THE WORK OF THE RAILWAY CARMAN

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By

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Member of Burnside Lodge No. 838

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PREFACE.

Much has been said and written of the construction and repair of railway equipment and its importance to the transportation requirements of the country. Almost nothing has been said or written of the skill and knowledge of the men who build and repair this equipment. This is especially true of the men who build and repair railway cars.

This book has been written, first, to help the carman to realize more fully the importance and dignity of his work, to give him a truer index of his place in the railroad industry and a just pride in his contribution to the life of the country.

Second: To give to the prospective apprentice a simple guide to the work of the carman to assist him in choosing the branch of mechanics for which he may have special aptitude.

Third: To give the apprentice carman a clearer and fuller conception of the exceptional opportunities and broad field the car department offers for the acquisition of mechanical skill and general knowledge.

Fourth: To bring to the minds of the public a true picture of the work of the railway carman. Further, to stimulate the interest of the public in a subject that directly concerns them, namely, the proper maintenance of the railway car. This subject does concern them because the railway car is the vehicle that brings the necessities of life within easy reach. It is still the most important vehicle of passenger travel.

For these reasons the Brotherhood Railway Carmen of America offers this book to the members of the craft and to the public. For assistance in the writing of this book for the Brotherhood, I wish to express my appreciation and thanks to many members on many different railroad systems. Their number is so great that it would be impossible to name them all. I am especially indebted to Brothers S. L. Watts and John Johnson, Chairman and Secretary of the General Executive Board; W. B. Hicks, Chairman Joint Protective Board, St. Louis So. Western Ry.; Maurice O'Connor, Chairman Joint Protective Board, Chicago and Northwestern R. R.; J. Bernatowicz, Grand Lodge Deputy; John T. Pewters, Chairman Joint Protective Board, Great Northern R. R.; A. O. Vetter, Chairman Joint Protective Board N. C. and St. L. R. R.; J. F. McCreery, General Vice President; H. Van Der Weyden of Lodge No. 1323; Harry Siegle of Lodge No. 838; Louis Mastriani, Chairman Joint Protective Board Erie R. R.; and also to Richard B. Gregg and Leland Olds of the Railway Employes Department A. F. of L.

General President Martin F. Ryan of the Brotherhood first conceived the idea of putting this study in its present form and has made its publication possible.

Some of the illustrations herein are reproduced from the Car Builder's Dictionary and Cyclopedia and from pamphlets of the Westinghouse Air Brake Co. and the New York Airbrake Co. The others were supplied by members of the Brotherhood.

EDMOND K. HOGAN.

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Part I.

WORK ON FREIGHT TRAIN CARS.

SECTION A.

GENERAL SURVEY OF THE WORK.

Few people outside of railway circles are aware that there are a quarter of a million men engaged in the building and repairing of railway cars. Fewer still are aware of the wide variety of work involved in the maintenance of this equipment and the skill, knowledge and qualifications necessary to perform it.

The railway car is a more complex type of structure than is a house. This is because it must serve a greater number of purposes under a greater variety of conditions than does a house. The house is built only for upright, immovable stability, but the railway car is built for movement while carrying heavy loads of many different characters and weight. It must withstand the stresses, strains and shocks it receives when switched around and when stopped and started in long heavy trains. This rigorous service makes the use of bolts, iron rods and other metal reinforcements necessary in car construction in addition to the common methods of joinery used in house building.

The car runs on flanged wheels and is held on the rails when running by the lateral pressure of the wheel flanges against the rails. The truck is a structure designed to hold the wheels in position under the car, to equally distribute the car weight to the wheels and to provide springs between the body of the car and the wheels to lessen the shock when the car is in motion. Every car has two trucks.

The weight of the car rests directly upon a center beam on the truck, called the truck bolster. Upon the truck bolster, at its center, is a circular plate called the truck center plate. There is a corresponding plate on the body of the car which fits into the truck center plate and together they act as a swivel which allows independent movement of the truck when the car is going around curves. The top center plates are fixed to heavy transverse beams, one near each end of the car. These beams are called body bolsters, and form the foundation of the car body.

The superstructure of the car is built upon heavy longitudinal timbers which rest upon the two body bolsters. The ends of these longitudinal timbers or sills are tenoned into two transverse end sills. The posts of the car are fitted into the side and end sills. The tops of the posts are fitted to the side and end plates which are at the top of the car in the same relative position as are the side and end sills at its bottom. Lighter

transverse and longitudinal timbers called carlines and purlines respectively, are joined to these plates and form the framework of the roof.

The superstructure of the car as described is similar to house structure except that it is joined differently. On a house the longitudinal sills are laid or gained on to the end sills but the sills of the car are joined together by tenons and mortises which make a stronger joint and save space. Unlike a house, the sills of the car cannot be supported by posts. The distance between the body bolsters on which they rest is so great that under load the sills would sag were they not supported by transverse timbers, one to each side of the car center. These timbers are in turn supported by heavy tightly drawn rods extending the length of the car. These rods rest upon the body bolsters and are fastened to the end sills.

The stresses and strains due to the movement of the car and the shifting of the loads carried would soon burst out the walls of the car were they not held together more securely than the walls of a house. Practically every joint in the frame of the car superstructure is reinforced by iron rods.

The great shocks to which the railway car is subjected are dissipated through the mechanism by which the car is drawn but on many cars, especially in passenger service, buffer apparatus assists.

These are the general characteristics of the railway car. In the pages that follow many differences in the structure of cars are described. No other vehicle is constructed to fill as great a number of requirements. The majority of the 2,600,000 cars in the United States are in freight service, and the work necessary to their maintenance is performed by the Carman.

The carman repairs and maintains—and when required—constructs the cars and equipment that are carried in freight trains. He also repairs and maintains in good condition all of the work equipment used by the railroads in the maintenance of the right-of-way and the construction of bridges, etc. Most of his work is concerned with cars that carry freight. These are divided into three general classes: house cars, gondola cars and flat cars. In the house car division are all box cars, grain cars, stock cars, refrigerator and fruit cars. The gondola cars include sand cars, cinder cars, ballast cars and various types of hopper cars. Some of these have doors that allow the escapement of the cargo through the floor of the car, while others have doors that open to the side and allow the cargo to escape or be ejected through the side. These cars are made in three general types: wooden, composite, (part wood and part steel), and all-steel cars.

Variety of Repairs.

The varieties of repairs to any one class of car are such that no two cars are repaired exactly alike unless they are completely re-built. Therefore it may be seen that the carman must have the ingenuity to cope with a different set of problems regarding his work on each car that he has to repair.

The variety of repairs is not more than the variety of cars upon which he works. Some of these cars are listed, and their peculiarities explained below:

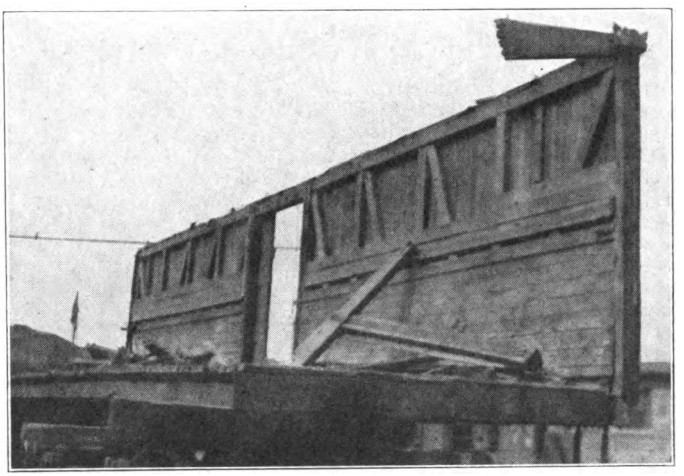


Fig. 1. Box Car as Received for Repairs.

VARIETIES OF WOOD FREIGHT CARS.

Box,
Express refrigerator,
Refrigerator,
Wood,
Coal,
Coke,
Poultry,
Stock,
Drop bottom gondolas,
National dump,
Hart convertible,
Caboose,
Cinder,
Flat,
Sand,
Circus,
Bunk,
Supply,
Tank,
Pickle,
Fruit,
Automobile,
Furniture,
Horse.

WORK EQUIPMENT.

Snow plows,
Wedge plows,
Sweepers,
Steam shovels,
Derrick cars,
Weed burners,

Sand plows,
Ballast spreaders,
Pile drivers,
Test-weight cars,
Ledgerwood cars.

ALL STEEL CARS.

Tank,
Solid bottom gondola,
Drop bottom gondola,
Hopper bottom,
70-ton, high-side hopper,
Box,
Automobile,
Furniture.

COMPOSITE CARS.

Steel under frame box,
Steel under frame coal,
Steel under frame hopper,
Steel under frame Hart convertible,
Steel under frame sand,
Steel under frame national dump,
Steel under frame flat,
Steel under frame cinder,
Steel under frame poultry,
Steel under frame stock,
Steel under frame horse,
Steel under frame fruit,
Steel under frame automobile,
Steel under frame furniture,
Steel under frame caboose,
Steel frame box,
Steel frame coal,
Steel frame stock,
Steel frame horse,
Steel frame fruit,
Steel frame automobile,
Steel frame furniture,
Steel frame sand.

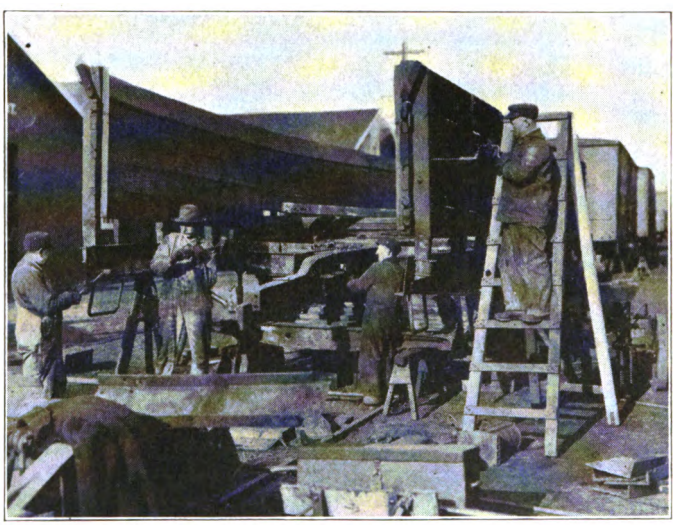


Fig. 2. Repairing a Steel Underframe Gondola Car.

PECULIAR WORK INVOLVED IN REPAIRING VARIOUS TYPES OF CARS.

Each of the different varieties of cars has its own peculiar feature. Freight carmen have to know the peculiar features of each car, the shapes and sizes of the different parts and how they should be put together and taken apart, both in regard to the matter of structural requirements and safety for himself and the men working with him. All of this, it can be easily seen, requires a great deal of knowledge and skill.

REFRIGERATOR CARS.

These cars differ from an ordinary box car in several ways. One of the most important is in the fact that the refrigerator car has many layers of flooring and walls made up of wood, paper and insulation. Between some of these layers there is also left an air space. This, of course, is to prevent conduction of heat and keep the contents of the car cool. The sides of the car are built in layers as follows: sheathing, paper, felt, paper, 3-8 inch sub-lining, posts and braces. Inside: sub-lining, paper, felt, paper, lining strips, paper, lining; making in all a five or six inch wall.

The floor is about nine inches thick. In the case of the floor, however, most of the insulation goes between the sills. This involves cutting the felt, paper and other kinds of insulation into seven sections in shapes and sizes that will fit between the different sills. There are four (4) different widths of insulation strips that have to be cut this way.

In the roof of the car, the layers from the inside of the car up, are as follows: ceiling, paper, strips, 3-8 inch wood insulation, paper, felt, paper, 3-8 inch wood insulation, paper. Outside: carlines, purlines, ridge pole, board roof, tar, plastic paper, metal or board top roof, making a thickness in all of about nine inches at the center and tapering down to about five inches at the sides. Special care must be taken to see that all of the car insulation fits tightly and accurately, otherwise there would be a leakage of cold air, loss of ice and spoiling of cargo.

There are additional differences between the ordinary box car and refrigerator car—one of these comes in the roof construction. In the roof are built hatch boxes, which are over the opening of the ice boxes, at the end of the car. These are for the convenience of putting the ice into the ice box. These openings are covered with a heavily insulated hatch plug, and a hatch-cover which has fixtures attached that make it possible to open it at the angle desired for ventilation.

Ice Box.

The carman is required to build the ice box at both ends of these cars. In some of these cars the ice box mechanism is quite

complicated, as the entire front of the ice box can be raised and fastened into position against the ceiling of the car, thus making the bunker, where the ice is kept, available space for storing cargo when ice is not used.

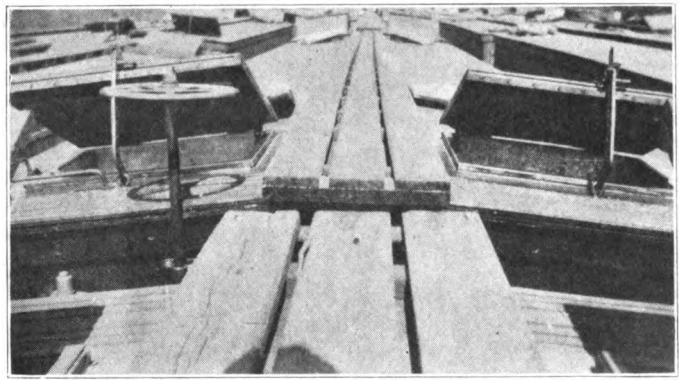


Fig. 3. Refrigerator Car Roof.
(Showing Hatch Covers.)

Doors.

The side doors on the refrigerator car differ from the ordinary box car side door, inasmuch as there are two to the door opening on each side, and they swing on hinges instead of sliding. They are about six inches thick and heavily insulated. The edges are padded so as to prevent the admittance of air to the car when the doors are closed. Some of this padding could be called upholstery, as small coil springs are fastened to the edges of the door in order to keep the padding resilient. The door fixtures are also much different from those on an ordinary box car, and must be applied properly or they will not hold the doors closed tightly.

OTHER CARS.

Furniture cars are generally fifty (50) feet long and about fourteen feet high. A car of this size is often sprung out of square through stress while in service, and comes into the shop for repairs with its body badly out of shape. The carman must be familiar with the method of straightening the body of this car. After the car body has been straightened, some roads apply roof braces, six in number, one of which runs from each corner of the car diagonally across it to the side-plate about five feet from the inside of the door post. There are two other diagonal

braces running from the point where the first mentioned diagonals meet the side-plate, to the opposite side-plate on the opposite side of the door. The fitting of these braces requires a good deal of care, and is important because they have to carry much of the strain which tends to throw the car out of shape.

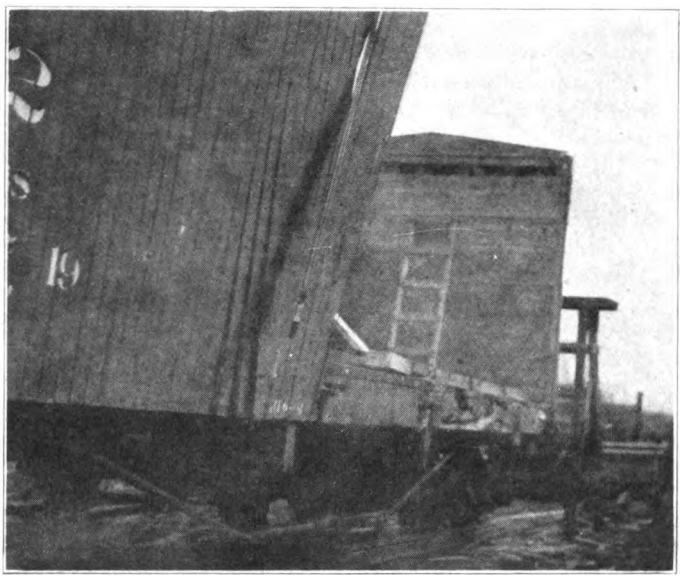


Fig. 4. Furniture Car as Received for Repairs.

Inasmuch as the distance from the floor to the ceiling of this car is about ten (10) feet, the carman must build his scaffold inside of the car and reach overhead to perform this work.

On **Express Refrigerator** cars or Refrigerator cars used in passenger train service, the freight carman must be familiar with the passenger car type of coupling and uncoupling arrangements, and also know the method of repairing the buffer attachment that these cars have. The buffer system consists of two cylinders which are cast integral with the buffer casting of the car and in which are two large double-coil springs. Over these is fitted a steel buffer plate.

On the **Wood Gondola Car,** the carman must know the method of renewing one or more of the side planks without removing all of them, and how to jack up the side planks and stakes, in order to renew a side sill. The rotting of the wood or the corroding of the steel depends partly on the character of

the cargo. Sand and coal, for instance, each holds much moisture and tends to rot and corrode cars rather quickly. This is especially true of the effect of coal on steel, because there is not only moisture in the coal, but also sulphur, which has a very rapid corrosive effect on the metal. The floor of a steel car carrying coal will not last more than one-half of the time the floor of a wooden car will last. In addition to the ordinary bending and racking of the cars while on the road, gondola cars are usually loaded and unloaded by "clam shells" or shovels, and these frequently bang against the bottom or side and dent the car, or if it is wooden, crush and break it.

In repairing **Poultry cars**, the carman must be able to apply the wire netting and also the numerous floors and compartments, together with racks for the troughs which hold the water and grain with which poultry is fed in transit.

In repairing **Stock cars** he must have a knowledge of the application of hayracks and side rails to prevent the cattle from breaking doors or pushing out side slats.

In the repair of **Drop Bottom Gondola cars** and **National Dump cars** he must be able to repair the door closing and locking mechanism, which on some cars is very complicated. In repairing **Hart Convertible** and **Sand cars** he must understand the side door operating mechanism. This generally consists of a bar half or full length of the car with off-sets opposite each door so that when the bar is turned by a ratchet lever at the end of the car, these off-sets are brought against a casting on each side door. The door is equipped with a heavy pawl to lock this operating bar in place. Again; this bar extends the length of the car on the outside at about the height of the top of the side-sill. The off-set is a bend in the bar opposite each side door, and can be made to press against the door which is hinged at the top, closing it so that the cargo cannot escape. In order to lock this bar in place against the door, the pawl, which is a flat casting somewhat pear shaped, hung on a pivot through its top, is turned on the door, wedging the locking bar into position. In order to open the doors, this pawl on each door must be turned back on its pivot, allowing the bar to be turned by the lever at the end of the car, which withdraws the pressure of the bar off-set from each door.

At times when **Circus cars** come to shops for repairs, the carman must be able to repair the cages for the animals, the ventilators and other special parts of cars in this service.

In repairing **Bunk cars** he manufactures the bunks and lockers, and also applies the metal washstands and water coolers that go in these cars.

When a **Supply car** is repaired, the carman manufactures the various sized bins and drawers that are needed in a car in

the service of distributing things necessary to carry on car, locomotive and track repairs at smaller points on the railroad system.

In the repair of **Tank cars** he must apply the head blocks on which the tank rests and also properly apply the straps around the tank so that it will not break loose and roll off of the car.

A **Pickle car** usually is a flat car having vats built upon it to hold the pickles. This work requires the carman to have the skill necessary to construct a water-tight wooden vat.

In the repair of a **Fruit car,** he must understand the repairing of side screen-doors and also the application and repair of the numerous patented ventilators with which these cars are equipped. Some of these ventilators are quite complicated and must be properly applied or they will not be in good working order.

In the repair of an **Automobile car** he must build and apply end doors,—which are used as runways when loading and unloading the automobiles,—in a substantial manner, so that in spite of the abuse they are subjected to in the loading and unloading of the cars, they will still be in condition to be closed tightly.

In the repair of **Horse cars** he must be able to manufacture the stall partitions, drinking troughs, hay and oats racks.

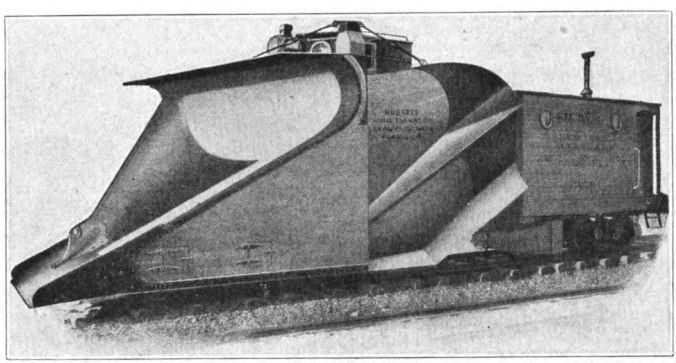


Fig. 5. Single Track Snow Plow.

In the repair of **Snow Plows** he must have sufficient mechanical skill with his tools to apply the curved sheathing which is common to these cars, and must be able to fit it tightly behind or against the metal cutting edge of the plow. We know of no job on buildings requiring skill equivalent to the application of this sheathing. In the repair of snow plows and like equipment a carman must be able to manufacture and apply the doors and window sash which are part of this equipment. In hanging the doors he must apply the hinges, handles, knobs and locks.

When **Snow Sweepers** need repairs, he must be able to remove and apply the brushes and repair parts of the mechanism that operates them. The carman is also required to repair **Rotary Snow Plows.**

He must be able to repair **Ballast Spreaders,** which have a large spreading plank to either side of the car, fastened to the car by heavy hinge castings and supported from the end of the plank to the top of the car by a heavy rod about one and one-half inches in diameter. These **Ballast Spreaders** are used to spread a carload of ballast which has been dumped on the track for purposes of filling or in construction work.

The carman must repair **Pile Drivers,** and all of the wooden booms, slides and blocks of the hammer must be repaired and constructed by him. These booms are sometimes between fifty and sixty feet in length and are of timber approximately fourteen by fourteen inches or heavier. He must repair booms and lifting mechanism of steam shovels and "clam shells," and also construct the cabins around the steam engine and boilers of this type of work equipment.

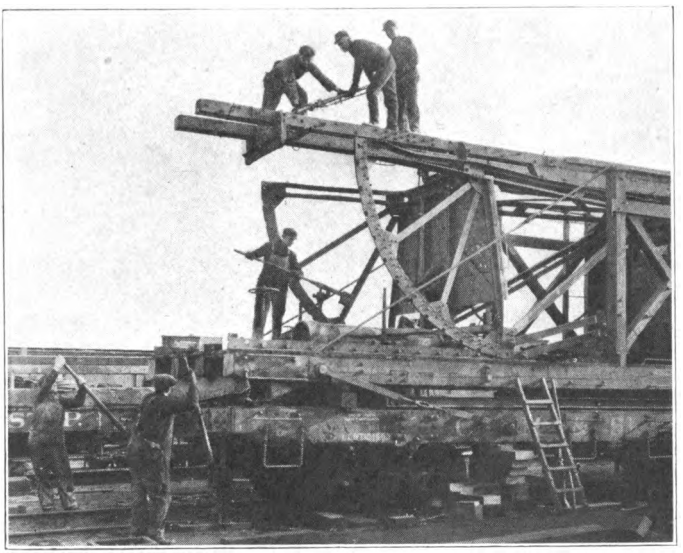


Fig. 6. Repairing a Pile Driver.

In the building and repair of **Derrick cars** used in construction work the carman assembles all the castings, the booms, cables, blocks and tackle, and other parts of the derrick car, with

the exception of the steam boiler and steam engine. The carman must understand all of the stress and strains involved in operating this type of car in order to be able to detect weaknesses in the blocks and tackle and any other parts of the derrick. The derricks vary in construction—there being five or more types of derricks, and with each of these the carman must be familiar.

The carman must be able to repair cars that are used as **Weed Burners** which are equipped with fuel oil projectors that are held out in the rear of the car by a framework and cover a space of about nine feet square on the right-of-way. These burners are lighted and a flow of fuel oil is continually forced through them by compressed air, which comes from an air pump operated by power transmitted from gears, and, in some cases belts, from the axle of the moving car.

One of the most complicated of cars is the **Test-weight car,** which car is used to test the accuracy of all the scales on the railroad system. This car is made up of an enormous number of parts which must be fitted together and applied with the greatest of accuracy. The journal bearings and roller bearings on the axle of this car are adjusted so finely that the car can be moved by the unaided efforts of the scale testers. These cars weigh forty and fifty tons.

The carman builds and repairs **Cabooses.** Some of its parts are constructed similarly to the parts of a passenger train car. Its most prominent characteristic is the cupola that is built above the roof line. This cupola is made with windows in order that a member of the train crew sitting inside can see the entire length of the train.

Differences Found in Cars of the Same Type.

The above list gives an idea of the variety of types of cars the carman constructs and repairs. *However, an outline of the types of cars alone does not adequately picture the variety of the work performed by the freight carman.* We must consider the differences of dimension in cars of the same type or classification. For instance, there are 33 foot, 36 foot and 40 foot box cars, and like differences in length will be found in any of the other types of cars. Not only will the cars of one type be sub-divided according to length, but the heights and widths will also differ.

Besides dimensional differences within a group of cars of one general type, there are differences of appliances. A thousand cars of the same type and numbered serially may be equipped with four different types of coupler. Five hundred of the cars may have friction draft gear, and five hundred have transom draft gear. The same thousand cars may have three types of trucks and three types of roof.

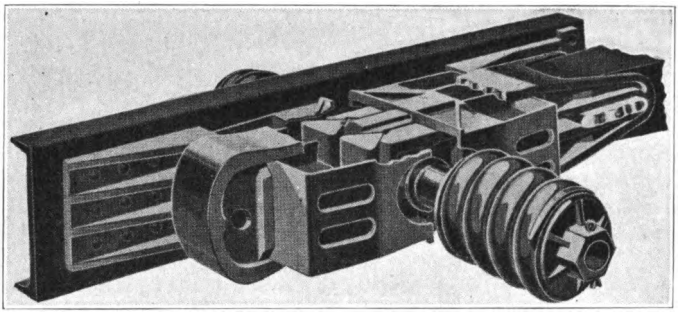


Fig. 7. Cardwell Friction Draft Gear.

Standard equipment is a misnomer when used in describing freight equipment, because the carman in repairing finds that it is a standard of almost no two alike. It requires a great deal of study and experience to select the proper parts and material for the repair of the many different cars of any one road, and to these we must add the large percentage of foreign cars repaired, nearly all without the aid of blueprints. Each foreign car can be considered as an added variety, and at many repair points they form fifty per cent of the number of cars repaired.

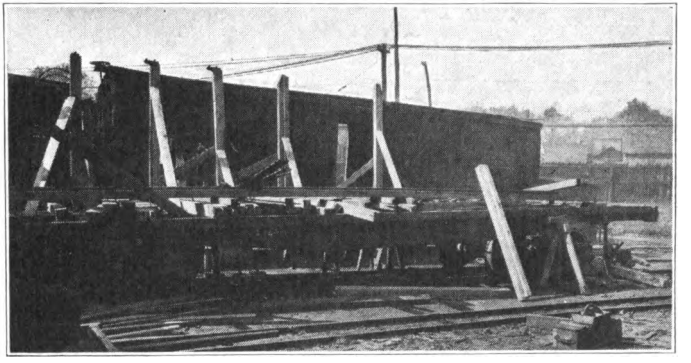


Fig. 8. Pennsylvania Car Rebuilt by Northwestern R. R. Carmen Without the Aid of Blueprints.

Tools

The performance of the work to be done on these cars requires the use of a number of tools, which are listed herewith:

1 Breast drill,
2 Braces—1 small and 1 large.

1 Set ship auger bits, 5/16", 7/16", 9/16", 11/16", 13/16", 15/16", 1 1/16", 1 3/16",
1 Expansion bit,
1 Countersink,
1 Claw hammer,
1 Machinist's hammer, 2 lb.,
1 Small hatchet,
1 Carpenter's Adze,
1 Set socket brace wrenches 3/8", 1/2", 5/8", 3/4", 1",
1 Monkey wrench,
1 14" Stillson wrench,
1 Jack plane,
1 Smoothing plane,
1 saw No. 8,
1 Rip saw, No. 6,
1 Panel saw,
1 Keyhole saw,
1 Hack saw,
1 Saw set,
Saw files, and clamp to hold saw while filing,
1 Set framing chisels, 3/8", 1/2", 3/4", 1", 1 1/2 2",
2 Gouges 1/2", 1",
1 Claw bar,
2 Screw drivers,
3 Screw driver bits, 3/8", 1/2", 5/8",
1 Large pliers,
1 Tinner's shears,
1 Large square,
1 Try square,
2 Rules, 2' and 6',
1 Oil stone,
1 Oil can,
1 Lead pencil,
1 Chalk line,
2 Center punches,
3 Nail sets,
1 Carpenter's apron,
1 Tool box—(Almost every man has 2 tool boxes.)
1 Nail box—(For 8 or 10 sizes of nails.) Lumber supplied by company.
1 Saw horse,
1 Mitre box,
S Wrenches—3/8" to 2", About 3/4ths of these tools are supplied by the railroad company.
1 Pinch bar,
2 Cold chisels,
Heavy hammers,
(Supplied by company.)
Coupler, wheel and axle gauges,
Chisel bars.
2 Ladders, 1 large for work outside the car and 1 small for inside work.
Air drill machines. These are movable and are carried around. About 50 feet of air hose is attached.
All tools and machinery that a freight carman uses are movable.
7 Jacks, 4 lever jacks, same size; 1 small jack for applying brasses; 2 screw jacks.
(To raise a loaded car the carman finds it necessary to use also 2 large hydraulic jacks.)

