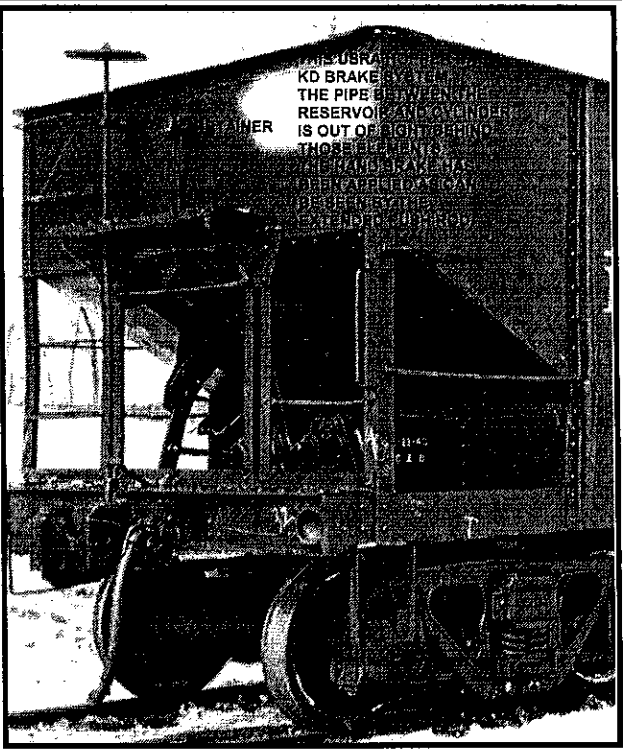
The drawing and photo below show more recent developments in the design of hopper car foundation brake gear. The air brake system in the photo is arranged differently and a welded reservoir is used. There have been provisions for welded reservoirs since before 1920 but their use has been rare until about 1980. On the following page are pictures of a few more hopper cars from different eras.

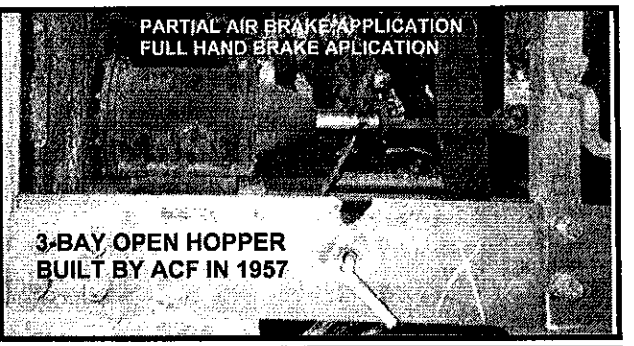


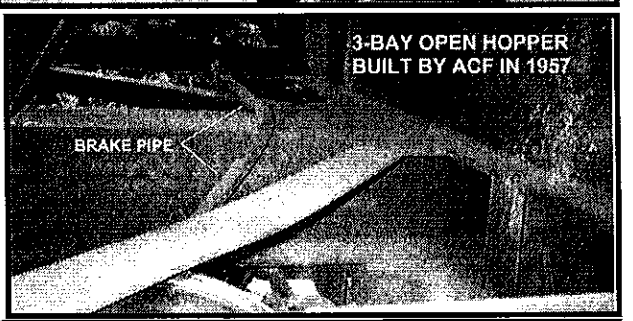


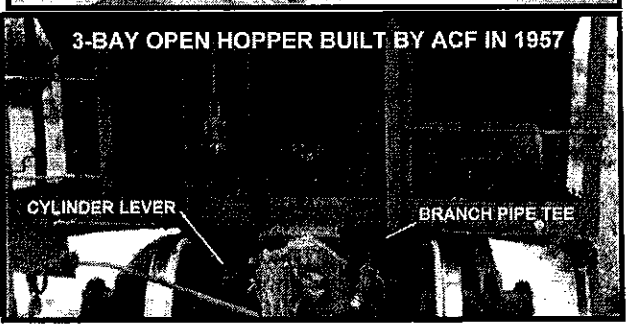
FREIGHT CAR UNDERBODY DETAIL APPENDICES

THIS PHOTO SHOWS THE "B" ENDS OF TWO PS-2 COVERED HOPPER CARS BUILT IN 1955. THE RETAINER PIPE, VISIBLY SILOUETTED HERE, ANGLES UPWARD FROM THE RIGHT SIDE OF THE CONTROL VALVE ON THE CENTER SILL TO A POSITION BETWEEN THE END LADDER AND HAND BRAKE.