Where the repairs to be made necessitate the jacking up of the car the carman finds it necessary to use from 4 to 8 horses or trestles, according to the weight of the car.

Operating The Air Drill.

The carman must know how to connect the air drill; set it up; adjust it; oil it; clean it and keep it in good condition. He must also understand the method of using it with the angle boring attachment,—which is an extension with a universal joint—in order to bore holes in confined places which do not admit the air machine itself. In boring splice slab bolt holes on cars equipped with Williams and Pries draft gear, the air motor is used with this angle boring attachment. Even with this attachment, it is impossible to bore the holes without using two lengths of drill bits on account of having but 7½ inches space between center sills and the same between center and intermediate sills. It is very dangerous when boring these holes with motor and angle attachment to have an inexperienced man handling the motor, for if, in boring through a 6-inch sill, nails are struck or bit does not clear as it should, the motor is liable to slip from his grasp or the auger may strike him or catch in his clothing, thereby causing possible injury. In using the motor to bore these holes, the carman has so little room in which to work that the borings are blown into his face by the exhaust.

He is responsible, when he takes a machine out, for its return in good condition. This is true of all the equipment, machines, appliances and tools which the company furnishes. He naturally is responsible for his own tools. In connecting up any of these tools or appliances that are worked with compressed air, he has to connect them in such a way that none of the air pressure will be wasted. He has to make a tight connection, because if there are any leaks, it affects the air pressure on the lines throughout the shop, which would result in there not being sufficient air to work similar appliances in other parts of the shop.

Frequency of Use of Tools and Appliances.

Horses or trestles are used constantly, ladders next in frequency, then his own hand tools, especially the hammer, wrenches, wood chisels, rules, brace and bits, pencil, saws, planes and squares. Nearly all of his own tools he uses regularly every day. The tools which he uses only occasionally are: air tools, expansion bits, punches and nail sets.

Weight of Machines and Appliances.

The weight of the machines and tools are somewhat as follows: The heaviest of them is the air drill. It weighs about 75 pounds, and one man can carry it. One man can usually carry a large horse or trestle, but in some shops they are made extremely large; are reinforced with iron, and require the efforts of two men to move into position. It requires from two to four men to carry the hydraulic jacks. Usually one man operates each jack, but it is good practice to always use two men on a jack, especially on heavy cars.

Tool Expense.

The carman must, from time to time, replace any of his tools that become lost, worn out or broken. The average cost of keeping in his possession tools that he requires in his work would be about forty-five dollars a year at the present time. Fully twenty-five dollars of this expense is incurred in keeping up his supply of woodbits and chisels because they are broken frequently. The original cost at the present date, January, 1921, of a complete set of tools, such as the carman is expected to own, is one hundred and thirty-five dollars. Eleven dollars of this is the original cost of the bits which he requires. This estimate is a very conservative one at present market prices. (The foregoing estimate was made up from the detailed items.)

Inasmuch as the carman has to supply his own tools, if he loses or breaks a tool while at work, he has to get these tools from the stores on his own time, thereby losing some time from his work and being docked from his pay accordingly.

Kinds of Material Handled.

The following woods are used in freight car repairs.

Oak,
Cyprus,
Pine,
Ash,
Fir,
Poplar,
Maple, occasionally.

The different kinds of woods mentioned above vary in respect to hardness, closeness of grain, frequency of knots, quantity of rosin, liability to split, weight, tensile strength, compression strength and hardness. All of these different qualities require special care in the use of tools in order that the work shall be done properly and tools kept from damage or breakage.

Therefore the carman has to know the different qualities of each of these kinds of wood and how they act when using different edged tools, such as saws, chisels, etc. A sample instance of this is that in some localities, sometimes in the winter

months, oak end sills are received for application to the car while in frozen condition. This necessitates great care by the carman in the use of his bits, and it generally is necessary for him to thaw out the hole with a red hot bolt as he bores it.

In addition to these different kinds of wood that the carman is constantly using he also uses the following kinds of material which go into the work:

Nails,
Lag screws,
Cotter keys,
Tacks,
Ordinary wood screws,
Wrought iron bolts, nuts and rods,
Wrought iron straps,
Malleable iron, steel and gray iron castings.

Car Parts.

The carman prepares all the car parts and assembles them. In an ordinary wooden 40-foot box car there are approximately 1,100 wooden pieces. Nearly all of these are handled when the car undergoes heavy, or re-built, repairs. There is a variety of about 30 different shapes. A list of some of the various makes of draft rigging and couplers which a carman is required to repair and apply, is shown below:

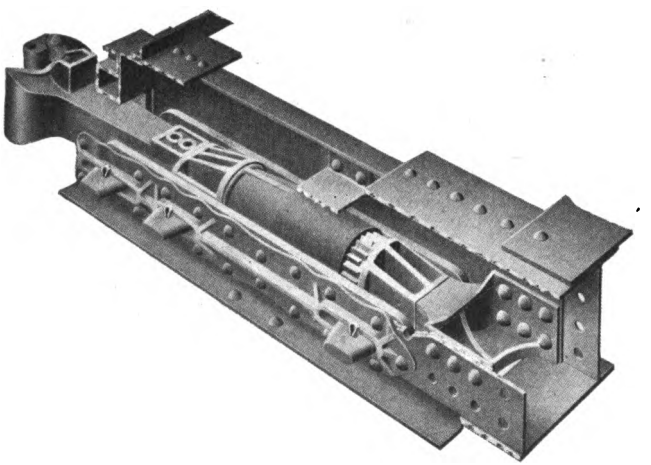


Fig. 9. Farlow Three Key Draft Gear.

DRAFT RIGGING.

Butler,
Graham,
Thornburgh,
Hennessey,
Hennessey friction,
Bradford,

Thornburgh tandem,
Miner tandem,
Miner friction,
Williams & Pries,
Farlow,
Farlow Westinghouse,
Cardwell,
Waugh,
Murray,
Sessions,
Republic.

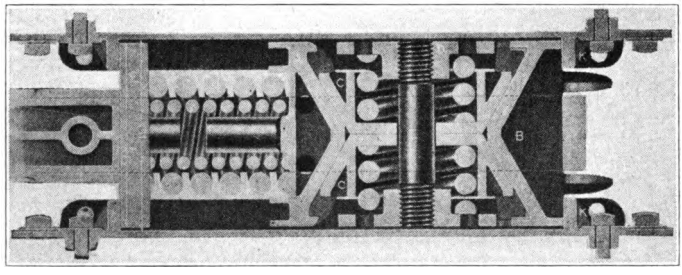


Fig. 10. Republic Friction Draft Gear.

COUPLERS.

"D" type A. R. A.,
Sharon,
Tower,
Climax,
Major,
Melrose,
Latrobe,
Lion,
Pitt,
Simplex,
Trojan.
Forsyth,
S. H. & H.,
Janney,
Janney, X,
Janney Miller,
R. E. Janney,
Gould, (3) types,
Hein,
Kelso,
Washburn.

Roofs.

There are a great many varieties of roofs used on box cars and the carman must be familiar with the method of applying all of them. One of these roofs is the single-board roof, which consists of single boards nailed to the purlines and the side plates, and are half the width of the car.

There is also the double board roof and the double board plastic roof, which roof is the same as the single board roof, with the exception that the carman must apply a layer of plastic paper on top of the single board roof and again cover with an entire board roof. There are a number of inside metal roofs, which roofs have metal sheets about thirty-two to the car, which are applied directly above the purlines. Each sheet is coated with a tar like solution and over this is applied a layer of plastic paper on top of which is nailed a single layer board roof.

There are a number of outside metal roofs, which consist of single board roof nailed on the purlines, a coat of tar or similar solution, one layer of plastic paper, and on the top the metal roof sheets. These roofs are usually flexible and held to the car

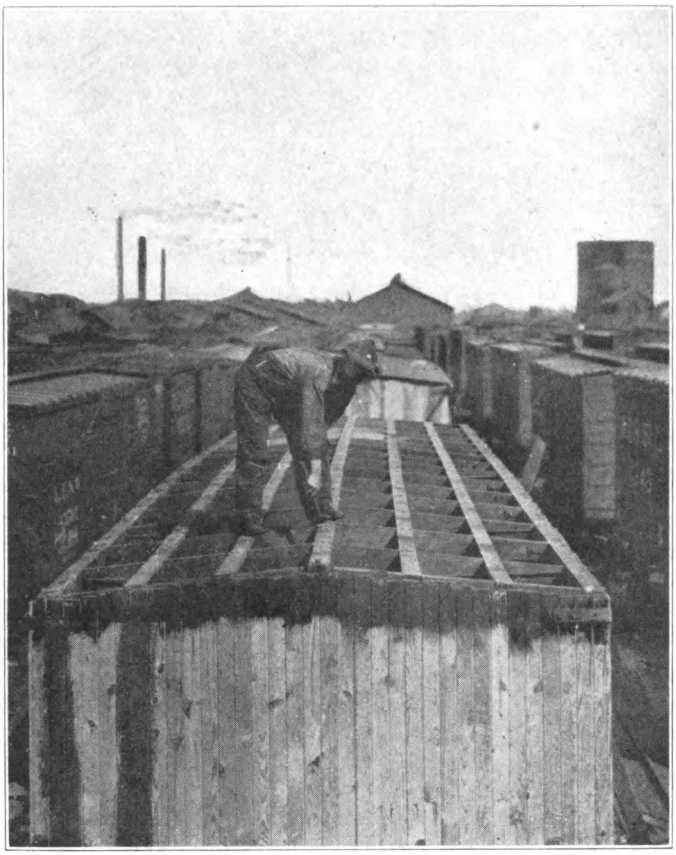


Fig. 11. Applying Roof Purlines.

by clamps at the side plate and nails at the ridge pole. The nails, however, do not go through the roof sheets, but are through caps which fit over the joint between any two roof sheets. The ridge pole cap is of metal and extends the entire length of the car, and, like the caps and the roof sheets, is interlocking, which allows movement when the car is under stress, as in turning a sharp curve.

The extent to which any of these roofs perform the functions for which they were applied rests entirely on the mechanical ability and care used by the carman in applying them.

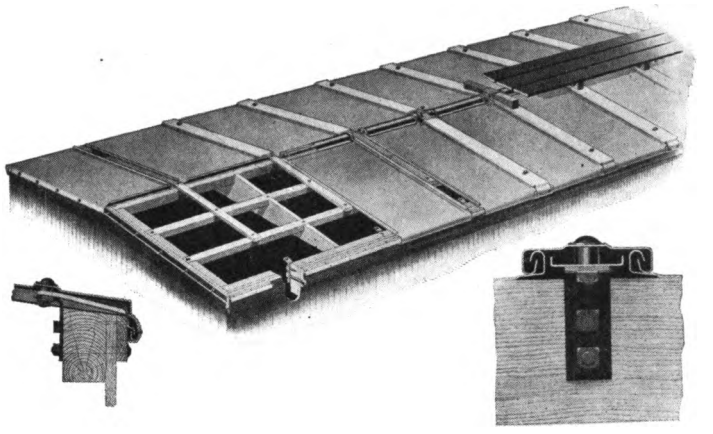


Fig. 12. The Flexible Metal Roof.

Knowledge of Car Parts.

The carman knows the standard and also any special sizes of all these parts. He knows how they fit together and in what order they must be built up or taken apart in repairing.

A knowledge of this order is an essential in the carman's work, and is of importance not only for the strength and life of the car, but also in order that it may be built or repaired with safety to the men working on it. For instance, if parts are taken down in the wrong order, it may mean that the roof or some heavy timbers will fall and injure or kill some of the men working on or around the car. The mechanics dismantling a car must take proper precautions and provide adequate support for all parts in danger of falling while they are repairing a car.

Most of the lumber required for car repairs is received by the carman already milled, that is, cut into standard shapes and sizes, but on the arrival of these parts to the car, the mechanic must complete the shaping and finishing of them in order to suit the individual requirements of the job he has to perform. In some repair points where there is no mill, the carman finds it necessary to mill or frame all of his own lumber by hand. A sample job of this kind would be the cutting of tenons on post ends and mortises in the sill into which these tenons must fit.

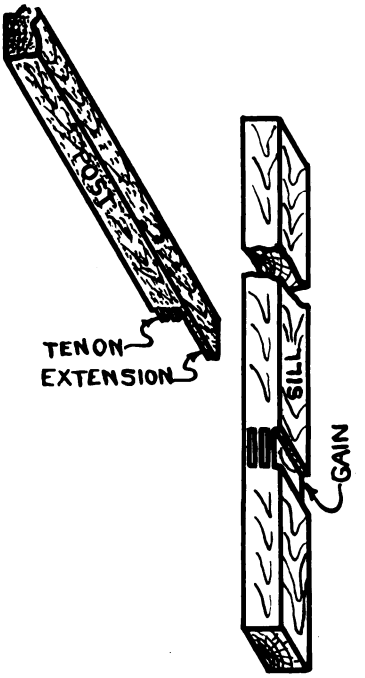


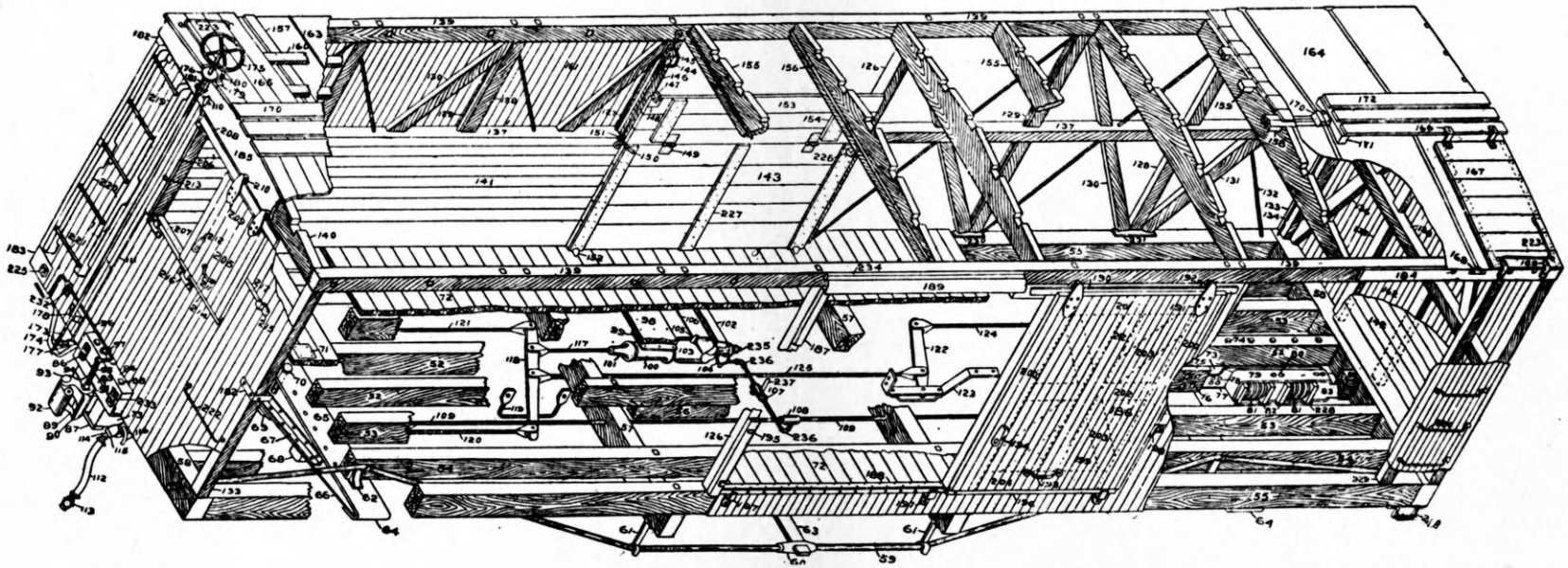
Fig. 13. Post Tenon and Extension. Sill Gain and Mortises.

At nearly all of the smaller repair points there are no mill facilities, and the carman must frame all of his material from the rough and usually oversize lumber, and sometimes he is compelled to carry his material as far as half a mile.

The draft rigging of the car is the mechanism most frequently in need of repair and most important in the running of trains, as any defect in these parts would probably cause the train to part while in service, and cause the delay of shipments. This draft rigging consists of a coupler, which is held in place between two draft timbers by a system of springs, yoke and followers, which are held by draft castings.

In the attached plate of the American Standard Boxcar Body see page 31. Figure No. 79 shows the coupler pocket; No. 81 shows the springs with the follower plates, No. 82, fitted in the yoke in front of and behind the springs. These followers fit into what is called here the coupler stop, No. 77. This coupler attachment, including the yoke, springs and followers, weighs approximately 350 pounds, and requires two men and a jack to put into position to be fastened. The carman has the

AMERICAN STANDARD BOX CAR BODY.



LIST OF PARTS

52. Center Sill.
53. Inner Intermediate Sill.
54. Outer Intermediate Sill.
55. Side Sill.
56. Center Sub-Sill.
57. Cross Tie Timber.
58. End Sill.
59. Body Truss Rod.
60. Body Truss Rod Turn Buckle.
61. Body Truss Rod Bearing.
62. Body Truss Rod Saddle.
63. Turn Buckle Block.
64. Body Bolster.
65. Body Bolster Top Plate.
66. Body Bolster Bottom Plate.
67. Body Bolster Angle Iron.
68. Body Side Bearing.
69. Body Center Plate.
70. Center Pin.
71. Center Pin Plate or Cover.
72. Floor.
73. Draft Timber.
74. Draft Timber Bolts.
75. Filling Block.
76. Filling Block Bolts.
77. Coupler Stop.
78. Coupler Stop Bolts.
79. Coupler Pocket.
80. Coupler Pocket Rivets.
81. Coupler Draft Spring.
82. Coupler Follower Plate.
83. Coupler Shank.
84. Dead Block.
85. Dead Block Plate.
86. Dead Block Truss Rod and Nut.
87. Carrier Iron.
88. Carrier Iron Bolt.
89. Coupler.
90. Coupler Guard Arm.
91. Coupler Safety Guard.
92. Knuckle.
93. Knuckle Pin.
94. Lock Pin.
95. Uncoupling Chain.
96. Uncoupling Lever.
97. Uncoupling Lever Bracket.
98. Brake Cylinder Plate.
99. Brake Cylinder Flange.
100. Brake Cylinder.
101. Brake Cylinder Head.
102. Auxiliary Reservoir Beam.
103. Auxiliary Reservoir.
104. Triple Valve.
105. Release Valve.
106. Release Valve Rod.
107. Cut Out Cock.
108. Air Pipe Strainer.
109. Train Pipe.
110. Pressure Retaining Valve.
111. Pressure Retaining Pipe.
112. Air Hose.
113. Air Hose Coupling.
114. Air Hose Nipple.
115. Angle Cock.
116. Angle Cock Handle.
117. Cylinder Push Rod.
118. Cylinder Lever.
119. Cylinder Lever Support.
120. Brake Connection Rod.
121. Brake Chain Connection Rod.
122. Floating Lever.
123. Floating Lever Guide or Fulcrum.
124. Floating Lever Brake Rod.
125. Cylinder Lever Tie Rod.
126. Door Post.
127. Door Post Rod.
128. Side Post.
129. Side Post Rod.
130. Side Brace.
131. Counter Brace.
132. Counter Brace Rod.
133. Corner Post.
134. Corner Post Rod.
135. End Post.
136. End Brace.
137. Side Belt Rail.
138. End Belt Rail.
139. Side Plate.
140. End Plate.
141. Side Lining.
142. End Lining.
143. Grain Door.
144. Grain Door Rod.
145. Rabbit for Grain Door.
146. Post Angle Iron for Grain Door.
147. Grain Door Catch.
148. Grain Door Catch Plate.
149. Double Grain Door Hinge.
150. Grain Door Arm.
151. Grain Door Ring.
152. Grain Door Stop.
153. Grain Door Flap.
154. Grain Door Flap Plate.
155. Carline.
156. Carline Tie Rod.
157. Sub-Carline.
158. Ridge Pole.
159. Purline.
160 Sub-Purline.
161. Side Sheathing.
162. End Sheathing.
163. Inside Metal Roof.
164. Outside Metal Roof.
165. Roof Boards.
166. Running Board Brackets.
167. Short Running Boards.
168. Eave Running Board Casting.
169. Joint Casting.
170. Ridge Saddle Casting.
171. Running Board Saddle.
172. Running Board.
173. Brake Shaft.
174. Brake Shaft Step.
175. Brake Wheel.
176. Brake Ratchet Wheel.
177. Brake Chain.
178. Brake Shaft Bracket.
179. Brake Pawl Holder.
180. Brake Pawl.
181. Upper Brake Shaft Bearing.
182. Corner Band.
183. Corner Plate or Iron.
184. Side Fascia.
185. End Fascia.
186. Side Door.
187. Side Door Closed Stop.
188. Side Door Threshold Plate.
189. Side Door Cap.
190. Side Door Track.
191. Side Door Hanger.
192. Side Door Roller.
193. Side Door Handle.
194. Side Door Hasp.
195. Side Door Staple.
196. Side Door Chafing Strip.
197. Side Door Guide.
198. Side Door Open Stop.
199. Side Door Sheathing.
200. Side Door Stile.
201. Side Door Top Rail.
202. Side Door Center Rail.
203. Side Door Braces.
204. Side Door Bottom Rail.
205. End Door.
206. End Door Closed Stop.
207. End Door Threshold Plate.
208. End Door Track.
209. End Door Hanger.
210. End Door Roller.
211. End Door Handle.
212. End Door Hasp.
213. End Door Staple.
214. End Door Chafing Strip.
215. End Door Stop.
216. End Door Bottom Guide.
217. End Door Rubbing Strip.
218. Sill Step.
219. End Ladder.
220. End Ladder Sides.
221. End Ladder Rounds.
222. End Hand Hold.
223. Roof Hand Hold.
224. Side Ladder.
225. Truss Rod Nut.
226. Grain Door Hanger.
227. Grain Door Stiffening Plate.
228. Follower Strap.
229. Side Ladder Post.
230. Counter Brace Rod Washer.
231. Double Counter Brace Rod Washer.
232. Uncoupling Lever Guide.
233. Dead Wood Block Washer.
234. Side Door Cap Filling Piece.
235. Triple Valve Cap.
236. Pipe Elbow.
237. Cut Out Cock Handle.

responsibility of seeing that the bolts in the draft casting or coupler stop are fastened securely, as on their security depends whether or not a coupler will pull from its fastenings when in service. After the application of the coupler, all of these bolts are not visible to the car inspector or foreman, and their proper application depends entirely on the integrity of the carman.

No. 59 on this plate shows what is known as the body truss-rod. There are usually eight of these rods to a car. They come in half sections held together in the center by a truss-rod turn buckle, shown on the plate as No. 60. The carman usually bends these truss-rods for application. In each half section the rod is bent at two different angles to suit the requirements of the car to which it is to be applied. If it is not bent at the proper angle, under the stress and strain of a load, the truss-rod will work loose. As the turn buckle in the center works in one direction, it can be seen that the threads on the ends of the truss-rod on which this turn buckle fits, are opposite —that is, one is a right-hand thread and the other left handed. If a carman makes a mistake in applying this truss-rod, he will probably find that at the end sill, when he is to apply the truss-rod nut, that he has a left-handed thread to apply that nut to, whereas there are no nuts with a left-handed thread.

Nos. 100 and 103 show the brake cylinder and reservoir of this car. These are applied by the carman, and he must know towards which end of the car the piston rod must travel. Figures Nos. 218 and 224 show the side sill step and the grab irons. These are safety appliances and must be applied to conform to Interstate Commerce Rules.. The carman must be acquainted with the standard method of applying these grab irons and sill steps in order to protect the railroad from liability of fine for violating the law pertaining to safety appliances, and he must also apply them in such a way that they will not be a menace to the lives of the trainmen and others who may have occasion to use them. The safety appliance regulations will be more fully explained later.

Applying the Side Door.

No. 190 shows the side door track from which the side door of a box car is suspended. This track must be applied properly in order that the door may fit securely to the car. The mechanic also must see that the side door rollers (No. 192) operate easily along the door track, in order that the door may be opened and closed. If the side door is not fastened at the proper height on the side of the car, it will probably strike the side door guide (No. 197), or rest thereon, which would make a door almost impossible to open or close, as the case may

be. The forcing open of doors that are improperly applied has much to do with the short life of the box car side door, and also the damage to shipments caused by the door not giving the proper protection. There are a great many different types of car doors and door appliances.

Safety Appliances.

The safety appliance rules of the Interstate Commerce Commission prescribe a standard location, dimension and manner of applying all car parts having an influence on the safety of employes and travelers upon railroads. The structural differences in the different types of cars made it necessary to provide different regulations governing the different types. Therefore the carman must familiarize himself with the safety appliance rules as given for Box cars, Tank cars, Hopper cars, Gondola cars, etc.

Space does not permit us to explain the safety appliances of all classes of cars, but an outline of the regulations given for box cars will give an idea of the knowledge of these rules the carman must have. We will assume that the railroad supervisory forces look after and are responsible for, the material dimensions of the safety appliances. It can readily be granted also that the carman must take care of, and is responsible for their location on the car and the manner of their application.

Hand Brake Rigging.

On box cars the hand brake shaft must be located on the car end, not less than seventeen inches nor more than twenty-two inches from the center of the car. There must be not less than four inches clearance around the rim of the brake wheel. The outside edge of the brake wheel must be not less than four inches nearer the car than is the inside face of the knuckle when closed and the coupler horn against the buffer plate. The brake shaft support must be secured with bolts or rivets not less than one-half inch in diameter. The brake shaft ratchet must be fixed so that it cannot move on the shaft. The brake pawl pivot must be a bolt or rivet at least five-eighths inch in diameter. The nut at the top of the brake shaft which holds down the brake wheel must be further secured by a nut lock or cotter key, or, the shaft end must be riveted over it.

Brake Step.

Brake step must be not less than twenty-eight inches long and its outside edge not less than eight inches from the face of the car. Like the brake wheel, the outer edge of the brake step must be at least four inches nearer the car than is the inside face

of the coupler knuckle when closed and the coupler back against the buffer. The brake step must have two metal supports and be secured by not lighter than half-inch bolts or rivets.

Running Boards.

Running boards must be fastened to saddles by bolts or screws. The running board end must be not less than six inches nor more than ten inches from vertical plane parallel with end of car and passing through inside face of coupler knuckle when closed and coupler horn against buffer. If the running board extends more than four inches from the edge of the car roof, it must have brackets to support this extension. On cars having outside metal roofs the running board must have extensions to the side of the car over the side ladders.

Roof Hand Holds.

Over each ladder location one roof hand-hold or grab iron must be applied not less than eight, nor more than fifteen inches from the edge of the roof.

Side and End Hand Holds.

Each car must have four horizontal side hand-holds. These must be not more than eight inches from the end on each side of the car. Four or more horizontal hand-holds are required on each end of the car and must be not more than eight inches from the side of the car. All horizontal hand-holds must be not less than sixteen, nor more than twenty-four inches in length. Cars having an outside end sill must have a twenty-four inch hand-hold across the center of the end of the car, not less than thirty nor more than sixty inches above the sill.

On the end-sill near each side of both ends of the car there must be one hand-hold located not more than sixteen inches from the side of the car. On cars having outside end-sills one vertical hand-hold is required on each end opposite the ladder, not more than eight inches from the side of the car, and not less than eighteen inches in length.

Hand-holds, with the exception of endsill hand-holds and ladder treads, must be not less than twenty-four inches nor more than thirty inches above center line of coupler. All hand-holds must have at least two inches clearance.

Side and End Ladders.

There shall be one ladder on each side of car, not more than eight inches from right end of car, and one on each end not more than eight inches from left side of car. Maximum space between ladder treads is nineteen inches. Spacing of ladder treads should be uniform. Top ladder tread must be not less than twelve inches, nor more than eighteen inches from roof at eaves. Side and end ladder treads must coincide within variation of two inches.

Uncoupling Levers.

Each car must have one uncoupling lever on left side of each end of car. Lever handles must be not more than twelve inches from the side of the car. Ends of handles must not extend less than four inches below bottom of end-sill or constructed so that at least two inches clearance is allowed around the handle. Drop of handle must be at least twelve, and not over fifteen inches over all.

Coupler Height.

On standard gauge track the height from the rails to the center line of coupler must be not less than thirty-one and a half inches nor more than thirty-four and a half inches.

Sill Steps.

One sill step is required near each end on each side of the car, not more than eighteen inches from the end of the car. Sill steps and all hand-holds shall be fastened by not less than one-half inch rivets or one-half inch bolts riveted over.

Every railroad has found it necessary to have blue prints made showing the location and method of applying the safety appliances to its own cars. On some classes of cars the roads found it difficult to devise standards to conform with the requirements of the law. The carman repairing a car does not receive specific directions from the foreman as to the location of these appliances. It is part of his trade to know these things. The foreman in his inspection of the cars, when ready for service, must give particular attention to the safety appliances, but generally he has not the time to look over every detail on every car.

Working Conditions and Hazards.

The carman is required to perform his work in the daylight or in a shop in which the lights are suspended so far overhead that they do not light up the interior of the car, nor do they shed any light underneath it. In the winter months, before he completes his work, it is practically twilight on the outside.

Working outside, the carman is required to work in snow and in rain, and in mud and slush caused by these conditions. The material with which he works also becomes wet or covered with mud from lying on the ground.

Working inside, while shielded from the full force of the winds and shielded from the rain, this advantage is sometimes offset by the draughts that run through the shops. Whether on the outside or in the shop, the ground is the floor and is very dusty. This condition is made worse because every car to be repaired is laden with dust, generally the remains of some materials the car has carried in transit—some of these being coal, lime, sulphur, cement and grain.

His drinking water in most shops is quite near him, but in the smaller outside points he must walk a great distance for water, or do without. In the smaller repair points there are no toilets, which are amply provided for in the larger shops.

Crowded Repair Tracks.

At times when railroad car shops are exceptionally busy, the repair tracks are crowded with cars to more than their normal capacity. This means that after the car is jacked up and the trucks pushed to either end of the car, the carman, in working on the ends of the car, is required to climb over and around the trucks. He also has to lift his couplers, end-sills, and heavy parts of that kind, over these trucks, which are continuously in the way of his doing his work.

The carman is working in considerable danger of serious accidents due to the falling of a car off of the horses, the falling of sills, couplers and other heavy parts. Also there is danger of being struck by flying particles of metal, etc.

The carman is required to make light repairs at interchange points, and in most shops, there are men assigned to make repairs to cars on tracks where a great deal of switching is done. He is liable to serious injury because of the cars being moved while he is working around or under them.

Importance of the Blue Flag.

The carman is supplied with a blue flag, which he is required to place at the end of any string of cars that he is working on. In most cases these flags have a plain wooden staff, which is put behind the end hand-hold and is held in place by a wooden wedge. If the switching crew neglects to see this flag and moves the cars, the carman is generally seriously injured. One case of an instance due to the failure of the switching crew to see the blue flag, or due to the blue flag having fallen from the end of the car, resulted in the killing of two carmen. These two men were experienced carmen and were repairing cars that were liable to be moved. To the best of our knowledge, and considering the long experience of these two men in that work, we will suppose that they had placed their blue flag on the end of the cars on which they were working. The switching crew, however, moved the cars, with the result that one man was run over, and in trying to pull him from danger, his partner was badly maimed, and one hour later died. The blue flag, which was intended to remain on the end of the cars was found on the ground some twenty-five feet from the scene of the accident. Another and similar case: A carman connecting up air hose, when the cars were moved, had his leg amputated between the ankle and knee.

A freight repair shop is littered with material and metal parts, which make it difficult to securely place horses for the support of the scaffold planks. The scaffold must be placed so that there will be no danger of it falling. The carman must use care in laying his tools on the scaffold so that they will not fall down and cause injury to some one working below it.

Injuries to the Eye.

As most of the work on the bottom of the car requires the mechanic to be looking upward, it frequently occurs that small particles of rust, dirt or coal fall and lodge in his eye. Some railroads arrange a monthly report of personal injuries which usually show that some thirty per cent of them are injuries to the eye. Most of these occur to freight carmen.

Aside from the ever present possibility of serious accident and the ills and ailments he gets as the logical result of working conditions described herein, the carman often develops serious hernia from the weight of the work done in awkward positions.

When a carman is injured in the performance of his duty, it is sometimes months after his return to work before he is able to collect the compensation that the law provides for him.

During the time he is out of work he must get along as best he can without assistance from his employers.

Personal Qualifications and Responsibility.

The car foreman generally has a considerable force to supervise and a considerable number of cars to repair under his supervision. He generally marks out the parts on the freight car which require renewal and the method of performing the work is left entirely to the carman, and probably the only time that he receives specific directions is after he has made an error in judgment and has received censure for it. In nearly every matter pertaining to repairs of cars and the safest and best methods of making them, the carman generally uses his own discretion and judgment. When the car is completed the foreman makes a written record of the repairs that have been made and inspects the workmanship mostly of the parts that are visible—the proper repairing of the parts that he cannot see is left to the honesty of the carman.

Drawings and Records.

The mechanic must be able to make out his daily time slip, also to make simple sketches, writing in the dimensions. He must also be able to read ordinary blueprints. The mechanic must be able to count up and order the number of bolts of various sizes he requires. At some repair points he is required to keep a notebook record of the material that he uses in repairing the car, especially a record of the number of castings he applies. In keeping a record of the castings he must show the pattern number of every piece.

Need of Muscular Strength.

As freight car building and repairing is probably the heaviest kind of work that mechanics are required to perform without the aid of machinery, it will be understood that the carman must possess a great deal of muscular strength. His work requires steady muscular effort during his entire working day, as he is continually handling heavy metal and wooden parts of cars. The majority of freight cars are repaired where there are no appliances, except ordinary jacks, provided to lift these heavy parts.

All of the cars on any one repair track are generally expected to be completed and ready for service on the same day. While working at high speed to accomplish this, the carman must concentrate all of his thinking faculties on his work to

avoid making mistakes that would delay the completion of his car.

The carman must have the endurance to perform his work from day to day and possess the health and constitution to stand the rigors of the weather and the wet while working outside. A great many carmen suffer from rheumatism contracted while working in the wet and snow.

Difficulties in Using Edged Tools.

Mechanics doing some classes of work use their edged tools on materials that are held in vises or laid on the bench, but the carmen must cut scarfs and gains and fit mortises and tenons while stooping under the car or in places where the motions required to perform the work are hampered by the proximity of other parts of the car. Many carmen are able to use wood chisels accurately with either the right or left hand.

Versatility of the Carman.

The car mechanic must be extremely versatile because of the great variety of cars upon which he is required to work. The evolution of wood to steel construction of equipment requires the carman to be able to change from a wood to a steel car on the same day, and carry out the steel work in the same efficient manner that he performs the work of his craft on wooden cars.

The repair of steel equipment is described in Section C.

SECTION B.

WORK ON WOODEN FREIGHT CARS.

Operations Involved in Simple Repair Jobs Frequently Performed on a Box Car.

END SILL RENEWAL.

Reference to the American Standard Box Car Body Sketch will help to explain the details of this job. See page 31.

Many cars are sent to shops for repairs on account of a broken endsill. The carman assigned to the work is required to remove the carry iron and lower the coupler (No. 89) and in many cases the draft timbers (No. 73). After bracing up the center of the side sills to prevent the car from bending down at the middle, he takes off all the truss-rod nuts (No. 86), on that end of the car He also removes the dead-wood block (No. 84), two bottom cornerbands, and loosens the two center corner-

bands (No. 183). He removes the end sill grab irons (No. 222) on that end of the car.

He removes the uncoupling lever (No. 96), and the castings (No. 97), which hold it to the car. He removes the nuts from four end tie rods (No. 134), loosens the end sheathing and sets the nails. He also loosens the side lining from the corner posts. He then forces the endsill out three inches in order to clear the tenons of the longitudinal sills, and with a sledge, drives the endsill down, causing it to fall to the ground. After the endsill is on the ground, he cleans all nails from it, and in cases where it is broken in two, he generally fastens both pieces tightly together and sends the sill to the mill as a sample. When the new endsill returns from the mill, it is generally necessary for the carman to enlarge or deepen with the wood chisel the mortises for the longitudinal sills and bore the shallow holes for the post casting lugs. He then places all the parts together in the order that he removed them.

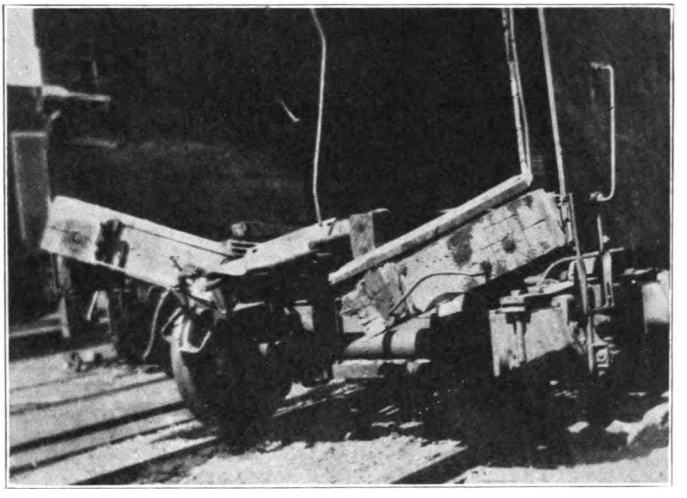


Fig. 15. Badly Damaged Sills.

Weight of Parts Handled.

A carman is required to handle all of the material and parts that go into the making of a car. Some of this material and parts are extremely heavy. A body bolster weighs approximately 750 pounds, and must be raised from the ground in order to apply to the car. A longitudinal sill five inches by nine inches by forty feet long, which is usually the size applied to a box

car, weighs 560 pounds. When heavy parts of the car are applied to the bottom, that means that all of this lifting must be done while the man is in a crouched and hampered position under the car. On practically every car the couplers, draft timbers and sill splices must be handled, because the majority of cars in freight service, when sent to the shops, are sent there for defects on these parts of the car.

The weight of the work the carman has to perform is illustrated by the full description of the work necessary in splicing a center sill on a wooden box car. (Reference to the American Standard Box Car Body sketch will help to explain the details of this job. See page 31.

Splicing a Center Sill.

The center sill, No. 52 on this sketch, is found to be decayed or broken. It has been found possible, however, to save most of this long sill, and orders are given for the carman to insert a splice. To do this he is required to jack up the car and set it on horses. He first brings four of the horses to the side of the car and sets them near the ends—one on each side of the car. He then blocks the wheels on the trucks at one end of the car in order that when jacking up the other end, the car will not move. A jack is set at either side of one end of the car so that when raised it will come directly under the side sill. Usually a small block of wood is placed on the top of the jack stand, as it has been found to insure a better purchase on the side sill. In setting the jack before raising the car, the mechanic must first see that it is perfectly straight and that it sits flat on the ground or on a wooden block. The carman on one side of the car and his partner on the other operate the jack levers simultaneously so that the raising of one side of the car faster than the other will be avoided. When the car is at sufficient height so that the horses can be placed under it, the truck is rolled out from under the car. The rear wheels of the truck, however, are left so that they extend under the end of the car until such a time as the horses have been securely set into position. This is to keep the car from falling to the ground in the event that one or both of the jacks might slip before the horses were placed into position to hold it. After the horses are set, the truck is rolled out all of the way and the car lowered a few inches so as to set its weight on the horses. The same operation is then repeated at the other end of the car.

The carman then removes the coupler (No. 92), and the draft timbers (No. 73). It must be understood that in removing the nuts from the draft timber bolts, the carman must kneel or sit under the car. He then uses a heavy sledge to drive the draft tim-

ber bolts up through the floor of the car. The rust sometimes binds them in the timbers, which makes it a heavy job. That is to say, the fact that the bolts are rusted in often requires pounding for a long time in this cramped position before they can be loosened. Handling a sledge for a long time under these conditions is very hard work.

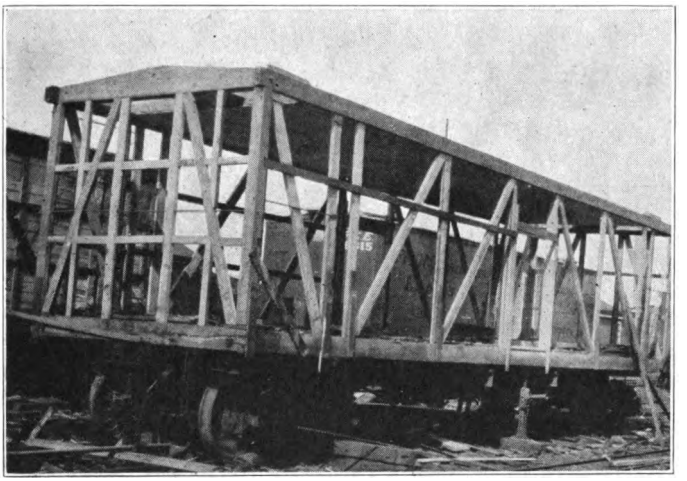


Fig. 16. Box Car in Course of Construction. (Note jack under side sill.)

He then sets a jack or brace underneath the center of each side sill to prevent it from sagging when he loosens up the truss rods. He removes the body bolster (No. 64), which job requires the removing of approximately sixteen heavy bolts. The bolts in this case are rusted into the metal bolster, which requires a great deal more heavy work to loosen. Metal rusts into metal much harder than it rusts into wood. This bolster weighs approximately 750 pounds, and care must be taken in letting it down so as not to injure any one. Usually the removal of about three feet of the car floor is necessary to effect the splicing. The approximate size of the centersill splice involved is five inches by nine inches by ten feet, and weighs 160 pounds. In the larger shops this splice is generally brought to the side of the car by material men, but in small shops the freight carman is compelled to go to the lumber pile—possibly a distance of an ordinary city block or more, to get this beam, and he and his partner have to carry it that distance to the car before they can begin work on it.

M. C. B. Rules on Sill Splicing.

It may be said in passing that in applying splices to cars the carman must have a knowledge of the M. C. B. rule requirements in the repairing of cars. In this case the M. C. B. rules require that all center sill splices must be made between the body bolster (No. 64) and the crosstie timber (No. 57). The M. C. B. rules also give the distances from the body bolster and crosstie timber that this splice must be made. The rule and sketch show clearly how the actual splicing is effected.

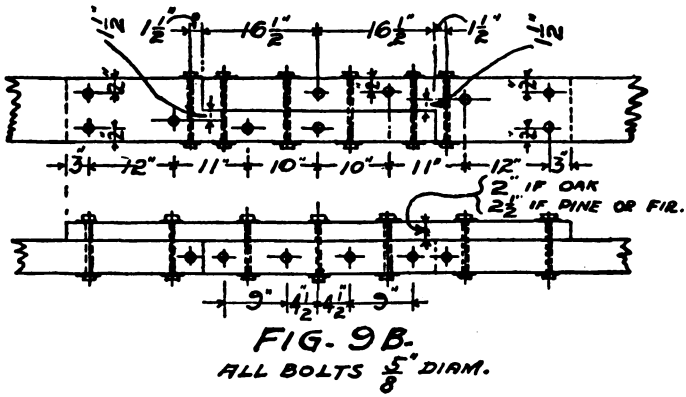


Fig. 17. Method of Making Centersill Splice.

We quote Rule 22, of the M. C. B. Rules:

"Draft timbers must not be spliced. Longitudinal sills may be spliced at both ends. The splicing of any sill between cross-tie timbers will not be allowed.

"The splice may be located either side of body bolster, but the nearest point of any splice must not be within 12 inches of the same, excepting center sills, which must be spliced between the body bolster and cross-tie timber, but not within 24 inches of the body bolster.

"In splicing longitudinal sills other than center sills, if same are less than 12 inches in depth, the plan shown in either Fig. 8 or 9C shall be followed. If the sills are 12 inches or more in depth, the plan shown in either Fig. 9 or 9C shall be followed. Where intermediate sills are spliced between the body bolster and cross-tie timber the splice must be reinforced as per Fig. 9A or 9B. In splicing center sills the plan shown in Fig. 9B shall be followed.

"The size of horizontal or cross bolts shall be ⅝ inch.

"Sills of foreign cars shall be spliced as above provided.

"Cars delivered in interchange with center sills spliced in accordance with Fig. 9A will be accepted."

Attention is again called to the fact that almost every car that comes in requires some of the foregoing repairs. It will be understood that the knowledge of the M. C. B. Rules that the carman must have in performing this job is also required in repairing any part of the car for which the M. C. B. Rules require a standard method of repairing.

Mistakes Often Due to Inexperience.

There are instances where a center sill splice is milled with the holes bored at the wrong place for the draft timber bolts. The experienced carman always measures the location of these holes before applying the splice. There have been cases where an inexperienced man has put the splice into position before measuring these holes for the draft timber bolts. In such a case, when ready to apply the draft timbers, he is confronted with the problem of whether he shall bore additional new holes in the correct location on the splice or remove it and get a splice that is milled correctly. The sum total of the time required to remove the splice and apply a correct one would be perhaps one-half day.

The boring of additional holes for the draft bolts is very poor car practice and is not allowed in the best shops, as it weakens the sill where its strength is most needed.

Mistakes of this kind sometimes cause great delay because, if the car concerned is not sufficiently advanced in construction to allow it to be switched, the cars on which repairs have been completed and which are behind it on the track cannot be pulled out for service.

SECTION C.

STEEL CAR REPAIRS.

Almost all of the repair work on steel equipment is done at large shops because the smaller repair points have no facilities for this kind of work.

Machinery and Tools.

In making repairs to all-steel cars and to the metal parts of composite and other cars the carman uses the following machinery and tools which are usually furnished by the company and replaced by the company when lost, worn out or broken.

A large fuel oil furnace, for the purpose of heating the smaller bent parts for straightening.

A number of straightening tables—flat steel tables at a height of about 8 inches from the floor, on which the parts are laid while straightening.

Various presses, operated by an air cylinder for the straightening of parts, such as dump doors, etc.

Press made of a large beam shod with iron, operated on a straightening table with the aid of two air cylinders—one at each end of the beam. When the air is applied the air cylinders force the beam down to the table, straightening any metal parts inserted between the beam and the table. Various sizes and shapes of blocks of iron are used on some of the work in conjunction with this press.

Spacing tables—Punch presses which have as many as 10 or 12 heads, punching that number of holes in a metal sheet at once.

Drill presses, for large and for small work.

Rivet machines, operated by a large air cylinder for large steel coupler rivets 1⅛" and 1¼".

Machinery and Tools—Portable Equipment.

Blow torches are used to heat parts not removed from the car and parts the size of which does not admit them into the fuel oil furnace.

Hand Forges, coal burning.

Rivet-heating furnaces; operated by fuel oil and compressed air.

Air drill machines (large and small) with various sizes of drills from ⅝" to 1½", and reamers of the same sizes.

One rivet-cutting gun, with 3 chisels for use as described hereinafter.

Pneumatic hammers, for driving rivets.

Crowbar, pinch bar and 2 long chisel bars.

Chipping hammers, used in cutting and trimming plates and castings.

Split bars or dolly bars,—bars with jaws at one end used in straightening.

Tongs used in handling hot material and rivets.

Sledge hammers, 4, 6, 8 and 10 lbs.

Straightening or backing hammers, 4, 6 and 8 lbs. These hammers have a flat, wide face which, in straightening, is laid against the hot metal and the hammer struck with the sledge.

Hand chisels—hammer shaped chisels equipped with long handle and struck with sledge in cutting off rivets.

Screw and ratchet jacks, and pull jacks and chains.

Drift pins used in lining up or matching holes in parts being applied to the car. Useful in holding part when raising into position as they can be quickly inserted into a pair of holes and sustain the weight of the part being lifted or held in place.

Holder-on for rivets—a heavy bar hollowed at one end to hold rivet head while man with air hammer fashions head on the other end of the rivet.

Old man—a bar and a number of flat pieces having holes at one end of a size to admit the bar. These flat pieces can be adjusted to a number of heights on the bar and are used generally

to aid in holding the heavy air drills. One flat piece on the bar is used as an anchor and the other is set against the top of the drill. A few turns of the wheel at the top of the air drill wedges it against the work.

In the operation of the rivet heating furnace, the blow torch, air drill machines, rivet cutting guns and air hammers, the carman uses compressed air and oil hose and connections.

The carman must have a knowledge of the setting up, adjusting, cleaning and oiling of all of these tools and machines. The mechanic is himself responsible for seeing that the machines and tools he uses are in good condition. The air tools and attachments are usually kept in a tool room over night. The carman keeps all of the simple tools such as sledges, bars, etc., in a tool box near the repair track. The carman generally sharpens his own chisels and other cutting tools.

Varieties of Materials.

Materials used in steel car repairs include sheet steel, round steel, steel castings, steel rivets, springs, forgings, malleable iron and gray iron castings, bolts, washers and a great variety of pressed steel shapes.

As in the repair of wooden equipment the carman must know all of the shapes, sizes and makes of the different parts which go to make up the great many types of cars. Steel or part steel construction of equipment is following and rapidly taking the place of equipment of wood construction. All of the tremendous number of parts and types of wood equipment have their counterpart in steel or composite cars. It is impossible in an exposition of any size to list even a major part of the different sizes, weights and shapes that enter into the construction of the steel and part steel equipment repaired by carmen.

Variety of Repairs.

The carman must repair, splice sills and straighten the steel underframes of box cars, coal cars, hopper cars, sand cars, flat cars, stock cars, fruit cars, automobile cars, furniture cars and cabooses. Some cars have five, six, seven or eight steel sills; some have only steel center sills, and others have steel bolsters and draft arms.

The carman's skill is needed to repair the steel frame box and gondola cars in which the superstructure is part steel and part wood. In the box car the posts, braces, carlines, purlines, side and end plates are of steel and the flooring, side and end planks are of wood.

Foreign Car Repair.

The carman not only must be familiar with, and able to repair the steel equipment of his own road, but also be able to repair all types of foreign cars. Foreign cars sometimes come to the shops for repairs in a very badly damaged condition; sometimes on their own trucks and sometimes loaded in another car.

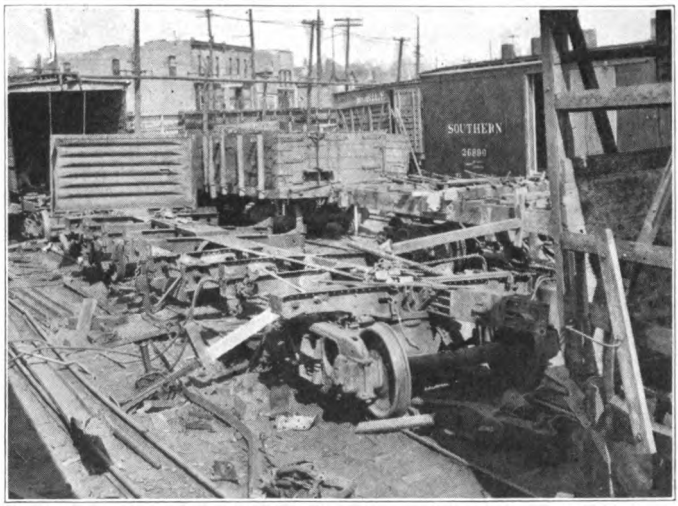


Fig. 18. A, B and A Steel Gondola Being Rebuilt by C. & N. W. Carmen Without the Aid of Blueprints.

The remains of the cars are so badly damaged, twisted and mixed up that the owners are requested to furnish blue prints from which the entire cars are reconstructed. Then again there are times when one end or one side of a steel car is practically destroyed or missing and the carman must make his measurements from corresponding parts on the other side or end in order that the parts needed may be ordered correctly.

Operations Performed in Repairing Steel Equipment.

When steel cars are received at the shop for repairs, it is generally found that along with many other defects that exist, parts of the draft rigging are broken or missing. Also the grab irons, sill steps, brake staffs and other safety appliances are bent, broken or missing. On box cars the roof is invariably worn through and leaky and on gondola cars the floors, sills and dump doors are worn and rusted thin. The door closing mech-

anism is found to be bent, rusted and inoperative and sometimes requires the use of the acetylene cutting torch to extricate. Cars are received in varying degrees of damage due to wrecks, collisions, cornering, side swiping, etc. There are times when the car superstructure is bent almost down to the underframe.

The first step in the repair of the steel car is the removal by cutting off, of the parts to be renewed and the parts to be straightened when off of the car. This is done by the use of a sledge and handle chisel. The chisel is placed against the widest point of the rivet head and then struck with the sledge. Repeated blows cut and break it off. A punch is placed against the cut rivet and struck with the sledge, driving it out of the hole. Loose rivets are especially difficult to cut, but where the rivets are tight and the stroke of the sledge unhampered, the carman can cut rivets with amazing skill and rapidity. The use of the rivet cutting gun is becoming general and necessitates that the carman acquire skill in its use.

The Use of the Rivet Cutting Gun.

The rivet cutting gun is a tool cylindrical in structure about four feet in length. With the cutting chisel or punch it is some-

Fig. 19. Cutting Rivets from Side of Gondola Car. (Note that chisel must be held.)

what longer as these attachments vary in length from 8 to 20 inches. The cylinder contains a piston which works up and

down in the cylinder with a 41 inch stroke propelled by compressed air admitted in sudden and full volume by the operation of a valve at one end of the gun. At the opposite end of the gun is a socket for the insertion of the cutting chisel.

How the Gun Operates.

When the mechanic opens the valve the pressure of air forces the plunger out of the full length of the cylinder where it strikes the chisel. The plunger having struck the chisel and the chisel in turn having struck the rivet, there is a recoil and the plunger comes back into its first position. When the piston reaches the end of its stroke a port hole in the cylinder becomes open, releasing the air pressure after the mechanic has shut the operating valve. At the same time a moderate pressure of air given automatically to one end of the piston through a steel tube on one side of the gun, forces the piston back into position at the valve end of the gun. It will be understood in this respect that the valve operator is required to open and shut the valve with each stroke of the chisel. In this respect it differs from the use of the air hammer where the mechanic operating it simply keeps the valve open and the strokes of the hammer are regulated automatically.

Cutting Off Rivets.

In cutting rivets one mechanic holds the chisel and directs its blow. He must have a knowledge of the angle at which the chisel must be placed against the rivet head to secure the best and quickest results. The mechanic operating the valve must carefully watch the mechanic who is directing the chisel inasmuch as if the gun is operated without the chisel being against the rivet, the chisel will fly out and cause possible injury. If the air valve is operated too fast, the piston inside of the gun will not have sufficient time to return entirely into position, which would mean much irregularity in the strength of the stroke and corresponding difficulty in handling the chisel by the mechanic who directs it. Under ordinary working conditions the gun makes approximately from 30 to 40 strokes per minute, which requires the operator to be quick as well as accurate.

To get the utmost efficiency from the use of the gun, the man operating the valve has to know how many finished strokes can be given to the chisel under the variety of conditions that attend its use. In the large shop the air pressure for its operation will vary at times from 30 lbs to 90 lbs., according to the

amount of compressed air being used on other work, and according to the efficiency of the air compressing machinery which at times is in poor working condition. In cold weather the compressed air has more water in it and this makes the action of the gun somewhat less powerful. However, in cold weather the

Fig. 20. Cutting Off End Door Roller Castings.

steel rivets are very hard and brittle, and the smaller ones can be cut with one stroke of the gun, whereas, in warm weather and especially when the steel car is exposed to the hot sunshine, the rivets are soft and tougher and require more strokes to cut. The manner in which all of these conditions affect the operation of the rivet cutting gun must be known both by the mechanic directing the chisel and the mechanic operating the valve. It is clear, therefore, that the work cannot be done without experience, but requires a real mechanic's skill.

Danger from Flying Rivets.

The element of danger is ever present in the cutting of rivets with the gun. The gun will cut a five-eighths inch rivet in about two strokes, which gives some idea of the power of the machine. A stroke at an improper time will cause the chisel to fly out or, if its movement is resisted at an improper angle, the chisel is liable to break. When rivet heads are cut from the side of the car, they fly through the air at high speed for a distance of sometimes 30 feet. These rivet heads weighing from

½ to 1 ounce with sharp, jagged edges, produce an ugly wound if they strike a person. Sometimes a piece of burlap or a broom is held over the rivet to prevent the head from flying, but this

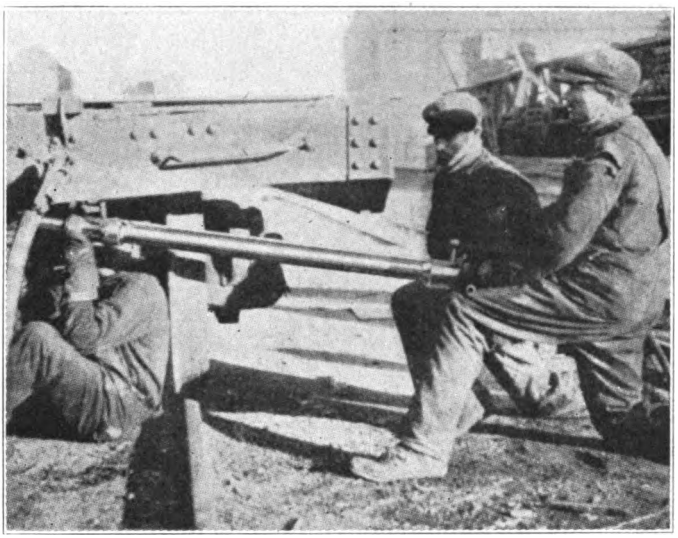


Fig. 21. Removing Draft Gear Rivets.
(Note position of mechanic directing chisel.)

service requires the assignment of a fourth man to the gun crew, and this generally is not done. It may be further stated that if there was another man blanketing these rivets, it would hamper and slow down the work considerably.