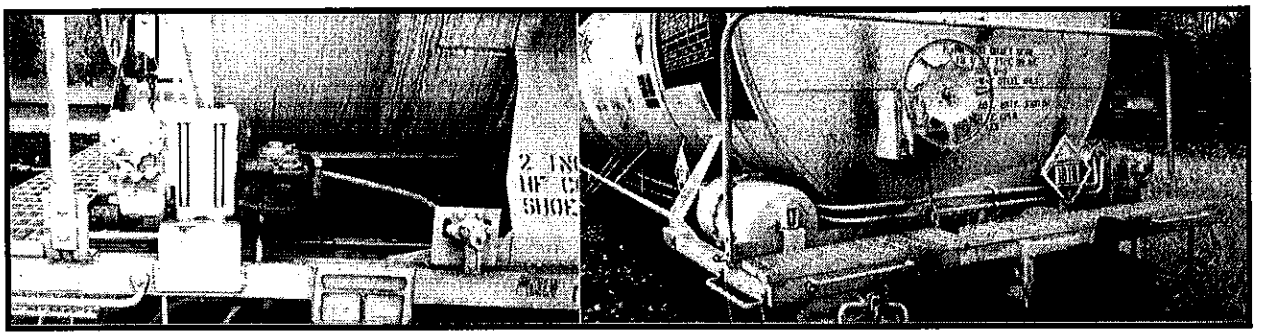


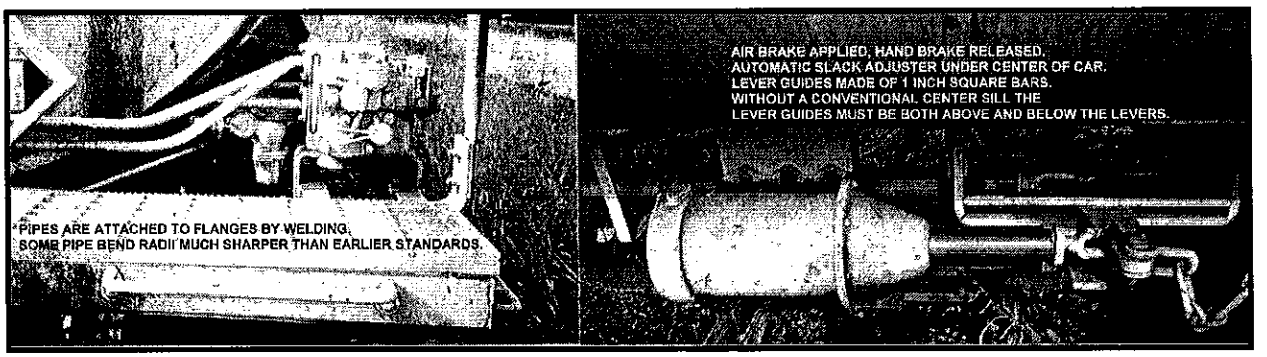


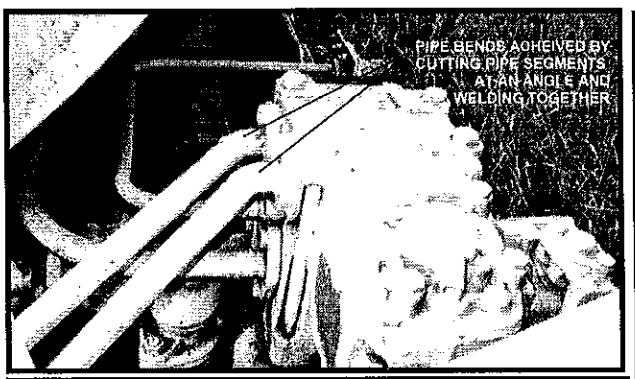
APPENDIX F

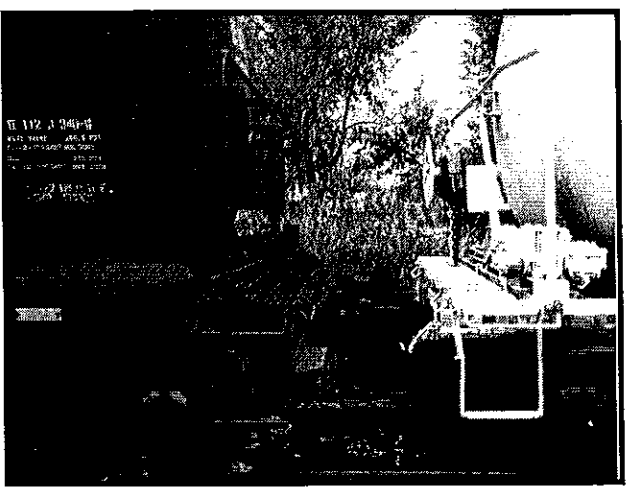
MODERN TANK CARS

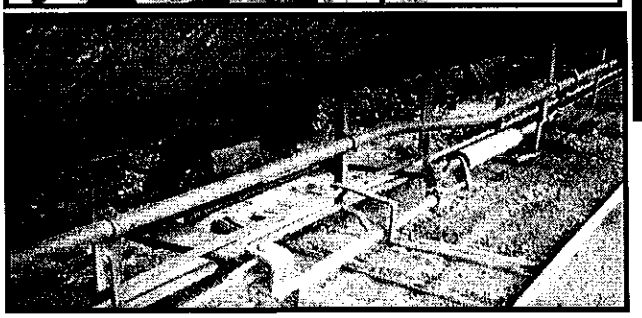
Finally, a look at modern tank cars. Into the 1950s tank cars had air brake system and foundation brake gear layout much the same as box cars of the same era. With the advent of widespread use of tank cars with no underframe it was expedient to move the air brake system components to the end of the car. Where truck mounted brakes are used there is no air brake cylinder or foundation brake gear, otherwise the cylinder is mounted to the bottom of the tank and the foundation brake gear is quite visible. The top four pictures are all of the same tank car.











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