Chisels Used.

The chisels used with this gun must necessarily be of very good steel, but the rigors of this service require them to be sharpened frequently, sometimes every hour. This is done by the mechanics themselves or sometimes by the tool room attendant. There are usually three chisels for each gun in order to eliminate delay due to breakage or resharpening.

Punching Out Rivets.

After the heads of the rivets have all been cut off, a punch is inserted in the socket of the gun in place of the chisel and the machine is then used to punch the rivets out of their holes. This requires as much, if not more, skill than the actual cutting

of the rivets, because in the use of a gun so powerful, the punch will not only knock the cut rivet out but will sometimes follow through and stick in the hole that held the rivet. The stroke given the punch by the gun would probably enlarge the hole. An unskilled mechanic on a job of this kind would spend most of his time trying to extricate the punch from the rivet holes.

No two rivets require the same punch power to remove from the hole, and the mechanic operating the valve must be able to judge from the results of the first stroke how much power must be exercised to remove the rivet and not allow the punch to follow it into the rivet hole and become fastened tightly there. In other words, the mechanic operating the valve tells by the feeling of the resistance given by the rivet to the first stroke of the punch how much power should be given to the second stroke in order to drive out the rivet without driving the punch into the hole. As the stroke of the gun is so rapid, this decision has to be made instantly—so fast that it is practically instinctive—which means that only long experience with this type of work enable a man to make such rapid judgment and act upon it accurately.

Gun Operation is Tiring Work.

The work of operating a gun is hard and exhausting. The lightest of these guns with chisel weighs 60 lbs., and other types weigh as much as 90 lbs. This weight is added to by that portion of the air hose and coupling that does not rest on the ground. The valve operator and the helper support one end of the gun and the man at the chisel directs its blow and also supports his end of the gun. The supporting of this weight and the direction of the chisel is so tiring that the valve operator and the man at the chisel relieve each other by changing positions from time to time. Also the jar and vibration of the gun in operation and the danger from flying rivet heads and broken chisels makes the work decidedly unattractive.

Straightening.

After cutting off all of the necessary parts, the carman conveys the ones that require straightening to the straightening table, where he re-shapes them after heating with the blow torch. The blow torch is of cylindrical metal about 10 inches long and 4 inches in diameter. Two narrow pipes about six feet long are attached to the cylinder, one of which ejects a steady flow of oil, and the other compressed air, into it. About thirty feet of hose conveys the oil and air to each pipe. A valve in each pipe near the cylinder regu-

lates the flow of oil and air. The oil when ignited and blown by the air causes the cylinder to eject a flame against the part to be heated.

Heating Bent Parts.

In order to concentrate the flame on the part that is to be heated, the carman sets up a screen of sheet iron or tin sheets which hold the flame from the torch around the parts being heated and also serves to spread the flame over a greater surface. The mechanic must know how to adjust the screen in order to create a spread of the flame suitable to the size and thickness of the part heated and also keep within the limits of the efficiency of his torch.

When the part is sufficiently heated to be workable, it is straightened by strokes of sledges and hammers and the use of the air press. The mechanic also uses varied sizes of split bars to grasp the edge of the part in bending. Rivet tongs are also used to aid in handling the hot metal.

In straightening these parts, care must be taken not to overheat them, because when straightening, the metal will be liable to spread or contract so as to cause humps or thick spots and corresponding thin spots in the sheets or parts being worked. Such thin spots mean a weakening of the piece of material.

Different bends and kinks in the different weights and shapes of material require varied amounts of heat. It is good practice to straighten the parts with a minimum amount of heat, as the application of fire produces scales on the metal, lightening and weakening it. When we take into consideration the variety of steel shapes that the carman must straighten, it will be seen that he must know the action that heat will have on each of these shapes.

Sheet and pressed steel is of such character that the straightening must be done in the shortest possible time, preferably with three or less heats, in order to procure the best results. This is because the more frequently steel parts are heated, the more flexible the metal becomes, and if it becomes too flexible, in attempting to straighten, the parts bend too sharply, causing the kinks, which are very difficult to remove without splitting the hot metal.

It requires long experience to know the action of the fire on the metal and how to avoid straightening methods that would fracture or cause it to kink. In straightening any of the pressed steel shapes, the efforts of the inexperienced man would result only in the complete loss of the part.

Definite Methods Must be Used in Straightening.

The improper application of force to lift a bend generally means that there will be a corresponding depression. The application of force or weight to flatten a bulge will sometimes simply

effect the transfer of the bulge from one side of the sheet to the other, or will cause it to roll or undulate to a contiguous location. Possibly this would be made easier to understand by comparing it with the straightening out of a tin can which has been bent. Anyone who has attempted this has observed that when a bend is removed from one spot the strain is apt to be somehow transferred through the sheet to another point, causing a crinkle or bend there. It requires skill and considerable knowledge of the way forces are transmitted through the sheet metal in order to gradually get rid of the bends and twists, using the right order of procedure and applying the force in the proper manner and direction so as to avoid these kinks in other parts of the metal.

When parts to be straightened are large, the carman must follow a definite line of heating and straightening. The employment of haphazard doubtful methods will result in a poor job. For instance a gondola side top angle is perhaps 42 feet long, of steel, in dimensions 5-16x4x5 inches. We will suppose it to be badly bent and twisted at both ends. The inexperienced man would probably attempt to straighten it first at one end then the other, overlooking the fact that in twisting and pulling it at either end he bends it at the center, whereas the carman would commence work at one end and work right through center to the other end and the results achieved would be better.

The majority of steel cars have a pressed steel end sill, which, on account of its exposed position at the end of the car, is most liable to be received badly bent. As this end sill is shaped with six or more different flanges and as the mechanic may straighten one flange and bend another at the same time, he must know the correct method of doing the work.

When the flame is applied to the metal, the center of the heated portion is naturally hotter than towards the edges. Consequently the metal is soft and flexible at the center of the heated portion and stiffer at the edges. The distribution of this softness as the result of the heating must be well understood by the mechanic so that he can apply the pressure regularly and the blows of the sledge in proper force and angle to straighten. The strokes must be "pulled" or "spliced" to secure the desired effect. Similarly, if the part is large, and after one place has been heated and straightened and the mechanic moves on to the next portion of that part to heat it, he must be careful to heat this new portion in the same manner and to the same degree as he heated the previous portion, or if he makes any variations, the variation must be suited to the amount of straightening that has to be done in this new section. Pressed steel shapes are generally much harder to straighten than sheet steel and the structural shapes, angles, I beams, etc. This is because the pressed steel shapes are curved and the flanging more complex than in other parts.

The straightening of the smaller parts that are entirely heated in the large fuel oil furnace is done by two carmen, who, in reshaping some of the parts and castings on the straightening table require considerable skill.

Straightening Metal Parts Without Heating.

The straightening of parts without heating and while in position on the car requires the use of many different methods. Special care must be used in straightening the light parts, such as posts, braces, roof carlines, etc., in order that the force applied to straighten does not also contrive to pull them from their anchorage and place on the car. This possibility is increased because of the greater power that must be applied to straighten parts cold than when heated.

Straightening Steel End Posts.

The shifting of cargo often bends out the steel I beam end posts of box cars. To straighten, the car with the bent posts and a second car are coupled together. A screw jack is then placed between the cars, one end of the jack on the bulged post on one car and the other end on a heavy plank laid across the end of the second car. The moderate tightening of the jack wedges it into position between the cars. A small block is placed against the bent post in order to insure better purchase for the jack. The plank across the entire end of the good order car distributes the pressure to the four end and two corner posts. The tightening of the jack gradually forces the bent post back into line. It is necessary to force it beyond the exact vertical line and when the jack is released the post springs back into correct position.

Another method used consists of pulling the post in with the aid of a pull jack or turnbuckle and chains. This method is used when the floor is off of the car. The chain is fastened securely to the post at the point of bulge and also to the centersill or fish belly inside the car. The pull jack or turnbuckle on the chain is then operated, shortening the chain and pulling the post in. As it is not a square pull on the post, the chain must be fixed at the post so that it will not work down when the jack or turnbuckle is tightened. This is done by laying the chain above bolts placed in holes on the post or if the post is without holes, at the point required, a simple clamp of two bolts and two short straps is fastened on the post and the chain allowed to fit against it.

Straightening Carlines.

The straightening of carlines is sometimes accomplished by setting a metal framework similar to a bridge over the bulge. A

turnbuckle and chain attachment pulls the bulge up and the resistance is given by the legs of the bridge direct to the carline itself. Little of the force exerted is taken by the carline anchorage.

Straightening Steel Sills.

When the heavy center sills or fish belly structure is bent to any degree, the weight of the part necessitates the use of heat in straightening. These sills are of various types. Some are box-like in character being made up of two long channels placed on edge, parallel, from ten to sixteen inches apart and held together by cover plates top and bottom. The structural shape called a channel is similar in outline to the letter U, except that the bottom is square instead of rounded and the upright prongs are very much shorter.

The fish belly type of center sill is so called because it is of narrow construction at the bolsters and sweeps down wider in the center of the car.

In cross section it appears somewhat like the letter H laid on its side. It is sometimes made of two channels riveted together back to back and reinforced by additional angles running full length of the sill. This fish belly is generally around two feet in depth at its widest portion, but on some cars this fishbelly structure is 30 inches in depth. These structural shapes are generally of 5-16 inch steel.

One of the methods of straightening a badly bent center sill is the placing of a heavy iron shod beam against the bulged portion. This beam is set against a screw jack which is in turn set against the car rail. The car rail is blocked in a manner calculated to aid in withstanding the strain. The screw jack is then turned, forcing the beam against the bulge in the sill which has been prepared by heating. Another part of the same sill may require pushing in from the opposite side.

Besides lateral bends the sill may be bent upwards from the bottom in one section and downward from the top in another. The sill is pulled down by means of a chain and turnbuckle attachment which is drawn around the sill and fastened to one of the ties on which the rails rest. In forcing it up, screw jacks are used. It sometimes takes from two to four days to straighten a badly bent sill. The bends, kinks and twists that commonly occur in these sills are so complicated that it would be impossible for unskilled men ever to straighten them.

Effect of Heat in Straightening Sills.

The effect of the application of heat on these sills must be thoroughly understood by the mechanic. When beams of this weight are heated they will sag and the mechanic will allow this sag, if it is an aid in lining up the sill, but if not, he must take steps to prevent it. Also the long sills will move away from the

flame at the point heated. The mechanic must know to what degree they will do this in each case, and use this effect as an aid in straightening when possible, and prevent it where this movement cannot be put to advantage.

The difference in time required by some mechanics and the time required by others to do like work is sometimes considerable and goes to show that it requires a great deal of experience, knowledge and skill to do this work of straightening quickly and well. The carman in doing this class of work receives little supervision and follows his own ideas as to the best method of doing the work.

Bolting and Fitting.

As in straightening, three men usually work together on the bolting and fitting of the parts. The work consists of placing the various parts in position on the car where they are held temporarily by bolts. These three men also lay out the sill splices, new sheets and castings for the shearing, punching, drilling or grinding they may require. Experience and knowledge of the requirements of each part is absolutely necessary to perform this phase of the work. The carman must also have considerable skill in measurement to lay out these parts correctly. In laying out the part, he marks the location of each hole with his center punch and writes in the size it must be. He then takes the part to the carman operating the shears and the punch machine or spacing table.

Great care must be taken to mark accurately the location and size of each hole to be punched. If the laying out is done incorrectly, it means that in the event of a slight mistake some of the holes have to be reamed or drilled larger and the rivets placed in holes too large for them. This results in a weak spot and when the part comes under the strain of use, the rivets are likely to work loose and make the car defective. If the sheet is laid out extremely inaccurately, it results in having a whole series of holes punched in the wrong place. This means that this part will have to be set aside and recut to fit some other place or some other car. The loss of time due to mistakes of this character would be considerable, as the carman would have to do all of the original work on that part over again, carry the material to and from the power machines twice and wait for it while the machine work on it is being performed.

In operating the air drill machine at the car or the drill press in the shop, the carman must know the qualities of the kinds of steel and iron used in order that in drilling he will know what pressure to put on the drills, the proper speed, and how quickly the drills are likely to become hot. The overloading of these machines would result in the frequent destruction of the expensive high speed

drills used. In the operation of the spacing table or punch machine, judgment must be exercised in order that the punches may not be broken or the machine put out of commission through overloading.

The placing of all of the parts into position on the car is generally accomplished without the aid of any overhead hoists. The part is jacked up or slid up an incline of planks until raised high enough to insert a bolt to hold it. As some of these parts weigh as much as 800 pounds, their lifting into place requires some degree of engineering ability to accomplish without accident. The carman must know the correct places to apply bolts and the number required to properly hold each part for the application of rivets.

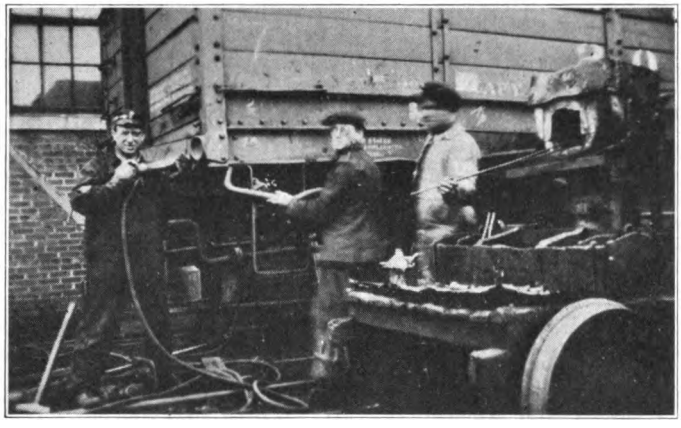


Fig. 22. Riveting Gondola Car Push Pole Casting.

RIVETING.

In riveting, as in straightening, and bolting, and fitting, three men usually work together. One of the men heats the rivets, one operates the air hammer and the third man holds the rivet in place with a heavy bar hollowed at one end to fit around the rivet head. The rivets are brought to the proper degree of heat in the rivet heating furnace, picked out with tongs and placed in the holes. The head of the rivet is held tightly up against the sheet while the man operating the air hammer fashions a head on the other end of the rivet. It is understood that the rivets are intended not only to hold steel parts together, but to hold them together tightly. This requires that the rivet be just the right size to fit the hole and that when the head is welded by the hammer that it fits closely to the surface of the metal. If the head is poorly made so that the edges stick up from the surface or are ragged, water can get under-

neath the head and rust the rivet or the edges of the holes in which it fits, which means a weakening of the part and that the rivet will eventually work loose. The rivet heads must be of good appearance and shape to pass inspection by the foreman or car inspector before the car is sent to service. In making the rivet head it is not only necessary for the operator to place the air hammer against the hot rivet, but it is necessary for him to manipulate the hammer in such a manner that a proper head will be placed on it. This must be done quickly while the rivet is hot. It is not the air hammer itself that makes a perfect rivet head, it is the manipulation of the hammer by the mechanic that does the work.

When an inexperienced man is given a job of riveting a car, probably three-fourth of his rivets must be cut out and done over and he feels heavily the strain of the work for an entire day.

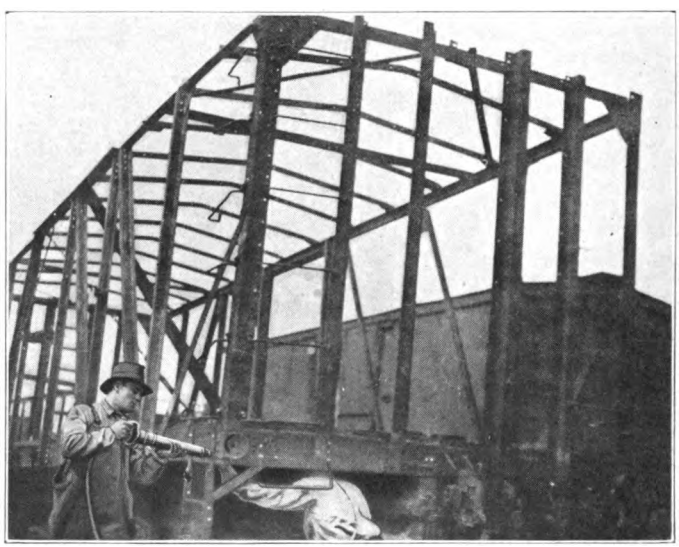


Fig. 23. Riveting Side Sill Step.
(Note the man holding on the rivet.)

It is sometimes erroneously assumed that the work of holding on rivets requires no degree of skill or care. Each stroke of the air hammer on the opposite end of the rivet causes the holder on bar to jump from the head of the rivet, and it is brought back into position immediately by the weight of the man holding it. As the rivet head is hot and flexible, the holder on bar must be brought squarely over it each time or its shape and fit is likely to be spoiled.

Knowledge of Rules.

In the repair of steel equipment the carman must have the ability to read and understand blue prints and to be able to make simple working sketches when required. He must be able to count the number of rivets, bolts, washers and castings he needs to complete the job. He must have a working knowledge of the Interstate Commerce Commissions Safety Appliance rules and also be familiar with the Master Car Builders' rules of the American Railroad Association insofar as they cover the method of repairing steel cars. A sample of this knowledge required is in the observance of Rule No. 22 of the Master Car Builders' rules which gives the method of applying splices to steel sills.

Rule 22, p. 42, American Railroad Association Code of Rules:

"Steel sills may be spliced in accordance with Figs. A, B, C and D. Adjacent sills may be spliced.

"The splice for center sills, except as otherwise herein stated, to be located not less than 7 inches from either side of the body bolster consisting of butt joints. The butt joints to be reinforced by plates on both sides to be not less than twice the length of the protruding end, but not exceeding 24 inches, and not less than thickness of web plate, with the one on the flange side of channel to include flanges, while the outside plate should only cover the web. The rivets to be spaced as shown on Figs. A and B.

"Fig. A shows the method of splicing center sills in front of body bolster.

"Fig. B shows the method of splicing center sills back of body bolster.

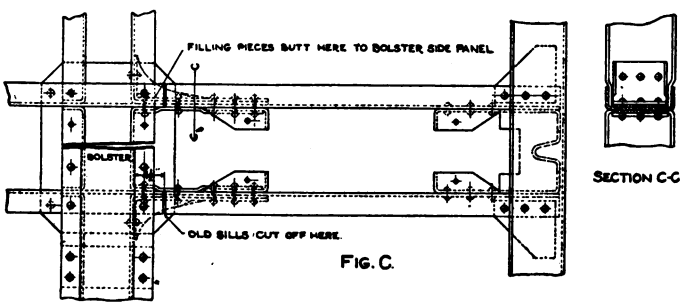


Fig. 24. One Method of Splicing Steel Center Sills as Given by M. C. B. Rules.

"Fig. C shows method of splicing in cases where cars are damaged to such an extent that the center sills have to be cut off less than 8 inches from the front side of the body bolster. This method is not recommended for sills with protruding ends less than 3 inches. The outside plate in this splice may be made of pressed steel or a steel casting. The rivets should be spaced as shown on sketch.

"Fig. D shows the method of splicing side sills. This splice may be located on either side of the body bolster. The rivets should be spaced as shown on sketch."

The carman must keep himself acquainted with the changes in these rules that affect his work.

Working Conditions.

The regularity of the work on steel equipment and the physical conditions under which it is done are substantially the same as when repairing wooden equipment. Working in the hot sun or in very cold weather, however, brings some additional discomforts when working on steel cars. When a steel car stands under the hot sunshine in summer, the metal gets so hot that it actually burns the hand when touched. In the winter the metal parts are extremely cold and uncomfortable to handle, as is sometimes necessary, without gloves, or with very thin ones. As previously mentioned, the qualities of steel vary in the cold or hot weather, which calls for the exercise of skill and knowledge by the mechanic. For example, a steel casting that will stand considerable sledging in hot weather will crack much more readily when made brittle by frost. In the repair of steel cars the carman works in an atmosphere of continual noise and vibration. The noise from the air hammer in some cases causes deafness. He also is subjected to the fumes, smoke, and odors arising from the use of the oil burning rivet furnaces and the blow torch.

The carman using fuel oil is responsible for fires that may break out on the rivet heating furnace. These rivet furnaces, after being in use for some time, become literally covered with thickened fuel oil, which sometimes breaks into flames. The usual method of putting out the fire requires that the carman shut off the supply of air and oil. As the valves are flame covered, he must protect his hand and arm by gloves and a winding of burlap. The furnace is thrown on its side and dirt and cinders spread over it.

As the steel foreman has a large gang and many cars to look after, the men do not work under close supervision. It is generally left to the judgment of the mechanic by what method and in what order his work is to be done. He must plan his work and get the material he needs to the car promptly, so that no time will be lost in waiting.

SECTION D.

REPAIRING FREIGHT CAR TRUCKS.

In repairing freight car trucks the carman must have a knowledge of the best and quickest way to perform his work on

each type of truck. Some of the most common are: Arch bar, Bettendorf, Kindl, Fox, Ajax, Scullen, Andrews and Vulcan.

Repairing the Arch Bar Truck.

The Arch Bar truck is probably in greater use than any other type. The repairs to this type of truck generally consist of the changing of wheels, some of the journal boxes, renewal of dust guards, raising shims, column bolts, journal box bolts, the application of nut locks, new brake shoes and the repair of brake beams and hangers when required. To remove the wheels, the journal box bolt nuts are removed and the bolts pulled up

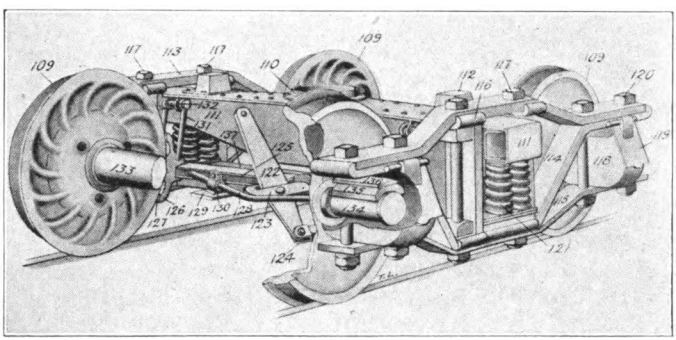


Fig. 25. The Arch Bar Truck

out of the holes in the arch bars; blocking is placed under the pedestal castings on the side the wheels are to be removed from. The wheels are rolled, carrying the journal boxes out from between the arch bars, the journal boxes are then removed and cleaned out after which the journal bearing and wedge are examined by the carman. He is able to recognize any defects in the bearing such as worn through the babbitt lining, cracked lining or back, bent out of shape, impregnated with gravel, etc. He must also inspect the wedge, because on its condition depends the performance of its principal function—the equal distribution of car weight on the journal bearing and thence to the journal. He must be able to inspect the wheels, journals and axles, and detect any of the great number of defects to be found in these parts, and at most repair points he is required to keep the wheel and axle record showing the number of each wheel, its size, capacity, date cast, date applied and removed, diameter and length of journal, length of and diameter of axle at center,

showing also the existing defects causing him to remove these parts. Generally some of the defects in the following list are found:

Wheel and Axle Defects.

Sharp flange,
Worn flange,
Shelled out,
Brake burn,
Slid flat,
Worn tread,
Worn thru chill,
Chipped flange,
Chipped rim,
Burst wheel fit,
Loose wheels,
Out of gauge,
Bent axle,
Cut journal,
Broken collar,
Worn collar,
Worn fillet.

He must have a working knowledge of these defects and the limit of wear to these parts given in Rules 68 to 86 inclusive, of the American Railway Association M. C. B. Code of Rules. The carman takes the description of the new wheels and axle brought to the car for application in place of the pair he has removed. He cleans the journals and bearings thoroughly with waste and puts a quantity of clean oil on the journal. He then puts the journal box over the axle journal, pushing it well back against the wheel in order that it will sit securely while he tips up the box at its outer end and inserts the journal bearing and wedge. Holding the journal boxes upright, he rolls the wheels into place on the truck, with the journal boxes properly between the top and bottom arch bars. The holes in the arch bars and journal boxes will generally not line up accurately for the re-insertion of the journal box bolts. This the carman accomplishes by inserting the round end of his pinchbar in one set of holes, levering them into line while his partner drives down a bolt through the other set of holes on the same corner of the truck.

The Jones nut lock is usually applied to the top and bottom of the column and journal box bolts. This is an ingenious little device of light, flat metal with a hole in it large enough to admit the bolts. One lip is flanged over the edge of the arch bar and the lip on the other end is hammered over the bolt head or the nut. This nut lock is applied on top to prevent the bolt from turning, and on the bottom to prevent the nut from turning.

The renewal of wheels is only a small part of the work of the carman in repairing trucks. Generally the repairs needed require that the truck be virtually dismantled, and he must secure the right material to enter into its reconstruction, such as bolsters, center plates, springs, column castings, spring channels, brake beams, brake beam hangers, brake lever guides, etc. He must know the size and type of material standard to the great number of varieties of trucks of all sizes.

Packing Journal Boxes.

After the truck has been reconstructed the carman or helper assigned to that work packs the journal boxes with oily waste. There are a great many points regarding even this apparently simple operation that the carman must know. There is literature continually being published varying in size from pamphlets to small books, describing how a journal box should be packed properly. No railroad library is complete without various treatises on journal box packing. Few railroad operating department conventions or meetings are held where it is not discussed.

Side Bearing Clearance and Coupler Height.

When the carman lets down the car on the truck after repairing it, he measures the side bearing clearance and the distance from the rail to the center line of coupler, which distance is not the same when the car is loaded as when empty. If the side bearings, upper and lower, are too close, the car rides rigid and the weight, when turning curves while in service, will not be distributed properly. This, together with the tremendous friction on sometimes but one side bearing, will probably derail the car. Oppositely, when there is too much clearance, the car rolls and being top-heavy when loaded, alternately lifts the wheels from the track on either side of the car. Result: derailment, damage and delay.

When the coupler is not high enough, the carman sometimes fastens a metal shim on the carry-iron under the coupler shank. Sometimes he increases the thickness of the wooden shims under the truck springs, which is done in this manner.

He takes the weight of the car from the truck by jacking it up. He then lifts the end of the bolster from the springs with another jack, and his partner pries up the springs so that he can insert the shim on the channel under the springs. This shim raises the truck bolster and the center plate which is part of it, which raises the car height and coupler height. Coupler height is prescribed by law: Loaded cars 31½ inches to 33½ inches. Empty, 32½ inches to 34½ inches.

Brake Connections.

The carman must know on which cars to apply the M. C. B. No. 1, No. 2, or No. 3 brake beam according to the weight of the car. He must know the length of the rods and brake levers and how to apply in order to get the proper brakeing power. He applies all of the brake connections so that when the air is applied, all the shoes are brought properly and squarely to the wheels. He must have a knowledge of how to adjust them when

they do not work right. He must know the proper piston travel from the cylinder; that holes in the levers are spaced properly, and that the truck levers are in the proper hole on the lever guides.

Each connection pin is held in place by a split key, which is inserted in the hole at one end of the pin. The carman is depended upon to spread these keys properly, because if he does not, the connection pin will fall out and the rod or lever will fall to the ground and drag, probably causing derailment, damage and delay. An inexperienced man could not put up the brake connections properly on a car.

Every truck bolt should be secured by double nuts or better. We have seen mechanics without car experience who did not know how to apply double nuts to a bolt in the best manner. The first nut should be applied top first and the second nut applied in the usual way,—bottom first. The top of the nut is sometimes beveled off at the corners and generally raised somewhat at the center. The bottom is usually flat, some even slightly concave, with corners left square and sharp. When applied in the order above given, the flat bottom of each nut is brought together tightly and evenly. This gives greater friction between each nut, locking them tightly, and the natural growth of rust binds them better.

Part II.

WORK ON PASSENGER TRAIN CARS.

SECTION A.

GENERAL DESCRIPTION OF THE WORK.

The carman repairs all cars carried in passenger trains. These include postal, palace horse cars, day coaches, chair cars, parlor cars, observation, private cars, sleeping cars, cafe, buffet and dining cars. In the construction and repair of these cars the carman uses a number of mechanical appliances, and besides must have a complete set of tools.

Machinery and Tools Used.

On passenger car work the carman operates drilling machines of three or four different sizes, some operated by air and some by electricity. These machines are portable, weighing from about twelve pounds to seventy-five or eighty pounds. Each machine has its air hose and couplings or its electric wire and fixtures, and the carman is responsible for their proper application, removal and care. He must connect the air hose in such a way that none of the air pressure will be wasted, and when using electric drills, he must see that the connection is properly made in order that he will not blow out fuses that may affect the lights in the shop or hamper the use of other electric appliances. He must know how to best set up and adjust these machines to the work he has in hand. These machines require from one to three men to operate, according to their weight and the accessibility of the part to be drilled.

The carman places the scaffolding he uses and is responsible for the care of the planks, ladders and horses which compose it. Lever jacks and hydraulic jacks are used in jacking the cars up from the trucks. Screw jacks are used in jacking parts into place when powerful, gradual pressure is needed. Small screw and hydraulic jacks are used to jack up the truck journal boxes in removing and applying journal bearings. Each car, after being jacked up, is set securely on horses, four or eight being used, according to its weight. All of the equipment mentioned above is supplied by the company.

A summary of the principal hand tools that the carman is required to have for use on passenger car work is given below:

Breast drill,
Hand drill,
Push drill,
3 Braces, 1 small, 1 medium and 1 large,
Brace and auger bits, from $\frac{3}{16}$" to $1\frac{3}{4}$",
2 or 3 sizes of wood countersinking bits,
Metal drill bits from 7/64" to 1",
Taps from No. 6, 32-thread to $\frac{5}{16}$", 18-thread.

With the power machines countersinking and drill bits up to 2″ in diameter are used. (Supplied by the company).
1 Expansion bit,
1 Large and 1 small jack plane,
1 Smoothing plane,
2 Rabbit planes,
1 Block plane,
1 Circle plane,
1 Beading plane,
Wood chisel, ⅛″, ¼″, ½″, ¾″, 1″, 1¼″, 1½″ and 2″,
Gouges, ¼″, ⅜″, ½″, ¾″, 1″ and 1½″,
1 Rip saw, No. 6,
1 Saw No. 8,
1 Fine saw, No. 10,
1 Mitre box saw,
1 Keyhole saw,
1 Scroll saw,
4 Scroll saw blades,
1 Hack saw,
4 Hack saw blades,
1 Saw horse,
1 Mitre box,
1 Saw set,
4 Saw files,
Clamp to hold saws when filing,
1 Light and 1 heavy claw hammer,
1 Small tack hammer,
8 Screw drivers of various weights and lengths,
1 Ratchet screw driver,
1 Large and 1 small automatic screw driver,
3 Nail sets,
1 Small and 1 large square,
1 Bevel square,
1 Compass,
1 Divider,
1 Calipers,
2 Foot rule and 6 foot rule,
1 Marking gauge,
1 Chalk line,
Chalk,
1 Lead pencil,
2 Small punches,
2 Large punches,
1 Long pierce or lambrick,
2 Small scratch awls,
2 or more small clamps which are used to hold firmly together parts that have been glued, while the glue is drying,
1 Large cutting pliers,
1 Slip joint pliers,
1 Small pincers,
Socket wrenches from ⅜″ to 1″,
Steel S wrenches from ⅜″ to 2″,
Short pinch bar,
3 Cold chisels,
} About one-half supplied by the company.
1 Small and 1 large monkey wrench,

1 10″ Stillson wrench,
1 Small and 1 large flat file and 1 round file,
1 Wood rasp,
4 Steel scrapers,
1 Scraper holder,
2 Tap wrenches or tap handles,
2 Tool boxes. Each man buys his lumber, lock and hinges for making his tool boxes. He usually has more than one because he cannot carry all of his tools around from car to car. Some mechanics have three tool boxes.
1 Hand box in which he carries various sizes of screws, from ½″ No. 3 to 3″ or 4″ No. 16 or 18, with differently shaped heads, round, flat, oval and special heads.
1 Carpenter's apron,
1 Curtain winder,
1 Sash balance winder,
1 Oil stone,
2 Oil cans, 1 large and 1 small. The large one contains kerosene, and the small one lard oil or machine oil,
1 Four pound hammer,
1 Sledge hammer, } Furnished by the company.

Horses, ladders and scaffolding are in constant use.

Jacks, in frequent use on truck work. Nearly all of the hand tools are used every day, especially the hammers, wrenches and screw drivers. The tools used only occasionally are the Power drills and Expansion bits.

Tool Expense.

From time to time some of the carman's tools become broken, worn out, or lost, and require replacement. The average yearly cost of this tool replacement is about forty dollars, at the present time. This amount varies considerably in the different shops. In some shops the mechanic's tools are practically safe from theft, but in others he must watch them carefully. About twenty-five dollars of this tool expense is incurred in keeping up his supply of bits, drills and chisels because they break frequently.

The original cost of a complete set of tools such as the passenger carman is required to have, is one hundred and seventy-five dollars. This estimate is based on the present market prices of tools and will vary because no two carmen have precisely the same number and variety of tools. The carman must lose some time from work to replace the loss of any of his tools, because after his day's work is done, he would find most of the stores where tools are sold, closed.

Materials Handled.

Passenger car repair work necessitates the use of a great number of kinds of wood. Most of these will be found on the list

below in order of the approximate degree that they are handled:

Poplar,	Mahogany,
Oak,	Maple,
Ash,	Birch,
Pine,	Walnut, and occasionally
Fir,	Spruce.

In some parts of the country other different woods, generally obtained near by, are used as substitutes for some of the kinds given above. The different kinds of woods mentioned above vary in respect to hardness, closeness of grain, frequency of knots, quantity of rosin, liability to split, weight, tensile and compression strength. The carman must know the different qualities of each of these kinds of wood in order that the work shall be done properly and his tools kept from damage or breakage.

The carman is required to handle sheet steel and many shapes and weights of malleable iron, brass and steel castings. He also uses light sheet steel in repairs to the inside of all-steel passenger cars.

In addition to these different kinds of wood and metal parts that the carman is constantly using, he also is using the following kinds of material which go into the work:

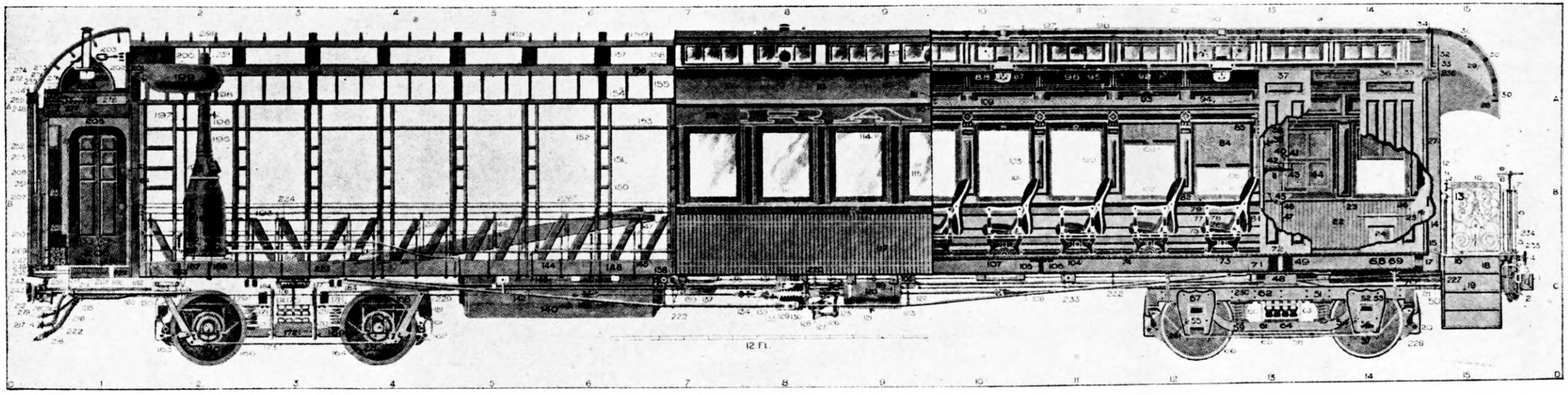
Wire nails from two penny to sixty penny.
Finishing nails from ½" to 3" long in the various weights,
Lag screws,
Brass and iron wood screws from ½" No. 3, to 4" No. 18,
Brass and iron machine screws from ¼" to 3" in length, and in sizes from No. 3 to No. 18, with threads from 64 to 16 to an inch.

In using screws he must select the kind most suitable to the work he has in hand, as they are made with flat, oval and round heads and many heads of special shape. He also uses stove bolts and carriage bolts in sizes from one inch to eight inches in length, and from one-eighth inch to three-fourths inch in diameter, and square and hexagon head bolts up to one and one-half inches in diameter and twenty-four inches long. He uses various kinds of tacks, carpet tacks and gimp tacks being some of the varieties. Many of the parts are also held together with glue.

Wide Variety of Material Because of Differences in Equipment.

Of these materials that go to make the passenger car, there is an innumerable variety of sizes and shapes. The carman must know the standard and special sizes and shapes of these parts that he requires in repairing any particular car. In this respect we might say that passenger train equipment is as far from being standard as freight car equipment is. An instance: Of the 1,624 passenger cars on the Southern Railway System, the Railway Equipment Register shows that there are 200 different headings under

ANATOMY OF A PASSENGER CAR



Reference List of Parts Indicated by Numbers on Diagram.

1 Janney Coupler 16C
2 Safety Chain 16D
3 Brake Chain 16C
4 Buhoup Buffer 16C
5 Platform Railing 16C
6 Platform Railing Chain 16C
7 Platform Rails 16B
8 Brake Shaft 16B
9 Brake Wheel 16B
10 Platform Gate 16B
11 Gate Lock Handle 15B
12 Bell Cord Coupling 15B
13 Platform Gate Hinge 15C
14 Body Hand Rail 15C
15 Threshold Plate 15C
16 Platform 15C
17 End Sill 15C
18 Step Riser 16C
19 (Tread Board) Step 16D
20 Safety Strap Brake Safety Strap 15D
21 Brake Chain Connecting Rod. 15D
22 Wainscot Panel 14C
23 Wainscot Panel Rail 14C
24 Closet Hopper 15C
25 Urinal Pipe 15C
26 Urinal 15C
27 Corner Post 15B
28 Platform Hood Bow 16B
29 Platform Hood Carlines 16A
30 Platform Roof—Platform Hood 16A
31 Platform Hood Ceiling 15A
32 End Plate 15A
33 Deck End Sill 15A
34 End Carline 15A
35 Car Signal Valve 15A
36 Deck Sash Opener 15A
37 Partition 14A
38 Water Cooler 14B
39 Cut-off Valve, Pintsch System. 14B
40 Water Cooler Faucet 14B
41 Tumbler 14B
42 Tumbler Holder 14B
43 Water Cooler Support 14B
44 Window Blind 14B
45 Basin Washbowl 14C
46 Basin Coupling 14C
47 Washbowl Pipe 14C
48 Side Bearing 14C
49 Body Bolster 14C
50 Main Train Pipe 15D
51 Equalizer Spring Cap 14D
52 Pedestal Jaw 14D
53 Pedestal Horn 15D
54 Journal Box Cover Spring ... 14D
55 Journal Box Lid 13D
56 Axle Box 14D
57 Pedestal Jaw Bit 14D
58 Pedestal Tie Bar 14D
59 Equalizer Spring Seat 13D
60 Equalizer Spring 13D
61 Sand Plank—Spring Plank ... 13D
62 Truck Side Frame 13D
63 Spring Band 14D
64 Equalizer 14D
65 Car Truck 13D
66 Wheel Flange 13D
67 Pedestal 13D
68 Check Chain 15C
69 Check Chain Eye 15C
70 Check Chain Hook 15C
71 Truss Rod Anchor Iron 13C
72 Flooring 14C
73 Seat Leg 13C
74 Foot Rest 12C
75 Seat Bottom 13C
76 Cushion—Car Seat 13C
77 Seat End 13C
78 Seat Lock 13C
79 Seat Arm 13C
80 Seat Arm Plate 13B
81 Seat Back Band 13C
82 Seat Back 13C
83 Inside Window Sill 13B
84 Shade 13B
85 Conductor's Valve 13B
86 Discharge Pipe 13B
87 Globe 11A
88 Gas Burner 11A
89 Lamp Arms 13A
90 Lamp Vent 13A
91 Clearstory 11A
92 Bell Cord Hanger 12A
93 Bell Cord Hanger Ring 12A
94 Bell Cord 13A
95 Car Moulding 12A
96 Ceiling 11A
97 Roof Boards 11A
98 Roof 12A
99 Sash 12B
100 Adjustable Shade Holder ... 12B
101 Window Lock 11B
102 Sash Lift 12B
103 Match Striker 11B
104 Steam Pipe Cover 11C
105 Floor Timber Distance Block. 11C
106 Cross-tie Timber 11C
107 Side Sill 11C
108 Truss Rod 11D
109 Basket Rack 11B
110 Basket Rack Netting 10B
111 Basket Rack Rod 10A
112 Torpedo Ventilator 8A
113 Lower Deck 9A
114 Window Lintel 9B
115 Window Panel 10B
116 Outside Window Sill 8B
117 Outside Panel 9C
118 Auxiliary Reservoir Beams ... 9C
119 Auxiliary Reservoir Bands ... 9C
120 Auxiliary Reservoir 9C
121 Auxiliary Reservoir Drain Cock 9D
122 Body Truss Rod Bearing Strut 10D
123 Truss Rod Bearing 10D
124 Auxiliary Reservoir Nipple ... 9C
125 Cylinder Lever 9D
126 Triple Valve Branch Pipe ... 9D
127 Drain Cup 9D
128 Triple Valve 9D
129 Turnbuckle 8D
130 Bleeding Valve 9D
131 Brake Cylinder 8C
132 Piston Packing Leather 9C
133 Release Spring 8D
134 Cross Head 8D
135 Back Cylinder Head 8D
136 Gas Pipe from Governor 8C
137 Pintsch Gas Governor 8C
138 Pintsch Gas Gauge 7C
139 Gas Pipe to Governor 8D
140 Pintsch Compressed Gas Tank. 6D
141 Floating Lever (Air Brake) ... 6D
142 Train Signal Pipe 6D
143 Train Brake Pipe 6C
144 Body Brace Straining Rods ... 6C
145 Compression Beam Brace 7C
146 Body Brace 6C
147 Panel Rail 7C
148 Steam Heating Pipe 7C
149 Compression Beam 7C
150 Window Post 7B
151 Window Panel Furring 7B
152 Sill and Plate Rod 6B
153 Upper Belt Rail 7B
154 Plate 7A
155 Main Carline 7A
156 Deck Sill 7A
157 Deck Post 7A
158 Deck Sash 7A
159 Deck Plate 7A
160 Upper Deck Carline 6A
161 Brake Block 5D
162 Brake Beam 5D
163 Brake Beam King Post 2D
164 Car Wheel 4D
165 Axle Safety Bearing 3D
166 Back Face Plate 3D
167 Axle 4D
168 Axle Safety Bearing Thimbles. 5D
169 Axle Safety Bearing 4D
170 Spring Plank Hanger 4D
171 Bolster Springs 3D
172 Lower Spring Hanger Pivot .. 3D
173 Lower Brake Rod 3D
174 Bolster Spring Cap 3D
175 Truck Bolster 3D
176 Centre Pin 3C
177 Truck Centre Plate 4C
178 Safety Beams 4D
179 Brake Rod 3D
180 Brake Lever 2D
181 End Piece of Truck Frame .. 5D
182 Combination Side Spring 2C
183 Side Stem 2C
184 Twin Body Bolster 3C
185 Shank End of Drawbar 2D
186 Draft Timbers 2C
187 Bottom Stove Plate 2C
188 Steam Pipe Jacket 3C
189 Ash Pit Door 3C
190 Ash Pit Door Handle 2C
191 Ash Pit (Baker Heater) 2C
192 Baker Heater 3C
193 Lower Belt Rail 3C
194 Baker Car Heater Coal Hopper. 2B
195 Stove Pipe 3B
196 Stove Pipe Damper 3B
197 Circulating Pipes 2B
198 Circulating Drum Water Gauges 3A
199 Circulating Drum 2A
200 Safety Vent for Baker Heater. 2A
201 Filling Funnel for Baker Heater 2A
202 Vestibule Equalizer 2A
203 Vestibule Equalizer Chain ... 2A
204 Vestibule Lamp 1A
205 Vestibule 1B
206 Vestibule Doors 1C
207 Curtain 1B
208 Vestibule Face Plate 1B
209 Platform End Sill 1C
210 Platform Plank 2C
211 Platform Short Sills 2C
212 3-Stem Car Coupler 1D
213 Coupling Valve (Air Brake) .. 1C
214 Coupling Valve Handle 1C
215 Angle Fitting 1D
216 Armored Air Brake Hose 1D
217 Coupler 1D
218 Steam Hose 1D
219 Letter Board 8B
220 Air Brake Piston 9C
221 Axle Safety Strap 4D
222 Signal Hose 7D
223 Body Centre Plate 4C
224 Body Counter Brace 3B
225 Brace Straining Rod 5C
226 Brace 6B
227 Brake Shaft Chain 15C
228 Brake Shoe 15D
229 Dead Lever 5D
230 Equalizer Spring Cap 13D
231 Truck Bolster-Flitch Plates .. 4D
232 Deafening Flooring 12D
233 Intermediate Cross-tie Timber. 11D
234 Platform Railing Post 16C
235 Base Washer for Platform Railing Post 16C
236 Door Lintel 15A
237 Clearstory Post 10A
238 Stove Pipe Cap 2A
239 Stove Pipe 3A
240 Axle Journal 3D
241 Journal Box Cover Bolt 13D
242 Knuckle Pin 1C
243 Vestibule Buffer Plate 1C

PARTS OF JANNEY-BUHOUP VESTIBULE AND COUPLER

244 Arch Plate 1A
245 Buffer Stem 1C
246 Foot Plate Housing 1C
247 Foot Plate 1C
248 Upper Spanner Bar 1B
249 Lower Spanner Bar 1C
250 Channel 1C
251 Curtain Plate, Rear 1B
252 Curtain Roller 1B
253 Curtain 1B
254 Post Plate 1C
255 Arch Plate Cap 1A
256 Dome 1A
257 Upper Holder for End Gate ... 1B
258 Lower Holder for End Gate ... 1C
259 End Gate 1C
260 Bell Cord Guide 1B
261 Strap Hinge 1C
262 Butt Hinge 1B
263 Door Bolt Keeper 2B
264 Door Bolt 2B
265 Door Latch Keeper 2C
266 Patent Plate 1A
267 Door Latch 2B
268 Spanner Bar Bolt 1A
269 Curtain Spring 1C
270 Piston Stem Spring 1A
271 Accordeon Hood 1A
272 Arch Plate Band 1A
273 Shield 1A
274 Arch Plate Cap Bolt 1A
275 Piston Stem 1A
276 Piston Stem Guide 1A
277 Piston Stem Washer 1B
278 Piston Stem Bracket 2A
279 Catch Lever 1D
280 Uncoupling Lever Chain 1D
281 Uncoupling Lever 1C
282 Stirrup 1D
283 Side Stem Bracket 2C
284 Buffer Spring 1C
285 Buffer Stem Bracket 2C

which these cars are classified. In other words, the average number of each type of car in regard to construction details would be only slightly over eight. It can be readily seen that in repairing passenger cars it is impossible to maintain in stock the different parts in any standard size. Of course the different moldings, battens and sheathing will be found perhaps common to all of the wooden equipment. As the dimensions differ somewhat, it is necessary for the passenger car man to cut and frame his posts and braces to suit the conditions required by each car. The side sill framing would perhaps differ in every one of these types, and therefore each individual car must be laid out and the proper measurements for holes and gains sent to the mill in order that the sill may be properly fitted.

Outline of the Repair of a Wooden Passenger Car.

(Refer to Fig. 26, Page 73)

Platform and Body Repairs.

It is the intent of most railroads to shop their wooden equipment for general repairs once in every period of twenty-four months or less. However, many cars are kept in service for a period of thirty months or longer, and when the car is sent to the shop, it is generally found that it requires one or two new head timbers or platform end sills(No. 209), and the renewal of one or both end sills (No. 17), together with a splice on one of the longitudinal sills, probably the side sill (No. 107) and the renewal of the draft timbers (No. 186) or the bolts that hold them into place.

The platform itself will be badly decayed, which means a renewal of the platform planks (No. 210) and the platform short sills or supports (No. 211). This part of the repairs is effected first by removing the coupler (No. 1), the taking down of the safety chains and rods (No. 2), the removal of the brake chain (No. 3), the brake shaft and brake wheel (No. 8 and No. 9), the platform gate hinge (No. 13), the buffing attachment (No. 4) and the removal of every one of the parts of the vestibule and coupler attachments. (Shown under Nos. 244 to 285 inclusive).

The old platform end sill is taken to the mill, where the layer-out or the man working on the car measures it and marks a new timber for the necessary holes, mortices and gains it must have. If the sill is missing the layer-out goes to the car and takes measurements from which he makes a template as a guide in laying out the new timber. The same process is repeated in taking down the body end sill, and the carman, when applying them, cuts and fits all of the platform floor supports (No. 211), and fits the end sill so that the tenons on the longitudinal sills fit the mortises accurately.

Splicing a Side Sill.

In splicing the side sill he must first remove the sheathing (No. 117) and the apron moulding with the aid of a pinch bar, and after the removal of the decayed parts, must cut a scarf on the portion of the sill that is left in the car. It will be noted in removing this portion of the sidesill, it is necessary for the carman to remove the nuts at the bottom end of the sill and plate rods (No. 152), and also the bolts that go through the body bolster (No. 49), and also loosen the truss rods No. 108) and let down the intermediate crosstie timber (No. 233), in order to get the sill out. Before loosening up the truss rods he sets braces under the car center at each side.

He then measures the decayed portion and sends the dimensions to the mill, and when the splice returns, he measures and marks the splice for holes for the sill and plate rods (No. 152), and also the holes for the bolts that go through the body bolster (No. 49), and the crosstie timber (No. 233). After boring these holes he puts the sill splice into position with the aid of a sledge and jacks, and fastens it into place by the bolts and rods which he has loosened in its removal. All of the above described work is usually done by two mechanics. After he has tightened up the bolts through the body bolster and the intermediate crosstie timber and the sill and plate rods, he then nails the flooring (No. 72) which, when removing the splice, he was required to lift.

Applying Car Sheathing.

He then measures and saws the sheathing (No. 117), and after nailing it to the sill, and to the belt rail (No. 193), he is required to plane and finish it so that it will be level and smooth and correspond in thickness and on line with that portion of the sheathing that was left on the car. The method of applying this sheathing is as follows:

After it has been cut to proper length, the tongue and groove on the edge of each piece is brushed with a solution of white lead. The portion of the car surface over which each piece of sheathing is placed, is coated with glue. Then the tongue of one piece is pounded tightly into the groove of the other, special care being taken that each piece is absolutely vertical. The application of the glue must be done with care as it must be applied to only as much of the car surface as each piece of the sheathing will cover, because, if spread over a greater surface, it will be forced into the beading of each tongue and groove, and prevent it from being fitted together tightly.

Dressing Down New Sheathing.

After the setting of the nails, the whole surface of the new sheathing is gone over with the jack plane and the smoothing plane,

to bring it down to the thickness of the sheathing left on the car. This job requires much muscular exertion and considerable skill in handling the plane. The carman must take care that he does not plain hills and hollows in the new part of the sheathing. This requires constant use of a square or a straight edge, and great dexterity and muscular control of the pressure on the plane. The plane marks are removed with a steel scraper. It will be understood that this planing causes the bevel on each piece at the joint to become sharpened somewhat, and this requires that the carman must use a plane with a small V blade to run up and down the joint, where each piece fits on to the other. He then sandpapers the sheathing with the aid of different grades of sandpaper—fine and coarse—until a smooth surface results.

In this work on the sheathing the new portion must be exactly level with the old portion, and correspond with it in every way, so that when painted, there is no difference whatever to the eye between the old and the new place. The glassy-like, even surface noticed as one looks along the side of a railway coach is attained only after the most careful and painstaking endeavor of the mechanic. The extent of this sort of work varies from two to three patches of a few feet each to the replacement of the entire side of the car.

In all of the passenger car repair work, curved parts are found in much more frequency than in freight repair work. In the finishing and fitting of each of these parts, care must be taken that the proper bevel of the part is maintained.

Application of Posts and Braces.

A job that requires a great deal of mechanical accuracy is the renewal of side posts (No. 150), post furring (No. 151), and the renewal of body braces (No. 146). The application of these posts and braces must be absolutely accurate to the one-sixteenth of an inch, because of the fact that the window sash operates up and down between the posts, which, if out of line or the distance between them being greater at the top than at the bottom or vice versa, the sash will not operate properly, and it will either jam so that it cannot be raised and lowered, or there will be openings in either side through which the rain and wind will come to the inside of the car. In applying the posts and braces, it is usual that the sheathing (No. 117) on the outside and the letterboard (No. 219) are removed, the outside window sill (No. 116) removed, and the window panels (No. 115) together with the battens, which are on each edge of them, are taken off, and sometimes the inside finish of the car is stripped in a like manner, leaving only the posts and braces on that portion of the car.

The braces (No. 146) and the brace straining rods (No. 225) are applied, the braces being held to the posts and the lower belt

rail (No. 193) and the side sill (No. 107) by nails. In doing this work, the carman must make constant use of his square in order that the posts will be vertical when the job of bracing the car is completed.

The window posts (No. 150) and the belt rails are usually fitted one into the other by a halved joint. It will be readily understood that these joints must be made tightly and neatly because under the stress and strain of service a loose joint and poorly fitted tenon would allow the post to move slightly out of the vertical, with the danger of binding the sash as explained above.

Application of Outside Window Sill. (Sash Rest.)

After the sheathing is reapplied, the outside window sill is fitted into place, which requires that it be cut out so that it fits around each post to the depth of about two inches. The mechanic must use accuracy in his measurements of the distance between the posts in order that the gains on this window sill will fit each and every post accurately when placed into position.

In the event that the roof of the car is in need of repair, it may be found that a number of carlines (No. 160) require renewal, which is effected by removing the canvas and longitudinal roof boards from the portion affected, and the fitting of the carline which is gained to fit into the deck side plate (No. 159).

The Vestibule Buffer Rigging.

On every car that is sent to the shops it is found necessary to repair the vestibule buffer rigging, and it requires considerable skill to remove and re-apply these parts, which are many in number, so that they will be in good working order. Some of these parts are the piston stem (No. 275), the piston stem washer and spring (No. 270) and the accordeon hood (No. 271).

The buffer rigging on vestibule cars generally consists of a buffer plate at the bottom, outside of the platform end sill, and a face plate or diaphragm around the passage opening. This buffer has three legs which extend through holes or openings on the platform end sill, in such a manner that the shock of striking the buffer is conveyed through the three buffer legs and taken up by springs, which are blocked securely into position underneath the platform floor. Fastened to this buffer at the end of the car is a heavy plate in the shape of a "U", the "U" being inverted, the bottom of the "U" being at the top of the end of the car. This plate at the top is held by two legs, which protrude inside the ceiling of the vestibule of the car, and, like the legs at the bottom, are equipped with springs (No. 270), to take up the shock when two cars are together. This buffer attachment or "U", sometimes called a diaphragm, extends about six inches from the platform end sill and from the end carline. From this diaphragm to the vestibule

of the car is fitted what is called an accordeon hood (No. 271), which is for the purpose of keeping the rain, snow, cinders, etc., from falling down into the passage between each of the cars when coupled together and in service. This accordeon hood is made of heavy canvas bound together by iron bands riveted to it, and is fastened to the vestibule and to the diaphragm plate by small bolts.

The coupler arrangements in the passenger car are of many different types, and the carman must have the ability to apply and repair all of them. The conditions met with in repairing the draft gear are similar to those met with in doing this kind of work on freight cars, with the exception that the passenger car work is generally done under a roof and in a shop that is fairly well heated in the winter.

Difficulty in Applying Parts to Car Bottom.

In the application of crosstie timbers (No. 233) or body bolsters (No. 49), the carman must cut holes in and gain them, so that the number of pipes, air pipes, signal pipes, steam pipes and the like will fit through and around them. He must also apply the brake connections, fulcrums and levers in such a manner that they will operate without coming in contact with the crosstie timbers, the various pipes or the gas tank, battery boxes, coal and ice boxes and similar attachments which are suspended from the bottom of the car.

Removal of Sash, Doors and Trimmings.

When the car enters the shop for repairs, all of the sash, doors, locks and trimmings are removed and sent to a portion of the shop where repairs to these parts are made. The work of properly removing these parts requires considerable mechanical skill in order that in the removal none of the parts will become damaged. The work of removing the steel parts, such as ventilator coverings on the inside of steel passenger equipment must be done conscientiously because a careless and unskilled worker, in endeavoring to open or close the ventilators when clogged with cinders, would, in all probability, break off the handle with which it is operated, which would require perhaps half an hour to repair before the part could be again used. Also as the heavy machine screws are sometimes rusted into the metal, the inefficient workman would not know the best methods of removing them and would cut them off with the cold chisel, which would make it necessary in re-applying these parts, to re-drill and re-tap the holes for the screws. This work of re-drilling and re-tapping the holes for machine screws takes considerable time, and is hard work.

During the time that the car is being repaired, its sash and doors and brass fittings are undergoing repairs in a shop assigned

to this work, and the seat backs and cushions are being repaired in the upholstery shop.

Some of the doors require complete renewal and others require new side rails or top or bottom rails and panels. Where a new door must be made, the old door is taken out and sent to the mill and the new door made up in the mill with new parts in accordance with the measurements of the old door. In applying a new door rail, the mechanic repairing the door is required to fit it to place on the door and apply the glue to the tenons and the mortices so that it will be held securely. The sash of the car is repaired in a similar manner to the doors, and where new glass is put in, the carman applies the beading that holds it into place, or renews the beading when loose or decayed.

Inside Finishing.

When in the shop for repairs, it is commonly necessary to remove the varnish from some of the parts on the inside of the car. To properly remove varnish from such parts as veneered panels requires both skill and experience because of the thinness of the surface layer of veneer. This, when first applied, was perhaps one-sixteenth of an inch thick, but during previous shoppings the scraping to remove varnish has further reduced its thickness.

Cleaning a Veneered Panel.

To remove the varnish, a coat of varnish remover is applied with a brush. The panel is then scraped with a sharp steel scraper usually two inches wide or greater. The intention in scraping is to remove varnish cleanly and take as little of the wood as possible off with it. This scraping must be done with the grain of the wood and it is best to go the complete length of the panel with each stroke. By feeling the shavings between his fingers the mechanic can tell the thickness of the shaving removed and whether he is scraping the entire panel uniformly.

An inexperienced man would use no method and would scrape with short strokes wherever he noted a spot that appeared dark with varnish. On these dark spots he probably would exert more pressure. The result would be that after the panel was re-varnished many of the strokes of the scraper would be visible. He would perhaps scrape across the grain, causing the thin veneer to sliver. He would persist in digging the varnish out of any little nicks in the panel until he had a hole worn in it.

Frequent Jobs on Inside Finish.

In passenger cars there are at times alterations to be made in the arrangements of lockers or salons which necessitate the

building of new ones or the renewal or moving of some of the partitions. The wooden seat arms (No. 79) are generally found to be broken, split or badly chipped and require either renewal or patching. The headlining of the cars will be found to be bulged or warped and decayed on account of water coming through a leaking roof, or it will be found that the heat of the lamps has caused the headlining veneer to work loose, or in some cases the ceiling may be burned.. This last is true only of cars having gas or oil lamps.

Repairing Seat Arms.

In the job of repairing seat arms (No. 79) from which chips have been knocked by passengers striking them with the sharp corners of packages and luggage, the carman cuts out the affected piece and glues on a new piece which he holds with a wooden clamp until the glue is dry. He does not finish fitting this piece or rather smoothing out the outside surface of the patch until the glue is dry and the piece firmly attached. He then removes the clamp and chisels the patch to the shape of the seat arm and sandpapers it until it is smooth and ready for painting. This job requires considerable skill, especially in the case where the patch must fit where the seat arm is carved into a scroll or some other design. An inexperienced man attempting to perform a simple job of this kind will usually attempt to make the patch a finished product as regards its size and design before he glues it to the seat arm. Some of this scroll work is quite complicated, and as the mechanic has to work sometimes in oak as well as in mahogany or walnut, he must have a considerable knowledge of wood carving and the use of chisels and gouges at different angles of the grain. Jobs of this kind are done so nicely that after the seat arm is stained and varnished, it is impossible to detect the patch.

Some Work is of Extensive Character.

Occasionally a more complicated job of inside finish is required of the mechanic when the sleeping cars that some roads have in service or a private car with Pullman upper berths, require repairing. Private cars and cars in office service are frequently remodeled, during which work the entire inside of the car is re-built. This means that the work of building new staterooms, new bathrooms, dining rooms, kitchen, new berths, new wooden beds, and all the work of erecting the partitions and allowing the proper door openings and hallways for these rooms is done by the mechanic with the aid of blueprints. Each partition must be fitted into the floor and must fit at the ceiling and side deck of the car tightly.

Poorly Fitted Inside Finish Readily Seen.

There are considerable difficulties to be met in fitting a partition around the irregular shaped deck of a passenger car. Much mechanical skill is used in measuring, cutting, and framing the partition to fit. Every part of the inside finish of a passenger car must be exactly fitted, the workmanship resting entirely on its own merits, as there is no plaster or the like to cover any defects. All the work is fully exposed to view and the least defect or crack will be clearly visible.

Fitting Sash.

Most of the passenger cars have outside and inside Gothic sash, the outside sash being stationary. This sash mentioned is the narrow sash just above the window. If a perfect fit is not effected, this outside sash will probably admit the moisture, causing decay, or it may extend inside the window opening far enough to hinder the raising of the window sash.

Repairs to Headlining.

The headlining of a wood passenger car is usually made of three ply veneer, and when found to be decayed or in poor condition due to heat or dampness, it is removed and another part fitted into its place. As the deck of the car is curved, and as this veneer must be fitted around the decksash opening, it must be cut carefully. Circular holes must be cut near the center to admit the smoke jacks or flues for the lamps. Most of the cuts the mechanic is required to make are not straight, but are curved and correspondingly difficult.

Mistakes are Costly.

In the application of panels and partitions in the cars of the better class, these parts are made of the finest veneer, either oak, walnut or mahogany, and he must use great care in fitting the parts, because of the value of the veneer he is using, as it can be appreciated that from the spoiling of a veneer partition, in some cases five ply, not only the original value of the lumber and the veneer is lost, but also the labor that it took to put the veneered parts together. Great care also must be taken so as not to injure its surface in order that when the car is finished and its grain brought out by the painter's treatment, no defects can be seen.

The method of putting together veneer will be discussed in the description of the cabinet maker's work.

TRIMMING.

After repairs have been completed to the body, the roof, inside, platform, bottom and trucks of the passenger car, it is painted inside and out, which will be described later. After it is painted the carmen apply the sash and doors, seat backs and cushions, oil lamps, baskets, signal ropes, emergency valve cords, hoppers, curtains, door stops and door holders, door checks, sash stops, sash balances, sash lifts and locks, deck sash, deck sash clamps and ratchets, deck sash pulls, window screens and deck sash screens. The doors and sash are delivered to the car from the varnish room where the painting and varnishing of them has been completed, and the mechanic applies the hinges and locks, hangs the doors, inserts the window sash (No. 99) into the window openings, applies the wooden stops that hold them into place, and also the sash lifts (No. 102) and the window locks (No. 101). He then applies the curtains (No. 84) and the blinds (No. 44).

Applying Sash, Blinds and Curtains.

In applying the sash, the carman must see that they operate freely up and down the window opening, and in the event that they are too tight, he must remove them and plane the sash rail until the sash fits correctly and works freely. The blinds he must apply in the same manner, and they must be fitted so exactly that when raised they will not fall down, and when required to be pulled down, they will not be too tight. He must apply the sash lock correctly so that when the window is raised, it will stay in position and not fall down, perhaps striking and breaking the arm of a passenger. The window curtain (No. 84) is applied similarly to the house curtain, with the exception that the brackets into which it fits are on the window posts underneath the molding at the top of the window opening. This means that in the application of the curtain, the roller must be the correct length in order to fit securely in the bracket, and must be applied by sense of feel in the fingers of the mechanic, as he is not able to see the brackets and apply the curtain at the same time. Some of these brackets are in such cramped quarters as to only allow the admission of two fingers, which means that the mechanic is unable to hold the curtain tightly. It is a question of the sense of touch in his finger tips being educated to the point whereby he can drop the curtain roller into the bracket accurately and quickly. There are men working on passenger cars who have never been able to hang a curtain in some classes of cars on account of this difficulty, whereas other men can hang them very quickly and surely.

Hanging Doors and Applying Door Fixtures.

In hanging the doors the mechanic must cut the gains on the door post and on the door to hold the hinge butts which are each held by four or more screws, and he must also be able to fit the door to the door opening with the proper bevel so that it will easily open and close. The rule for applying a door to the door opening is that it must be fitted so as to allow the insertion of a five cent piece at any point on the perimeter of the door, and not more. The application of the door lock requires considerable experience, as these locks are different for every class of car. Some of them are simple in their mechanism and construction and others are of numerous parts and require that complicated gains be cut in the door in order to apply them. Some of these locks are especially constructed so that they may not be stolen from the door. They serve their purpose well and only a man who has had experience with these locks is able to remove them; and the same skill and knowledge is required to apply them properly. After the lock is fitted to the door the keeper on the door post must be fitted so exactly that when the door is closed, pulling on the knob without turning will not cause the door to rattle. The keeper is the plate into which the lock latches fit.

The carman cuts, fits and applies the platform and step tread rubber. He also applies the handrails which must be according to Safety Appliance Act requirements. In this branch of the passenger car work an enormous amount and variety of screws are used. As most of the trimmings serve an ornamental as well as useful purpose, the carman must choose the proper screws to hold each part and must apply them uniformly. These screws not only differ in size, but in color. Some are bright brass, some bronzed and others have the heads enameled yellow or red. As the trimming work is the last done before the car is sent to service, it is often necessary to work at very high speed in order to get the car done on the date it is scheduled to leave the shop.

THE BRASS ROOM.

As stated before, between the time of their removal and the time of their re-application to the car, all of the metal trimmings are repaired in a portion of the shop specializing in that work. Some of the different work done in this room is explained below.

All of the different locks removed from the car, door locks, sash locks, Yale cabinet locks and drawer locks are examined and repaired by the locksmith. The locksmith is a skilled me-

chanic, as he must know how to repair and assemble all of the different kinds of locks and fit them with keys when required. At times when new parts needed in the repair of a lock are not available, he makes the part himself from a brass plate or bar.

The mechanics in this department repair door checks and must be familiar with the assembling, repairing and making of parts for the various types, Yale, Corbin, Norton, etc. Where legs and other portions of baskets are missing, the mechanic fashions and attaches new ones.

The lamps, when removed from the car, are brought here for cleaning and repairing, and any new parts needed are applied. Fire extinguishers, cup vending machines, brake handles and vestibule tail gates are repaired. Vestibule tail gates are the folding gates that are drawn across the end opening of the last coach on a train to prevent passengers from falling off.

Oxidizing and Enameling Trimmings.

All of the screws used with the trimmings are washed, sorted and the damaged ones thrown in scrap. When required, these screws are oxydized or bronzed by dipping them alternately into nitric acid and into a solution of surphuric acid. They are rinsed in clear water. The more often they are dipped, the darker the brass becomes. In some cars the brass trimmings are enameled yellow, red or some other color. The heads of the screws for these trimmings are enameled to match. While the enamel is still wet, the trimmings are put into a drying oven and baked, which causes the enamel to set harder.

Lacquering.

Many of the trimmings are sand blasted, after which they are lacquered. In lacquering, a composition of fusel oil, shellac and some of the varnish gums are sprayed on the parts until they are well coated. This lacquer gives a shiny bronzed appearance to the trimmings. The mechanic who does the lacquering must wear a respirator over his nose and mouth, as the use of compressed air in spraying scatters the composition about in small particles, which if inhaled, would be injurious. Further, it has been proven that the inhalation of even the odor of wood alcohol and fusel oil is injurious. In hot, close weather it is very uncomfortable to wear one of these respirators.

Silver Plating.

Any of the brass parts that require it are buffed and brought to a high polish on buffing wheels and brushes. The mechanic that does the buffing also does silver plating and re-

silvers mirrors when needed. To make the plating solution the mechanic dissolves silver in Nitric Acid, which solution fizzes, releasing hydrogen to the atmosphere and what is left is Silver Nitrate. This he precipitates by putting in salt (Sodium Chloride), which separates the solution, precipitating Silver Chloride to the bottom and leaving Sodium Nitrate at the top.

Silvering Mirrors.

To silver mirrors a solution of Nitrate of Silver, Ammonia, Tartaric Acid, and distilled water is poured over the glass. In about one-half hour a thick deposit of silver will form if the temperature of the glass is kept at 100 degrees Fahrenheit. A coat of shellac after rinsing helps keep the silver on.

At the different shops different silvering solutions are used. Some shops have the apparatus for electro-plating, which requires that the mechanic be familiar with electrical equipment as well as with the chemicals used. The carman plater silver-plates and burnishes all of the locomotive headlight reflectors.

Other Passenger Car Work.

The carman must be a skilled worker not only in wood, but in metal. Time was when he could be fairly called a coach carpenter, but now he not only must be a skilled carpenter, but must build and repair steel and composite equipment as well.

Reinforcing Wooden Equipment.

Many wooden passenger cars are now being reinforced with steel underframe, steel centersills or anti-telescope steel ends. The carman must not only make any necessary changes in the body framing, but must also know what changes are required in the bottom arrangement of tanks, battery boxes, brake equipment and draft rigging. This work is very often done without the aid of blue prints.

Steel Car Repairs.

The same methods are used in repairing Steel parts of Passenger cars as are used in repairs to Steel Freight equipment. Steel Passenger car repairs do not present the difficulties met with by the carman in the repair of dump door mechanism and the like on freight train cars. Also the number of damaged cars received is not so great, and for the sake of appearance, badly damaged exposed parts of Passenger cars are scrapped,

whereas in Freight car work the carman straightens every part not fractured.

Between the posts and underneath the inside finish of Passenger cars the carman applies hair felt and mineral wool to

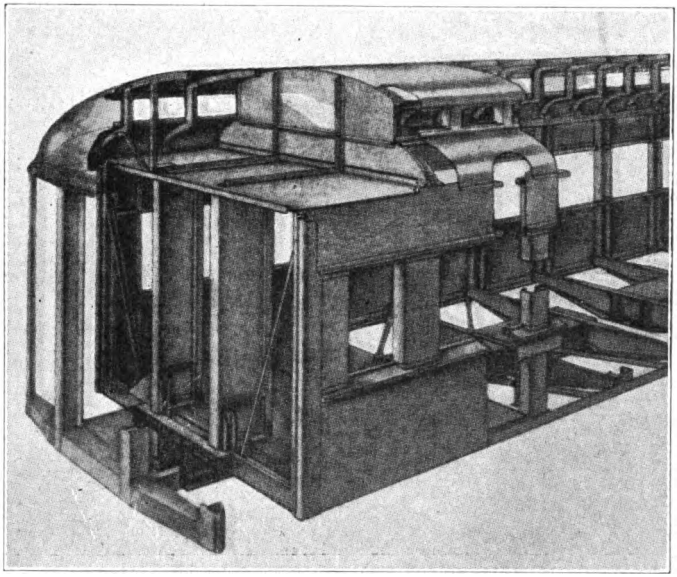


Fig. 27. The Anti-Collision Bulkhead.

deaden the vibration and noises given forth by the steel when subjected to the shocks of service. Mineral wool in appearance is what its name implies. It is made from molten slag, against which a cold blast of compressed air is turned.

Steel Car Cement Floors.

Many steel cars have a floor of deeply corrugated steel over which a cement composition is laid. This cement is similar to sidewalk cement except that instead of sand, other lighter material is used. This floor wears hollow in the aisles and requires renewal. The carman must chisel all of the cement from above and between the corrugations of the steel foundation. This work is exceedingly hard. After this steel foundation has been cleaned, the carmen mix and apply this cement, using the mason's trowel and float. To get good results, the cement must be well mixed and be of the proper consistency, that is, neither too thick nor too watery.

Steel Inside Finish.

In cars having steel inside finish the partitions and walls and the floor become rusted and decayed from moisture. The carman uses sheet steel to renew these parts, and needs considerable skill to fashion and shape it to correspond with the part to which applied.

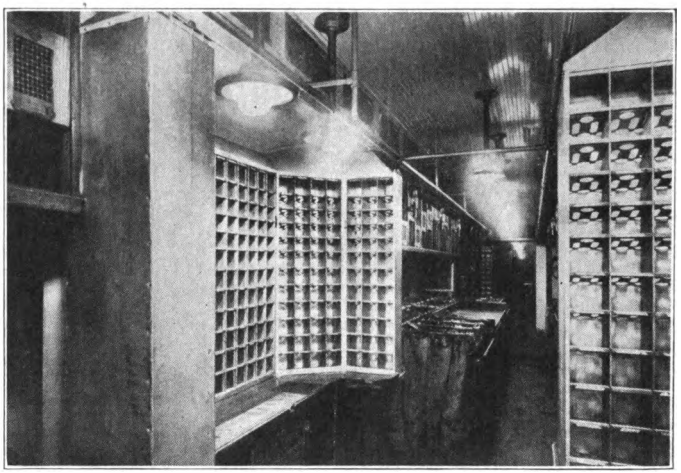


Fig. 28. View of Interior Postal Car.

Postal Cars.

To repair Postal cars properly, the carman must know the federal requirements as to space allowed, slope of racks, measurements of clearance necessary, and must be able to build and repair sorting tables and distributing racks. When these cars receive extensive alterations, they are inspected by a representative of the post office department before leaving the shop.

Dining, Cafe and Buffet Cars.

Dining, Cafe and Buffet cars are equipped with cooking ranges and a great number of iceboxes and lockers. Every inch of space in these cars is utilized, and the carman must work in cramped quarters while building these parts. Building a dining car ice box requires the utmost skill in measurement and the use of tools.

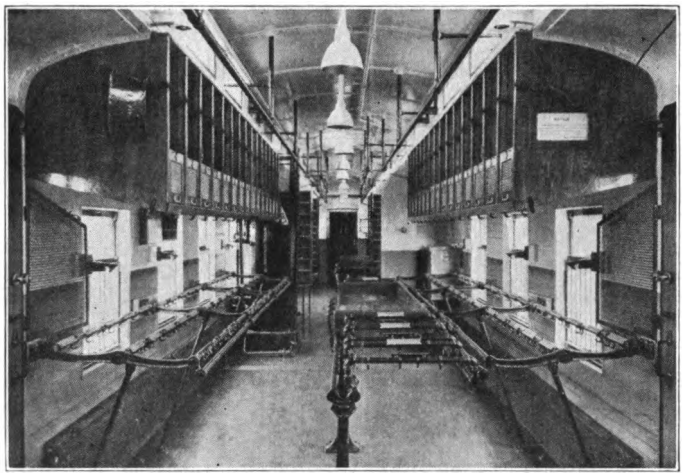


Fig. 29. Another View of Postal Car Interior.

Private Cars.

The maximum of mechanical skill is exerted in repairing Private cars. When ready for service these cars must run without the slightest squeak or rattle as far as it is humanly possible to prevent them. Every partition where gained into the floor, wall or ceiling, sits on a strip of flannel. After general repairs, the Private car has a trial trip over the division. A foreman and one mechanic sometimes ride with it, and it is their duty during the trip to detect any creaks or rattles and ascertain what causes them. Sometimes it is a loose curtain bracket that rattles, and sometimes a hidden post or brace will squeak. The inspectors mark the location of the noise as near as possible, and when the car returns to the shop, the carman's ingenuity is taxed to eliminate it.

Truck Work.

There are many types of Passenger Car Trucks in service under the cars of any one road. The truck is a structure built to hold the wheels in place under the car, distribute the car weight evenly to all the axle journals and to provide springs to absorb the shocks when the car is running. Some trucks have four and some six wheels. Every car has two trucks. In the exact center of the truck is a steel casting of circular pattern called the truck center plate. On the body bolster of the car is a like center plate called the top centerplate. The top centerplate fits into the bottom center-

plate and a large pin or king bolt is inserted into a hole in the center of both. These two centerplates act as a swivel on which the car rides.

Some types of trucks have wooden sides, wooden ends and wooden bolster. Other trucks called sandwich or plated trucks are wooden trucks having a steel plate added to each side of its side frame and end timbers. The heaviest trucks have a frame of cast steel. This steel truck frame is generally in one piece and weighs approximately 3,500 pounds.

Outline of the Rebuilding of a Four Wheel Wooden Truck.

(Refer to Fig. 26, Page 73)

Jacking Up the Car.

When received at the shop for repairs, it is often found that the wooden parts of the smaller trucks are so broken and decayed that they require renewal, and to accomplish this, the truck must be entirely dismantled. A jack is placed under the side sill of the car about midway between the body bolster and end sill. As the side sheathing generally extends about one-quarter inch below the side sill, a small block is placed on the jack so that its lifting force will be exerted on the heavy sill and not against the thin edge of the sheathing.

While the weight of the car is still on them, the elliptic springs (No. 63) are clamped by inserting bolts between the leaves and plates on the leaves in such a way that when the bolts have been tightened, the clamps keep the springs compressed after the car weight has been removed from them. This is done in order to easily pull out the springs through the space between the truck side (No. 62) and the equalizer (No. 64). The truck check chains (No. 68) are unhooked, blocks placed under the wheels of the other truck to prevent it from rolling, and the car jacked up sufficiently to allow the truck to be rolled out without striking the steps. Horses are set to hold the car.

Dismantling the Truck Parts.

The pedestal tie bars (No. 58) are let down by removing the split keys and double nuts from the bolts that hold it to the truck frame end pieces and to the pedestal castings (No. 67). The brake shoes (No. 228) are removed and the brake beams (No. 162) let down by removing the brake safety straps (No. 20), unhooking the hangers and disengaging the brake beam king post (No. 163) from the brake lever. The brake beam safety straps (No. 20) are simply loops of flat iron that go around the brake beam and are bolted to the truck ends. They are to prevent the brake beam from falling

to the track should it become unattached. The bottom brake rod (No. 172) is disconnected, the truck frame is jacked up, lifting the pedestals (No. 67) from the journal boxes (No. 55) and the wheels rolled out. The truck frame is set on horses. The journal boxes are pulled from the journals (No. 240) and the wedge and journal bearing removed from the box.

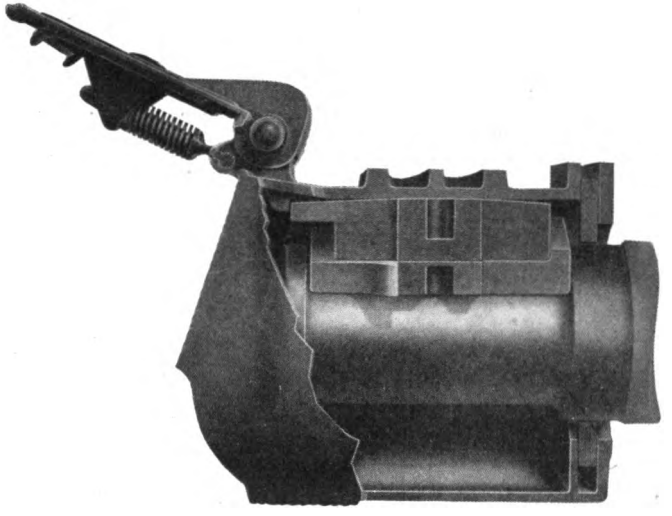


Fig. 30. How the Journal Box, Wedge and Bearing Set on the Axle Journal.

The truck bolster (No. 175) is lifted out by pinching one end up at a time with a bar and putting a two-by-four piece under it. The center plate (No. 177) and the bottom side bearings (No. 48) are removed from it. The elliptic springs (No. 63) are now pulled out. The bolts in the pedestal (No. 67) are removed, allowing it to drop to the floor. This lets down the equalizers (No. 64) which allows the coil springs (No. 60) and the seat they rest on to be removed. After one pedestal is let down the equalizer can be disengaged from the other.

The lower spring hanger pivot (No. 172) is let down by removing the split keys from each of its ends and hammering the hangers (No. 170) to the side. This lets down the spring plank which has bolts extending down through the lower spring hanger pivot (No. 172). The spring plank hangers (No. 170) are removed. They are held by bolts that extend up through the truck frame center cross pieces.

Dismantling the Truck Frame.

This leaves only the truck frame left to dismantle. The truck frame generally consists of two truck sides, two truck ends, two truck center cross pieces and four truck wheel pieces. The two truck center cross pieces extend from side to side on either side of the truck bolster (No. 175). From each of these two truck center cross pieces to the truck ends are fitted two wheel pieces. These are parallel with the truck sides. The bolts and rods that hold this frame together are removed and the parts separated by knocking the morticed pieces from the tenons on the others. The old timbers are taken to the mill as samples where the layer-out marks the new timbers for the necessary holes, tenons, mortises and gains.

At all small shops the carman repairing trucks must lay out his own timbers and where there are no mill facilities, he must frame them by hand. At some points the mill machinery consists of one circular cross cut saw and the carman of ingenuity and resource is able to make it cut gains and tenons and partly cut mortices.

Assembling the Truck Frame.

After the milling the carman cleans out the mortices and trims the tenons on each timber. The truck sides are placed on low horses and the two center cross pieces fitted into them. The tenons on these cross pieces fit tightly into the mortises on the truck sides and require heavy sledging to drive in. These truck center cross pieces are generally trussed by rods gained into each side of them.

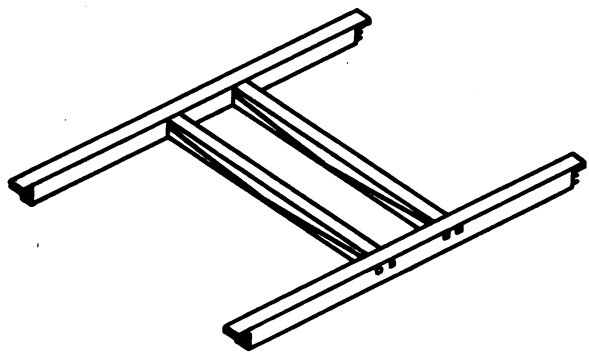


Fig. 31. Wooden Truck, Frame Partly Assembled.

These rods are bent at the center, forming a sort of a shallow V; therefore the gain on the cross pieces must be shaped accordingly. When the angle of the V on the rods does not exactly correspond

with the angle of the V gain on the timbers, it requires effort and skill to get the rods in.

The ends of these four rods go through the truck sides. The legs of these V rods do not strike the truck sides at right angles, therefore the holes in the truck sides through which they extend must be bored at an angle to suit. Where the angle of the rod and the angle of the hole do not perfectly correspond, the carman has great difficulty in getting the rods to go through. After the nuts on each end of these rods have been tightened, the truck center cross pieces are securely held in position. The truck frame at this point of construction is like the outline shown in Fig. 31.

The tenons on the four wheel pieces are then inserted into the mortices on the truck center cross pieces. The truck end sills are then lifted into position and its mortices fitted on the tenons of the truck sides and the wheel pieces. After this has been done, the truck frame outline is like Fig. 32.

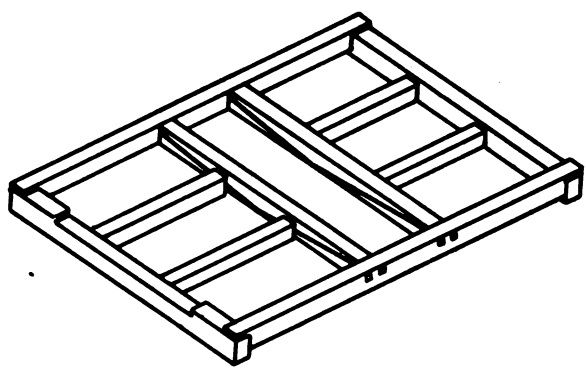


Fig. 32. Frame Complete Before Building up the Truck.

A light rod extends from the truck center cross piece, along the side of each wheel piece and through the truck end.

A bolt extends through both the truck end and truck side at each corner. The corners are held together further by anchors which are threaded at one end. These extend through the truck end sill and have a flat gib mortised into the inside of the truck side. If the mortise for this anchor gib is cut too low, the inside lip of the pedestal (No. 67) will partly cover it, making the insertion of the gib impossible without cutting an additional mortise.

Applying Pedestals and Equalizers.

One of the pedestals (No. 67) is jacked up into position on the truck side. The pedestal casting has an extension on the inside

similar to the lip seen on the outside, but not so high. The truck side is made of dimensions to fit snugly into the space between the lips of this casting and frequently while the jack holds the pedestal casting up, the truck side must be sledged down into it. Three bolts three-quarters inch by seven inches extend through the face of the pedestal and two bolts three-quarters inch by eleven inches go down through the truck side and pedestal casting from the top.

After one pedestal casting is in place, one end of the equalizer (No. 64) is inserted. The equalizer spring caps (No. 230) are fastened up to the truck side by one bolt. The spring seats (No. 59) are put in place on the equalizer and the coil springs set on them. The end of the equalizer is blocked up to level with the end resting on the pedestal already applied. The second pedestal is lifted up and placed on the equalizer end and the pointed end of a pinch bar is inserted in one of the bolt holes to hold it while putting a jack under it. Some heavy lifting occurs here, as this pedestal weighs approximately one hundred and fifty-five pounds, and as it requires movement in two directions to put in place, a jack cannot assist.

Squaring the Truck.

The truck is squared with the aid of a tram; that is each corner of the truck must be a true right angle. The tram is a pole on which are two gauge points, one of which can be slid to any point on the pole. In squaring the truck frame one gauge point is placed on the truck side at a point exactly above the wheel center. The other gauge point is placed above the wheel centre at the diagonally opposite corner of the truck. The measurement is repeated on the other two corners of the truck and if the distance is exactly the same the truck frame is square for wheels. The pedestals are squared so that they hang absolutely vertical to the truck sides. This is very important, as it determines whether the journal box and bearing sits in correct position on the axle.

Applying the Elliptic Spring.

The spring plank hangers (No. 170) are applied and the lower spring hanger pivot (No. 172) is attached. The spring plank (No. 61) is tilted, inserted, and each end is bolted down through the spring hanger pivot. The spring plank has a plate near each end in which the spring band (No. 63) sits. The elliptic spring is brought to the truck and laid on a low bench on a level with the equalizer. A roller is placed under it and it is pushed into place on the spring plank. These elliptic springs weigh two hundred and thirty pounds.

Applying the Wheels.

The journal boxes (No. 55) are placed on the axle journals (No. 250), tilted, and the journal bearing and wedge inserted. Holding the journal boxes upright, the wheels are rolled into place under the pedestal jaws. The truck is jacked down and the jaws of the pedestal fit in slides on each side of the journal box. It is sometimes exceedingly difficult to get the pedestal jaws to fit properly into the slides on the sides of the journal box.

Applying the Bolster.

Light timbers are laid across the truck center cross pieces, and the bolster, to which the center plate and side bearings have been applied, is laid on these timbers above the opening between the center crosspieces. The bolster weighs about two hundred and sixty pounds. One end of the bolster is held up with a pinch bar, one timber removed from beneath it and one end is let fall onto the elliptic spring. The other end of the bolster is let down in like manner.

Applying the Pedestal Tie Bars.

The pedestal tie bars (No. 58) are bolted into place. In laying out the six holes in a new pedestal tie bar and marking it for bending, the inexperienced man would get the bends so close to the casting that the bolts could not draw it up tightly, or he would probably space the holes wrongly, making it impossible to insert the bolts.

The brake beam hangers, brake beam (No. 162), brake beam safety straps (No. 20), brake beam release spring, brake lever and guide (No. 180), are applied to the truck end pieces (No. 181). The lower brake rod (No. 173) is connected. The truck is then pushed under the car and the car let down on it. The clamps are removed from the elliptic springs and the coupler height of the car measured. This height must be not less than thirty-two and one-half inches nor more than thirty-four and one-half inches. The general rule is to get it at thirty-four and one-half inches with new trucks as they are likely to settle somewhat in service.

Adjusting Coupler Height.

If the coupler height is too low, one man lifts up the spring plank with a bar and his partner places a wood shim on the lower spring hanger pivot (No. 172), but must be careful of his fingers while doing it, because if the pinch bar should slip, the weight of the spring plank would crush his fingers. If the coupler is still too low, the car must be jacked up, the truck run out, the bolster lifted, the

elliptic spring cap removed and a wood shim nailed to the bolster. This raises the height of the bolster, the center plate, and thereby the coupler.

Side Bearing and Spring Clearance.

The side bearings (No. 48) top and bottom, must have the proper clearance. There must be enough clearance between the elliptic springs and the truck side on top and the equalizer on the bottom, to insure it freedom of action. The repeated striking of the elliptic spring against the equalizer when in service would bend it.

Mistakes Due to Inexperience.

An inexperienced man could not assemble the truck above described, which is the simplest in passenger train service. The first mistake he would make would be to jack up the car before clamping the elliptic springs. When he came to remove them, he would find them distended and impossible to remove through the opening between the equalizer and the truck side.

The inexperienced man would be likely to jack up the car without blocking the wheels of the truck on the other end. If the car started to roll, the jack and car would fall, causing damage to the car and danger to himself and others. He might put up the second pedestal on one side without first putting the equalizer in place, which means that he would have to again remove it to put the equalizer in.

He would not know how to square a truck nor square the equalizers. Possibly he would not know they had to be square, If he could apply the wheels under pedestals that were not square, the result would be cut journals and continuous hot boxes in service. Unless a train crew reported that hot boxes were prevalent under that car, the journal condition might become so bad that the car would be set out in the middle of the run.

The inexperienced man would not know how to adjust the coupler height and would never look for side bearing or spring clearance. He would not know how to connect the brake levers and would put the journal bearings in backward. He could take this description of the building of the simplest passenger truck in service and when shown the pile of rods, bolts, and castings that he must transform into a truck, he would not know where to begin.

STEEL SIX WHEEL TRUCKS.

The repair of all-steel six wheel trucks, equipped with clasp brakes, requires the greatest care on account of the great weight of the parts the mechanic must handle. The truck frame which is usually cast in one piece weighs thirty-five hun-

dred pounds; each of the bolsters weigh four hundred and eighty-one pounds; the truck center weighs nine hundred and forty-eight pounds; each of the six pedestal castings weighs one hundred and ninety pounds; each of the four equalizers weighs three hundred pounds; each of the six brake beams weighs two hundred and twelve pounds, and all of the other parts in proportion.

Poorly Equipped Shops.

At some of the largest shops and most of the smaller ones the mechanic must assemble these heavy parts without the aid of any overhead hoist or tackle whatever. Expert use of jacks, strong backs and infinite care are required to assemble these trucks in the antedated shops the work is done in. The prevalence of hernia among carmen is largely due to the fact that their work is heavy and done in shops criminally ill equipped to carry on the work.

Sometimes in order to square up a set of new pedestals or to more easily weld a number of fractures on the lower side of the frame, it is turned upside down. This is occasionally done in shops having no hoist facilities. The method is to let one side of this frame down to the floor and about twenty men tip it up and over and let it down bottom side up. It weighs thirty-five hundred pounds. After the six pedestals and four equalizers have been applied, the total weight is five thousand eight hundred and forty pounds. This mass is then turned right side up again, and care must be taken in turning, that the entire weight does not rest on the pedestal jaws, as it would break them off. Almost two and one-half tons is a dangerous weight to handle with man strength only.

The Clasp Brake.

The clasp brake is an arrangement of the brakes on a truck whereby brake shoes are applied to both sides of the wheel simultaneously, giving added brakeing friction. On the six wheel truck the single pull from the top connection brings the six brake beams and twelve shoes to the wheels at one time. The arrangement of the levers and connections can be seen in the attached illustration. It requires much mechanical skill and experience to properly assemble and adjust them.

The safety of all who ride on passenger trains depends upon the integrity of the carman repairing trucks. The omission of a cotter key from the lower brake rod would allow the connection pin to work out and the rod would drop to the track causing

probable derailment. Truck levers wrongly arranged would cause improper piston travel and harsh or sticky brakes.

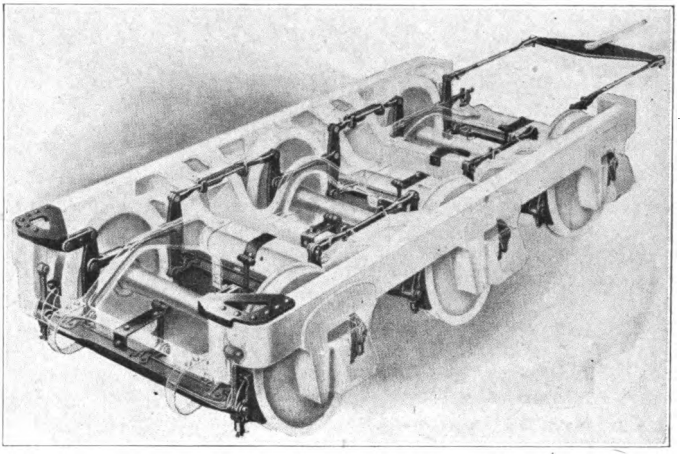


Fig. 33. The Simplex Clasp Brake.
(Truck details are eliminated from this sketch.)

Working Conditions.

Besides the normal hazards attending the use of step ladders and scaffolding and the handling of the heavy parts of the car, the carman is in continual danger of disease infection from contact with the filth and dust the car has accumulated in service. The railway car is undoubtedly the greatest germ collector in existence. Every diseased person who travels leaves his imprint therein, be it sputum on the floor and pipe shields or in the use of the toilet facilities. The railroad rights of way are an open sewer used by hundreds of thousands of persons daily. The decayed matter turns to dust, is whipped up by train suction and imbedded in every crevice of the car from whence it descends on the carman in a cloud of fine dust when he strips it for repairing. In his daily labor the carman meets this menace to his health, and to him there is no mistaking its origin.

There is no monotony to the carman's work as it is ever in variety. He must be strong and active, as only the physically fit can safely handle material of the weight of car parts without injury. He must be able to perform any of the work from the rails to the roof, and a statement of its requirements would be but repetition of all that has been written of his work.

Responsibility.

The requirements of the service must be always uppermost in the minds of the carman. A poorly driven screw may tear the dress of a passenger; an insecure lamp shade or a loose light of glass in the decksash may fall and strike some one, requiring the company to make financial settlement. Every service condition must be taken into consideration and guarded against, so that fixtures and parts will not tear loose and injure passengers even should the car overturn.

The carman works under little supervision as to the method of performing his work. He is simply told to go to the car and do his part of the repairs needed on it. Generally the visible defects are marked by the foreman, but the mechanic sometimes renews other parts that in his judgment require it.

SECTION B.

THE WORK OF THE CARMAN UPHOLSTERER.

When the passenger car is received at the shop for repairs, all of the upholstered parts are removed and brought to the upholstery shop. Some of these parts are seat cushions, seat backs, chair cushions, chair backs, sofas, dining chairs and parlor chairs of a great many styles and varieties, some of which are entirely covered with upholstery and others having only a portion of the seat, arms and back upholstered. Some of this upholstered equipment is covered with plush and some with leather, Spanish, or imitation leather, Fabrikoid, friezette, tapestry, mohair velvet, chase duck or rattan. The upholsterer also repairs willow furniture.

Besides the above equipment, the upholsterer manufactures and repairs mattresses, curtains, awning, tarpaulins, tents, leather mail pounches and satchels, suburban car straps, draperies, table covers, table pads, pillows, accordeon hoods, locomotive cab curtains, arm rests and cushions. He also sews and lays carpet and aisle strip, and repairs curtain rollers. He cleans and dyes plush seat cushions and backs, and cleans carpets, curtains, leather and rattan seats and backs.

Tools and Machinery.

In the performance of his work the upholsterer uses the following machinery and tools:

Punches and dies for fastening eyelets, grommets and riveting springs,

Punch, usually operated by an air cylinder for punching holes in the steel bands that form part of some styles of cushions and backs,

Picking machine for spreading old curled hair and shaking some of the dust from it,
Power sewing machine,
Motor driven revolving brush for cleaning cushions and backs.
Dye and wash tubs in which the fluids are heated by released steam.

The above equipment is furnished by the Company in addition to which he uses his own tools comprising the following:

3 Upholsterer's tack hammers,
1 Wooden mallet,
2 Blunt chisels with which tacks are removed without injury to the fabrics,
10 Upholsterer's needles, from 2" to 8" in length, some curved and some straight,
2 Upholsterer's pliers for stretching fabric tightly over the work,
1 Cutting pliers,
2 or 3 other pliers,
1 Hand drill,
1 Hack saw,
3 Screw drivers,
1 Large shears,
1 Small scissors,
1 Tinner's snips,
3 Awls,
2 or 3 sharp knives,
3 punches—different sizes used in repairing curtain rollers,
2 or 3 flat files,
Bees wax, used on the thread to moisture-proof and toughen it, and cause it to draw easily through the closer fabrics.

Making a Spring Edge Seat.

In the manufacture of a spring-edge seat cushion, the operations in the order performed are as follows:

The frame of wood with slats is screwed together by the carpenters assigned to that work. The upholsterer fastens the coiled springs to the slats by small staples. The springs are then tied with heavy twine one to the other, and the ends of the twine are fastened to the frame by staples. Each spring is tied so that the twine will hold it upright, and the knots are such that they will not slip. Around the edge of the springs the upholsterer bends, fits and ties a piece of heavy steel wire for the purpose of making the edge of the springs regular, and somewhat strengthen them at the edges.

The springs are then covered with a piece of canvas drawn tightly over them, and nailed to the seat frame. The upholsterer then applies a light layer of curled hair, which he spreads over the canvas. Over this layer of curled hair he applies a sheet of burlap, which he draws tightly across the seat, and sews firmly down through the hair and canvas about one inch from the edge all around the seat. This leaves a space of about one inch around the edge of canvas and hair that is not covered by the burlap. He then

fills up this one inch with curled hair and rolls it into the burlap, sewing it in as hard and tight as possible. After making this roll and sewing it, he tacks the edges of the burlap down to the seat frame. The result is a burlap cover on the seat, having a raised hair rolled edge.

The upholsterer then covers the burlap with a level layer of curled hair, over which he stretches a sheet of muslin and tacks it to the under side of the seat frame. The plush cover is next applied and brought down around the edges of the seat and tacked to its bottom. In applying the cover, the upholsterer must know how to fit the corners so that they lie flat with none of the upholstery exposed.

The above job is probably done more frequently than any other by the upholsterer. The inexperienced workman would not be able to do this work, as even mechanics on house furniture are unable to perform the various operations without a great deal of instruction and demonstration.

Difficulties to the Inexperienced.

An inexperienced workman would not know the correct number and size of coil springs that go into the seats of various dimensions. He would not know how many staples each spring required. The most difficult operation is the tieing of the springs. He would undoubtedly tie down the springs far out of balance, causing them to slip from place and making an uncomfortable seat to ride on. The worthy mechanics of the craft would share in the blame for the poor workmanship. The non-mechanic, instead of tacking a neat, uniform row of tacks with correct spacing on the material, tacks a zigzag row, either spread too far apart or too close. Some of the tack heads would not be down, while others would be beaten through the fabric. Instead of stitching a neat, smooth, firm roll edge, it would either be thin and pinched or baggy, clumsy and out of proportion. The inexperienced workman would be compelled to cut, fit and apply his own seat coverings. It would be unfair to the Company to entrust this material, costing from $6 up per yard, to his care.

Patent Spring Top.

Some cushions are equipped with "patent" spring tops in addition to all of the other spring covering. To each row of springs before application to the frame, is riveted a ribbon of canvas having glued to it a succession of short, narrow pieces of light wood. These pieces of wood are cut and glued to the canvas ribbon by the cabinet maker in the cabinet shop. They serve to

make a more level seat and prevent the springs, if worked loose, from forcing their way up through the upholstering.

The Two Part Seat Back.

The two-part back commonly seen in railroad day coaches is constructed similarly to the cushion seat. A two-part seat back is one having the head-rest built in separately from the lower portion of the back. Different heights of springs are used to form the slope of the back The hollow between the head-rest and lower section of the back is formed by tacking down the canvas and burlap to a cross rail at this point across the back. The muslin underneath the cover is made with a seam going across the back at this point. The muslin is laid with the rough side of the seam up, and the cover when applied, is sewed to it. The seat back is upholstered on both sides alike.

Other Work.

There are a great many types of seat backs and cushions, spring edge and hard edge, some with steel slats and bands over the springs and some with the entire frame of steel. The upholsterer manufactures the rattan covered seats and backs and repairs them by the insertion of new strips of rattan, which work must be done so that no sharp points stick up from the covering.

The upholsterer measures the seat mechanism in the car in order to give the carpenter the proper dimensions when ordering a frame for seat or back. He must measure all of the rooms of the car in which he must lay carpet and cut it, allowing space for the base of seats or chairs fixed to the floor. He must sew binding around all of the edges and openings, and when the carpet is laid, it must fit perfectly with no bulges and must cover the entire floor. The upholsterer repairs curtain rollers, applies new curtain fixture parts, and makes them the correct length.

The upholsterer takes the measurements for all such equipment as draperies, curtains, linen covers for seat backs, mattress ticking, table cloths and like articles, the cutting and sewing of which is done on the power sewing machine.

All canvas roofs on passenger cars and cabooses are cut and applied by the upholsterer. In doing this work the mechanic must carry the heavy roll of canvas to the car and up a step ladder to the roof, where he measures, cuts it and nails it to the crown and eave mouldings in such a manner that it will tightly cover the roof surface, leaving no openings for the admittance of moisture.

Plush Renovating.

After the upholstery of the seats and backs have been repaired, the plush covers that have not been renewed have not the bright clean appearance and fresh color of the new covers. These seats and backs having faded, stained and dirty covers are taken to the wash tubs where they are scrubbed clean, rinsed and when dry are dyed.

Cleaning.

In order to more thoroughly clean them, a revolving brush is used to scrub them while wet. This brush, of heavy bristles, is about nine inches in diameter and twenty inches long. It is hung on pipe rods, which are hinged at the top in order to allow the brush to be swung back and forth over the work. The brush is rapidly rotated by a belt from shafting or motor. Underneath this revolving brush is a movable cradle upon which the seat backs and cushions are placed and the brush moved over them. When one side of the back is scrubbed clean, the upholsterer turns it over and scrubs the other side. This cradle is of a height to bring the flat surface of the seat or back against the brush, but to properly clean the corners and edges, the upholsterer must hold it up to the brush himself.

Dyeing.

When the backs and cushions have dried, they are dipped into a solution of dye. The different colored cushions require different colored solutions in dyeing. The most common are green, red and golden. The different dyes are generally furnished in the form of a liquid and are mixed with the proper quantity of water in making the solution. After the dyeing the cushions and seat backs are set on a rack to dry.

The work of cleaning and dyeing this plush equipment is very unattractive. The mechanic usually works at high speed and his labor is particularly exhausting when using the revolving brush. The workman must hold these cushions and backs against it firmly, and as they weigh from twenty to sixty pounds the work is heavy, especially so when a number of cars are done having the heavier type of cushions and backs. It has been noticed that plush cleaners do not remain long at this occupation and that when first on the job they greatly lose in weight.

Rattan covered seats and backs are cleaned by scrubbing with a solution of lye which is prepared by the mechanic, and while using it he must wear rubber gloves. When rinsed and dry these are varnished by the painters.

Responsibility.

The upholsterer is generally assigned to repair all of the upholstering of one car, and it is left to his judgment what repairs the various cushions, backs and furniture require. He receives very little supervision, and the care and thoroughness with which he does the work is generally entrusted to him, as there is no doubt that mistakes and poor workmanship on hidden parts could be concealed from sight and would not be detected by inspection after the job had been completed. However, a job carelessly done or a part not well constructed would not give the same service as one done thoroughly. Some of the material which he uses in his work is very valuable, and much waste is prevented by his sense of economy. The materials with which he works are dry and inflammable, and he must use care so that none of it will come in contact with oils or fire.

Working Conditions.

The majority of upholstery shops are well lighted and heated, but there are some where the space allotted is too small, which results in overcrowding and inconvenience. The upholsterer must endure the discomfort arising from the great amount of dust in the articles he repairs. Due to the dust-laden atmosphere in which he works, the upholsterer is continually subject to skin infections, and the probability of his contracting tuberculosis is high. In the use of curled hair in most of his work he is in danger of contracting anthrax, epidemics of which sometimes occur among the employes of a shop using curled hair. After his day's work has been completed, the upholsterer is always required to wash on his own time.

Quality of Work.

The railroad cars of the country bear eloquent witness to the quality of the work of the Carman Upholsterer. Most of us have sat upon a seat cushion that had been in service two, three or even four years without repair, during which time it has been subjected to the hardest kind of service. Baggage of all descriptions has been piled upon it, children have danced on it, and it has ever been a footrest for the traveler. Yet this cushion still retains its shape and resiliency. Few, if any, travelers have ever been in sharp contact with a coiled spring, and how many cushions have we seen with "a hole in the middle,"—a common defect in house furniture caused by shifting springs and insecure padding. The work of the Carman Upholsterer everywhere bears witness to his skill.

SECTION C.

CABINET WORK.

The cabinet maker uses the same kind, and about the same number of tools as does the carman. His work consists of the manufacture of passenger car inside finish, partitions, and the repair and manufacture of car furniture. He makes new sash and doors and repairs and manufactures office furniture. The cabinet maker rarely does any work in the car. All of his work is done at his bench in the shop. He makes the different sections of the inside finish, and the passenger carman fits and applies them to the car.

The manufacture of inside finish for passenger cars includes the making of all panels, partitions, deck sash frames, headlining, and the ice box and locker work in dining and buffet cars. Most of the panels and many of the passenger car partitions are veneered. The cabinet maker manufactures all of the veneered parts, panels, partitions and wood veneer headlining.

Veneering.

Veneering is the applying of a number of thin layers of superior wood over an inferior piece of lumber. The purpose of this veneer is to make a partition, a door or a table top that will be free from warping, as it has been found by experience that a solid piece of lumber is much more liable to warp than a veneered piece. Another advantage of the use of veneer is that the best grained pieces can be selected, and if there are numerous pieces of veneer to choose from, it will be possible to perfectly match the grain in a large piece of work, such as a table top. If solid lumber were used, not only would it be impossible to match the grain so well, but the joints could not be so well concealed.

To successfully put veneer together, the mechanic must have a great deal of knowledge and experience. Veneered parts of cars are commonly five ply. The center piece is ¾ inch poplar, on either side of which is laid a piece of poplar veneer ⅛ inch thick, with its grain running across that of the center piece. On the inside of the part another layer of popular veneer is laid with grain across that of the first layer, and on the outside surface a 1-16-inch layer of oak or mahogany veneer is laid. This veneered panel is then of five layers, which, beginning at the surface, are namely: 1-16 inch mahogany, ⅛ inch poplar, ¾ inch poplar, ⅛ inch poplar. The dressing of the center piece and the cleaning and dressing of the surface veneer contrive to reduce the thickness of the combined layers so as to make a panel ⅞ inch thick.

The veneer is received from the lumber concern in the correct thickness, but in a variety of sizes, and many of the thin

sheets are split from handling. The cabinet maker joins enough of it together to make one piece, large enough to cover the entire panel. The different pieces must be accurately joined and are held together by a piece of muslin tape which is glued the full length of every joint and split, and also around the four edges in order to hold it firmly together.

Tooth Planing.

The center piece or body of the panel is then tooth planed. The blade of the tooth plane has its cutting edge made with small, sharp teeth somewhat similar to the edge of a saw. When this blade is run over the wood it scratches the surface. These scratches are to form pockets for the glue and tend by suction to hold the veneer firmly. The unskilled workman using the tooth plane will not make these scratches uniform in depth and number over the entire surface. He will also yield to the tendency to run the plane down over the edges. The veneer will not lay level if the tooth planing is not uniform, and the edges will not adhere firmly when glued if the tooth plane has scratched down over the edges.

Gluing Veneer.

After the tooth planing, the panel is given a level coat of clean warm glue. The mechanic must know how thick the glue should be and also makes certain that it is free from lumps. The layer of veneer that has been prepared is then laid carefully and the panel taken to the veneer press. The experienced mechanic allows the glue to cool somewhat before laying on the veneer because, when a little stiffer, its level is not so easily disturbed and its adhesive qualities are greater. The veneer press is a simple press operated by screwing down plates on the work. Near each press is a warming oven where the plates, made of wood, are warmed well before being placed on the veneer. After the veneer has been put in place with a warm plate to either side of it, the press is screwed down lightly. After the heat from these plates has rewarmed the glue, the press is screwed down tightly and uniformly. These wooden plates used with the veneer press are greased before they are laid on the veneer to prevent the glue from the tape, edges and joints from sticking to it when drying. The panel is usually left over night in the press. With the exception of the tooth planing, the same operations are repeated in the application of the following layers.

Cleaning Veneer Surface.

Great care and skill must be exercised in cleaning the surface layer of veneer. Its surface is spotted with dirt, glue, tape

marks and with grease from the press. These defects must be thoroughly removed because even the least of them would be conspicuous on the finished panel. The panel is scraped and sandpapered. The scraping must be done here in the same manner as by the inside finisher in cleaning an old panel as described in the Work on Passenger Train Cars, page 80. The scraping of the new panel is generally more difficult than scraping an old one. Only a mechanic can properly sharpen the steel scraper to the keen edge necessary to do this work.

Inlaid Work.

Some of the inside finish of passenger cars is inlaid with different colored woods, such as ebony, holly and rosewood. All of this inlaid work is done by the cabinet maker and requires great skill and precision in the use of edged tools. The mechanic must first prepare the inlay and afterward insert it into the panel or any other part of the inside finish for which it is intended. Inlay is made in exactly the same manner as veneer work except that the layers are generally applied differently in respect to the course of the grain. In veneered work generally the grain of the outer layer runs parallel to the grain of the center piece, but on inlay often the grain of the outer layer runs across the grain of the center piece. Inlay is made in sizes easy to handle and cut off into strips afterwards.

Inserting the Inlay.

The fitting together and insertion of the strips of inlay must be done to the accuracy of a hair's breath, and the examination of a piece of inlaid work will satisfy anyone that only such accuracy will result in a first class job. The first step of inserting the inlay is the cutting of the groove for it in the panel. The outline of the groove is drawn with the aid of a gauge. It is easily understood that these lines must be drawn perfectly straight and that the sides of the groove must be absolutely parallel. The sharp needle of the gauge used leaves a clear cut line.

The mechanic then cuts along both sides of the outline with a sharp chisel. The least unnecessary or careless cut of the chisel will ruin the groove by making its sides irregular. After cutting with the chisel, the mechanic levels the bottom of the groove at the required depth with the router plane. The router plane has a narrow blade somewhat shoe shaped, which is adjusted to the required distance below the sliding face of the plane. When we consider how shallow the groove generally is, we appreciate the care that is necessary to avoid chipping or slivering its edges.

Fitting and Gluing.

The amount of the glue used and its consistency must be absolutely correct. The experienced mechanic cuts the strips of inlay a little longer than the groove and slightly mitres the ends, —that is, cuts the ends so that the surface is a particle longer than the bottom. This is done in order that after the glue has set, the inlay will tightly fit the length of the groove. The appearance of the work depends entirely on the skill and care of the mechanic.

One mistake made in this work is that the workman cleans and finishes off the panel before the glue that holds the inlay is entirely set. To be sure that the glue is set, the panel should be laid aside two days before cleaning it. If the surface is scraped and finished before the glue is set, the inlay will probably settle some more, which makes the work slightly unlevel and makes the joints more evident.

Other Cabinet Work.

Besides the manufacture of the various parts that are required to be renewed in the various types of cars, the cabinet maker does a great deal of other work, such as repairing and sometimes completely manufacturing chairs, book-cases, filing cases, writing desks, book racks and shelves, telephone holders and a great amount and variety of miscellaneous work. Any small article on the whole system that requires repair or renewal is generally sent to the cabinet shop to be repaired or renewed. The cabinet maker must possess the skill to manufacture office furniture, lay out and shape the legs and attach the spider to the swivel chairs, put together and bevel the seat and fashion the arms and back of the chair.

Quality of Workmanship.

In the manufacture of desks and dressers and chiffoniers, the railroad cabinet maker usually turns out a more substantial and finished product than do the leading furniture manufacturers. The joints of the furniture made by the cabinet maker are more carefully glued, fit better, and have less tendency to warp or pull apart than furniture bought on the market. The cabinet maker must have the skill to dovetail all of the joints of the drawers of dressers, chiffoniers and desks. A man that is not a skilled mechanic cannot do a good job of dovetail joining.

Sometimes the cabinet maker is given jobs which must be completed quickly and which are sometimes jobs which require the greatest mechanical skill, and he must be an experienced mechanic in order to do a fine piece of work under these conditions.

When given a piece of furniture to repair or a partition, panel or other part of a car to build from blueprints, the cabinet maker is under no specific supervision. He is expected to be able to read his blueprints accurately and must also know the best methods of repairing any article that is given him to fix.

The conditions under which the cabinet maker works are generally good, as most cabinet shops are well lighted and evenly heated.

Part III.

AIR BRAKE WORK.

THE AUTOMATIC AIR BRAKE SYSTEM.

When near a locomotive, the attention of the passerby is sometimes attracted by a thumping, hollow sound repeated in regular cadence, and looking up on the side of the boiler he notes that it is caused by the working of a pump composed of two cylinders between which a piston rod can be seen to slide back and forth. Steam pressure admitted to one cylinder forces down its piston, and as the piston rod is connected to the piston in the lower cylinder that piston is also forced down, and the air under it is forced into the main locomotive reservoirs, where, on freight equipment, it is maintained at about 90 pounds pressure.

While the air brake valve operated by the locomotive engineer is kept in normal or running position, the air pressure from this main reservoir is allowed through a feed valve into a brake pipe extending the full length of the train. Between the cars the brake pipe is in the form of a flexible hose. The feed valve is adjusted so that 70 pounds air pressure is maintained continuously throughout the entire length of the brake pipe.

Under each car is a brake pipe branch connected to what is known as the Triple Valve. This triple valve, when in normal position, allows the air from the brake pipe to pass through it into an auxiliary reservoir, where it is maintained at the same pressure, or 70 pounds. This triple valve is also connected with what is known as the Brake Cylinder. The triple valve is a connection betwen the brake pipe and auxiliary reservoir and between the auxiliary reservoir and the brake cylinder.

Brake Application.

To apply the car brakes, the equilibrium between the brake pipe and auxiliary reservoir pressure is disturbed by allowing air to escape from the brake pipe. As soon as this is done the excess air pressure in the auxiliary reservoir throws the triple valve so that it admits the auxiliary reservoir pressure into the brake cylinder. The brake cylinder piston moves out under the pressure and its movement is transmitted through levers, rods and connections to the brake shoes which are forced against the wheels retarding their rotation.

Brake Release.

To release the brakes, the air pressure in the brake pipe is raised by admitting air into it from the Locomotive Reservoir. This gives an excess pressure in the brake pipe above the pres-

sure in the Auxiliary Reservoir, which throws the Triple Valve so as to close the inlet to the Brake Cylinder and open the inlet to the Auxiliary Reservoir from the Brake Pipe, thus allowing the two to attain equal pressures again. This same last movement allows the air in the Brake Cylinder to flow through an exhaust in the triple valve to the atmosphere. A Spring on the Brake Cylinder Piston Rod forces the piston back into position, which movement allows the Brake Shoes to drop away from the wheels, and the rods, levers and connections to resume normal position.

It will be seen that the Triple Valve automatically charges the Auxiliary Reservoir, applies and releases the brakes. It does these things with almost absolute certainty, as long as kept in good order, and the duties of the Air Brakeman are to keep the Brake Pipe, Triple Valve, Brake Cylinder and other air brake parts in good order, and to make the repairs necessary to restore them to good order when they become defective.

Operation of the Triple Valve.

The care and repair of the triple valve is the most important part of the Air Brake work, and requires the utmost

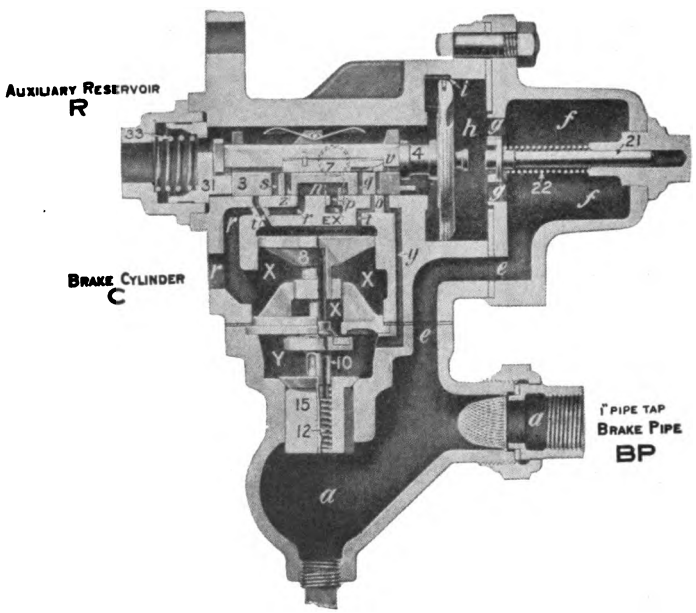


Fig. 34. Type K Triple Valve.
Normal Release and Charging Position.

mechanical knowledge and skill. To enable the reader to understand its operation, and to more fully appreciate the complexity of its mechanism, we reproduce three diagrammatic views of the Type K triple valve with an explanation of its workings in each position. This type of valve is in general use on freight equipment.

Normal Release and Charging Position.

With the triple valve in this position, air from the brake pipe flows through passages **e, f** and **g** to chamber **h,** forcing back main piston **4** and uncovering feed groove **i,** allowing the air to pass to the auxiliary reservoir. This feed groove is proportioned to prevent the air from feeding back from the reservoir when a brake pipe reduction is made. This re-charge will continue until the auxiliary reservoir pressure equals that of the brake pipe.

Quick Service Position.

If, when making a brake pipe reduction, the pressure in chamber **h** is but slightly reduced, the auxiliary reservoir pres-

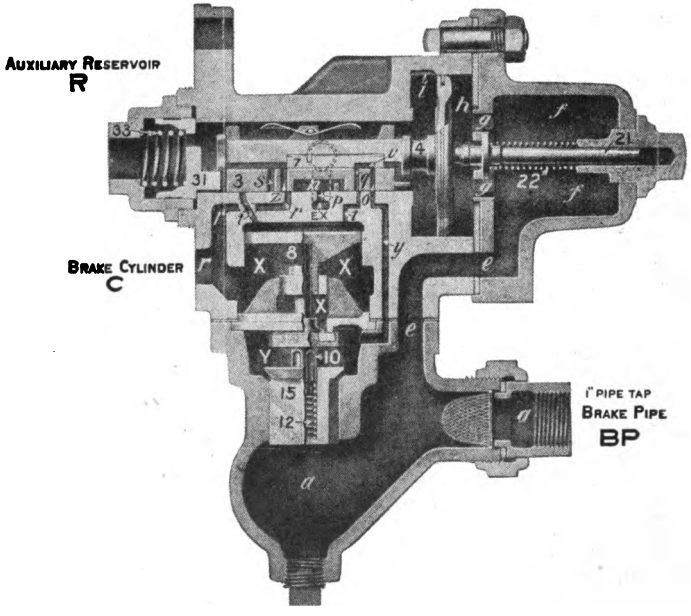


Fig. 35. Type K Triple Valve.
Quick Service Position.

sure will move the main piston forward, carrying with it the slide valve and graduating valve, until it strikes graduating stem **21,** which is held to its place by graduating spring **22,** and the parts will assume the position shown in Fig. No. 35.

Feed groove **i** is now closed, cutting off communication between the brake pipe and auxiliary reservoir. At the same time, graduating valve **7** uncovered port **z,** which is in partial registration with port **r** in the slide valve seat, allowing auxiliary reservoir pressure to flow to the brake cylinder. Ports **o** and **q** through the side valve, are also connected by cavity **v** in the graduating valve, so that air from chamber **Y** will pass through passages **y** and **o,** cavity **v,** and passages **q** and **t,** then around loose fitting emergency piston **8,** and through chamber **X** to the brake cylinder.

When the pressure in chamber **Y** has been reduced below that in chamber **a,** check valve **15** will raise, allowing brake pipe air from chamber **a** to flow through the passage just mentioned,

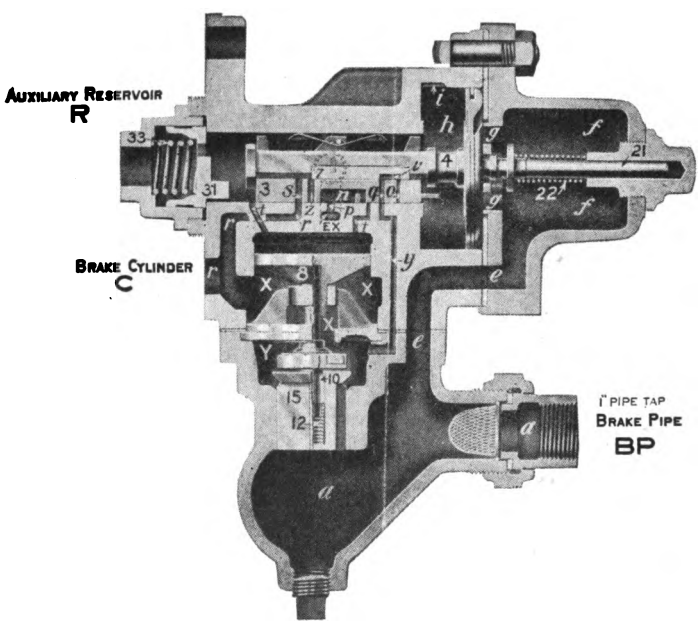


Fig. 36. Type K Triple Valve.
Emergency Position.

to the brake cylinder. The size of the ports are such that the amount of air delivered to the top of the emergency piston **8,** will not be sufficient to force it down and cause an emergency

application. At the same time they are large enough to cause a positive brake pipe reduction at that triple valve, which will cause the next valve to act, producing a regular, serial action throughout the entire train.

Emergency.

Emergency action is produced by a rapid reduction of brake pipe pressure to a point so far below that of the auxiliary reservoir, that the main piston **4** is carried forcibly to the right, compressing graduating spring **22**, and seating on the leather cylinder cap gasket. In this position, slide valve **3** uncovers port **t** in its seat, allowing auxiliary reservoir air to flow into the chamber above emergency piston **8**, forcing it down so as to unseat emergency valve **10**. Brake pipe air will now flow through chamber **a**, raising check valve **15**, and passing through chambers **Y** and **X** to the brake cylinder until their pressures are nearly equalized, when check valve **15** will be returned to its seat by spring **12**, preventing any back flow to the brake pipe. Emergency valve **10** will be held open by emergency piston **8**, until the reservoir and brake pipe pressures are nearly equalized, when both valve and piston will be raised to their original positions by spring **12**.

In this position of the slide valve, port **s** connects with port **r** in the seat, admitting air from the auxiliary reservoir to the brake cylinder. These ports are, however, so small that they do not interfere with venting brake pipe air to the cylinder.

The effect of this sudden local reduction of brake pipe pressure is to throw the next triple valve in the train into emergency position, and so on, through its entire length. This takes place so rapidly that it requires less than three seconds to apply all the brakes of a 50-car train, and at the same time the cylinder pressure is about 20 per cent greater.

The brakes are released by raising the brake pipe pressure, but the release takes more time than after a service application on account of the lower brake pipe pressure and higher equalized pressure in the auxiliary reservoirs and brake cylinders.

Full Service, Lap and Retarded Release Positions.

Besides the position herein given, the triple valve has three other intermediate positions called full service, lap and retarded release positions. The full service position is the quick service position augmented, allowing air pressure into the brake cylinder more rapidly. At the lap position all ports of the triple valve are closed or "lapped." There is no movement of air when the valve is at this position, and the "Status quo," quick or full service application is maintained. The retarded release is a

position whereby the release of the brakes caused by the increase of brake pipe pressure from the locomotive proceeds at the same speed on the last as on the first car of the train.

The relation of the air brake parts one to the other will be more clearly understood after examining the view of the entire Type K freight equipment. Fig. No. 37, Page 121.

It will be understood that in this diagram the piping details have been considerably simplified for illustrative purposes.

Tools and Machinery.

In the maintenance and repair of the automatic air brake system, the mechanic uses the following tools:

1 Large hammer,
1 Small hammer,
1 Stillson wrench,
4 Sizes of files,
S Wrenches,
Socket wrenches,
Hack saw,
2 Screw drivers,
1 Cold chisel,
1 Air brake test rack. (Part of shop equipment. Its operation will be explained later.)
1 Portable forge—for heating pipe for bending.
2 Vises—for holding air brake parts and pipes when bending, cutting or threading.

Materials and Air Brake Parts.

Materials Used.

Many different sizes of rubber and leather gaskets,
Kerosene,
Waste,
Cheese cloth, } For cleaning air brake parts.
Graphite,
Machine oil, } For lubricating triple valve and other valves.
Brake cylinder compound.—A grease for cylinder lubrication.
Powdered pumice.—For grinding valve parts.
White lead.—For pipe joints.

Besides the above, he is required to handle, repair and renew all parts of the air brake system including:

Air hose and coupling,
Angle cock,
1" and 1¼" pipe,
⅜" pipe,
Cut-out cock,
Pressure retaining valve,
Centrifugal dirt collector,
Drain cup. (Used on some cars.)
Triple valve,

Auxiliary reservoir,
Reservoir release valve,
Brake cylinders of different sizes.

The Brake Cylinder Parts are:

Body,
Piston and rod,
Packing leather,
Packing expander,
Non-pressure head.
Pressure head,
Cross head,
Gasket,
Follower,
Stud and nut,
Release spring.

On Combined Air Brake Equipment as shown in Fig. 37, the auxiliary reservoir wall forms the pressure head. In freight air brake cylinders the piston rod is a hollow sleeve in which is a loose push rod attached to the levers and rods of the foundation brake gear. This permits the brakes to be set by hand without compressing the release spring.

Referring again to Figure 37, it will be seen that there is a small groove, called the leakage groove, in the wall of the brake cylinder. While running over the road it may occasionally happen that brake pipe leakage and other conditions cause the Triple Valve piston to move, allowing a slight flow of air into the brake cylinder. This would gradually cause the brakes to creep in and drag, were it not for this leakage groove which permits air from such causes to flow past the piston to the atmosphere.

Following is a list of parts of the "K Type" triple valve, all of which the air brake mechanic must repair and order when they require renewal:

Body,
Slide valve,
Main piston,
Main piston ring,
Slide valve spring,
Graduating valve,
Emergency piston,
Emergency valve seat,
Emergency valve,
Rubber seat,
Check valve spring,
Check valve case, complete,
Check valve case gasket,
Check valve,
Strainer,
1" Union nut,
1" Union swivel,
Cylinder cap,
Graduating stem nut,
Graduating stem,
Graduating spring,
Cylinder cap gasket,
Bolt and nut (for cylinder cap),
Cap screw,
1" union gasket,
Emergency valve nut,
Retarding device body (marked K-1),
Retarding stem,
Retarding spring,
Graduating valve spring,
⅜" plug for exhaust outlet (not shown),
½" pipe plug.

There are many types of triple valve, both freight and passenger, all of which are tested and repaired by the air brake carman. These types include:

Types of Triple Valves.

Plain	B		
	C		
	D		
	E		
		Freight	F-1
			GN-1
			K-1
			K-5
			H-1
			GN-2
			K-2
			K-6
		Passenger	P-1
			J-4
			L-1-B
			S-1
			J-5
			L-2-A
			J-6
			L-3

These different types of triple valves, while all are constructed on the same principle, differ one from the other in the number and size of the parts. The passenger car triple valve has one prominent added feature called the safety valve attached directly to it. This valve prevents excess brake cylinder pressure in service applications. In emergency applications it is cut out entirely, that is, cut off from use.

The Repair and Maintenance of the Air Brake System.

When a car enters the shop for general repairs, all or the greater part of the air brake system is removed. This removal is necessary because the entire brake pipe may be badly rusted and the angle cocks and air hose defective, or that these parts must be removed in order to make other repairs to the car. The triple valve is always removed for testing, cleaning, and repairing. The brake cylinder can be cleaned and oiled at the car, but the methods used are the same whether it is removed or not. It requires two men to disconnect the brake cylinder and to replace it.

CLEANING THE CYLINDER.

The mechanic must first remove the cylinder head. This is done by taking off the bolts and disengaging it by a tap with the hammer. The mechanic causes it to drop to a box before letting it to the ground, as a heavy fall would be likely to break it. After removing the head, the piston is pulled out from the cylinder.

The old cylinder lubricant is removed from the cylinder walls, the piston and the packing leather. All the metal parts are wiped clean with kerosene. This kerosene must be well removed or it would cause damage to the gaskets and packing leather. Any rust is removed with sandpaper. The piston ring and packing leather are examined carefully, and if defective, are replaced. In applying new packing leathers, the flesh side is placed against the piston and the bolts to all sides of the follower are tightened uniformly. A thin coat of cylinder lubricant is applied to the cylinder wall, to the expander ring groove on the piston and to the inside of the packing leather. The piston is then put in place in the cylinder and the packing leather forced into position with a dull putty knife

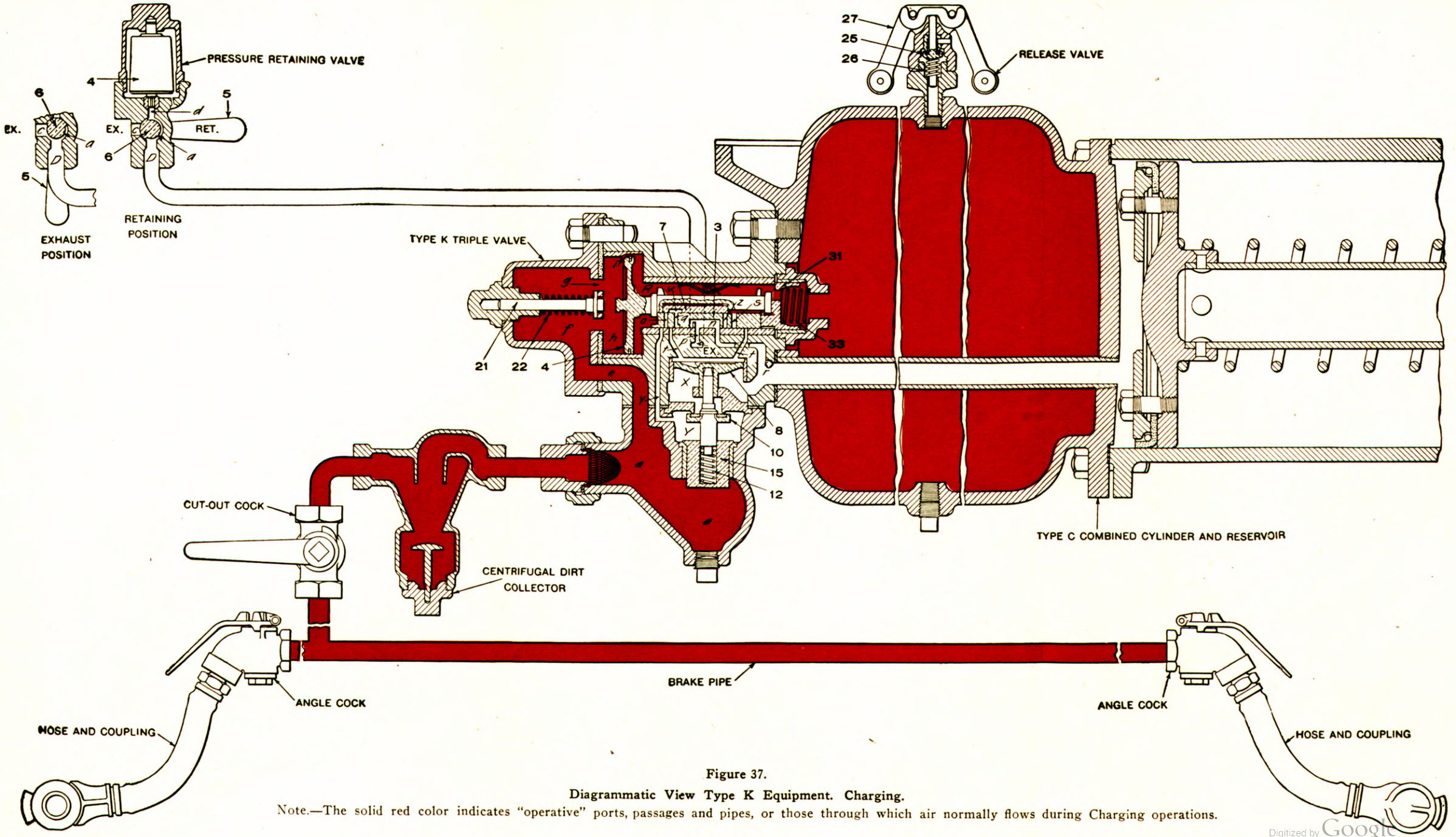


Figure 37.

Diagrammatic View Type K Equipment. Charging.

Note.—The solid red color indicates "operative" ports, passages and pipes, or those through which air normally flows during Charging operations.

or other instrument. Care must be taken not to damage or crimp the leather. Cylinders should be cleaned every six months and according to M.C.B. rules, cylinders not cleaned inside a period of 12 months constitutes a car defect.

Triple Valve Work.

The triple valve is disconnected, brought to the shop and taken entirely apart. The cylinder cap is first removed by taking off the bolts and giving it a tap with the hammer. The gasket generally comes off with the cap. The main piston, slide valve, graduating valve and graduating spring are all connected and can be taken out together.

Cleaning.

The check valve case is removed in the same manner. The emergency piston, emergency valve, check valve, check valve spring, emergency valve seat and check valve case gasket are then removed. One of these is right on top of the other and they can be picked out in succession. All of these parts, with the exception of the gaskets and the emergency valve seat which is rubber, are soaked in kerosene for about 10 minutes. They are then wiped with kerosene, blown off with air which dries them and then wiped with cheesecloth. The inside of the triple valve is cleaned in the same way. Care must be taken so as not to scratch any of the valve bushing, as this would cause leaks. After the bushing and slide valve seat have been well cleaned, the parts are lubricated and reassembled.

Application of Lubricant.

In lubricating the triple valve, no lubricant is put on the quick action parts. The piston ring should never be removed except for renewal, as it is easily sprung out of shape. The face of the graduating valve, both upper and lower faces of the slide valve, and the bushing where the slide valve spring bears are lubricated with a light coating of dry graphite applied uniformly. The graphite used is fine and of the best grade. It is applied with a stick having a piece of fine cloth tied or glued around one end of it. The covered end of the stick is dipped into the graphite and rubbed well onto the brass parts. A slight tap with the stick causes it to loosen from the pores of the brass, leaving it as the light uniform coating desired.

The piston is lubricated by putting two or three drops of oil on its bushing and sliding it back and forth, which works the oil in around the ring. There should be no free oil left on the parts nor should any be allowed to get upon the gaskets or rubber-seated valves. The slide valve spring tension should be light.

Triple Valve Repairs.

The repairing of the triple valve consists largely of grinding the parts to stop leakage and the grinding to fit, and insertion of parts that required renewal.

If the check valve leaks under test, it must be ground to closer fit. This is done by coating the bearing parts of the valve with oil and powdered pumice. The valve is then placed in the valve case and turned around with a grinding motion. In this way both the valve and the bushing it fits into are ground together.

If the main piston ring requires renewal on account of leakage, it is ground with a small file and with powdered pumice to make it fit the bushing. It must also be ground into the groove on the piston which is done with pumice stone and water until it works easily in the groove.

The main piston usually arrives from the factory slightly over size and also must be ground to fit its bushing. Some of this grinding is done with a file. The emergency valve seat is also ground with a file if it is too tight a fit in the valve case. If these parts are not kept round, leakage will result. Anyone who has ever used a file on work of any character will readily appreciate the skill required to file and grind light brass parts and keep them so perfectly round that they will not leak under high air pressure.

Care of Safety Valve, Etc.

When repairing passenger car triple valves, the mechanic must test, clean and repair the safety valve. On freight equipment he is required to test air hose and clean and repair angle cocks, cut-out cocks and the centrifugal dirt collector. The mechanic cleans, tests and repairs the different types of pressure retaining valves. The pressure retaining valve is for the purpose of maintaining pressure in the brake cylinder while recharging the air system when the train is running on a high grade. It is set by hand by means of a handle or lever, but it automatically measures the air pressure. They are manufactured in different types to meet different road conditions.

The Test Rack.

After being assembled, the triple valve is placed in the test rack and tested. The test rack is a complicated system of valves and gauges for the purpose of determining whether or not triple valves, cut-out cocks, angle cocks and air hose are in proper condition for service. The improved type of test rack shown in the attached sketch, tests all types of triple valves under every con-

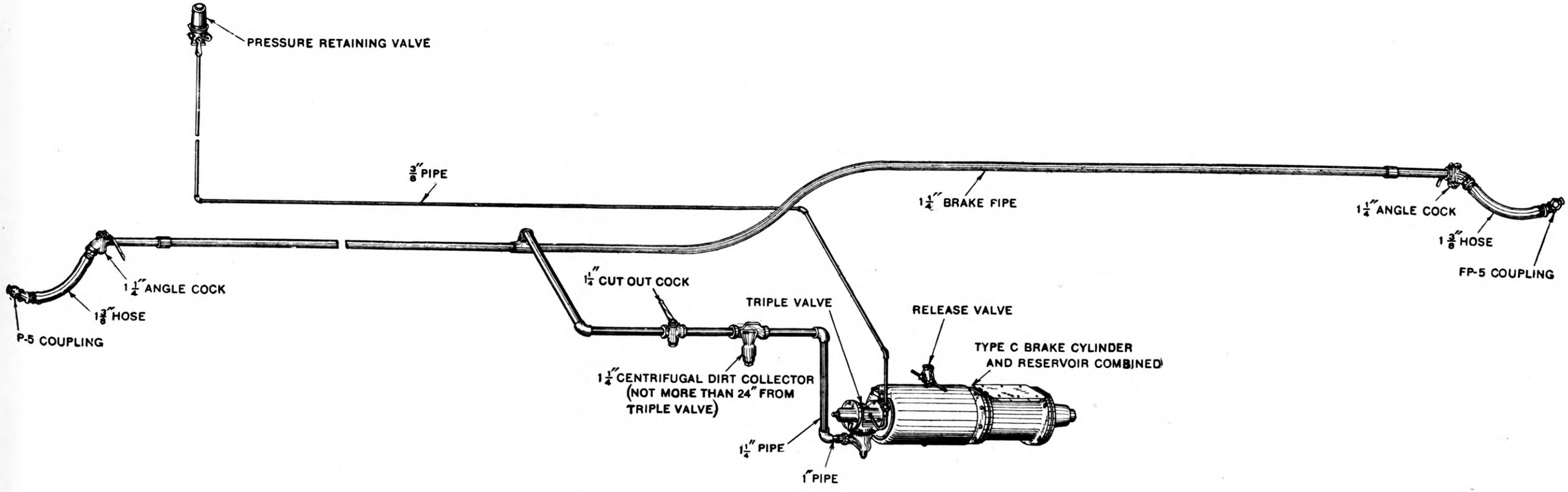


Figure 39.
Type K. C. Combined Freight Brake Equipment.

dition they will meet when in service. Four triple valve stand face plates are required for each test rack to permit the testing of all types of triple valves.

Not only does the test rack measure the performance of triple valves under all service conditions, but it tests every part for leakage and measures the amount of leakage, if any, through some of the parts. The operation of the test rack differs in testing the different types of valves which requires added knowledge on the part of the operator. It is not attempted herein to fully describe the operation of the test rack in making the various tests of the different types of triple valve.

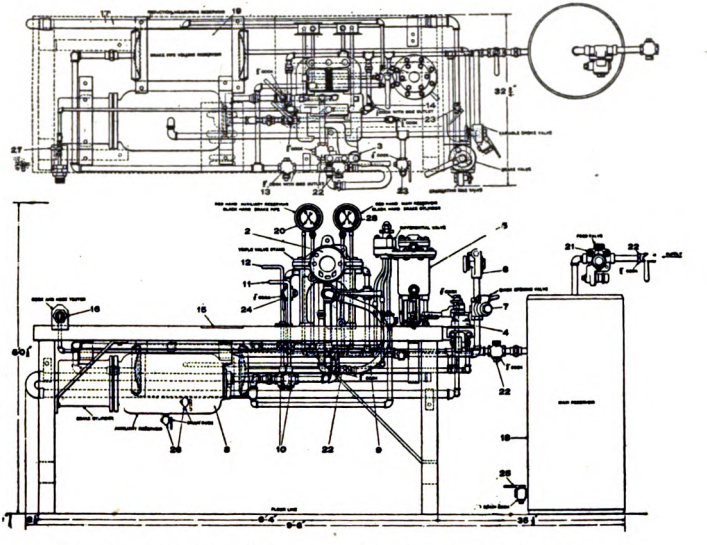


Fig. 38. Sketch of Improved Triple Valve Test Rack. (Plan and Front Elevation.)

Triple Valve Charging Test.

The triple valve, after attachment to the test rack, is first tested as to its efficiency in charging the auxiliary reservoir. The brake pipe pressure is maintained at 80 pounds and the valve must charge the reservoir to 70 pounds pressure in a specified number of seconds. This time required to charge the auxiliary reservoir varies with the different types of triple valve. For example, the L-3 type of passenger car valve should charge the reservoirs in from 9 to 11 seconds, and the G N-1 triple valve used on freight equipment should charge the reservoir in from 100 to 120 seconds. The test rack operator knows the charging time required of each type of triple valve without reference to any written table.

Leakage Tests.

The second test is generally for leakage at the exhaust port when the triple valve is in emergency position. The check valve and cylinder cap gasket are also tested for leakage. Soap suds applied to the vents aid in detecting and locating the leakage.

Other Tests.

Other tests are for exhaust when the triple is in release position and for leakage directly through the triple valve casting or gaskets. The graduating valve is tested for leakage, the amount of which must not exceed five pounds in 20 seconds, as indicated by the brake cylinder gauge. Tests are made for service sensitiveness, quick service, packing ring leakage, release test for excessive friction between the parts, service port capacity test, and for triple valves having that feature, a retarded release test.

The mechanic must know thoroughly the functions of the lever and the 16 valves and cocks of the test rack. These valves are operated differently, and each position of each valve has its function in making the different tests. The valve corresponding to the locomotive engineers valve is used in eight different positions.

The mechanic not only operates the test rack, but must test it every week for leakage. He also keeps it in repair and must order and apply any new parts it may need from time to time. Taking it all in all, the mechanical knowledge and experience required to operate and take care of the test rack is equal to the knowledge of triple valves the mechanic must have to test and repair them.

Piping the Car.

Besides the repair of the different air brake parts, the air brake mechanic must apply the entire air system to the car.

Figure 39 shows the piping details in general location. The air brake man cuts, threads, bends and applies all of this piping to the car. It requires not only pipe fitting skill, but also a great deal of experience on car work to measure the car properly in order to get every piece of pipe cut in proper length. The diagram does not illustrate the difficulties met with by the mechanic in fitting the pipe to the many different types of bottom construction. Besides the cross tie timbers, truss rods, body bolsters and brake connections, the pipe fitter must take into consideration hopper bottoms and dump doors on cars so equipped. On high-side steel gondola cars the brake cylinder, reservoir and triple valve are on the end sill shelf at one end of the car. This requires that the connections between this mechanism and the brake pipe be fitted

down through the underframe over the draft rigging and in such location that draft gear shocks or failure will not damage the pipe.

Other Pipe Work.

The application of the air brake system to all of the different work equipment presents many difficult pipe fitting problems. Some varieties of this work are listed below.

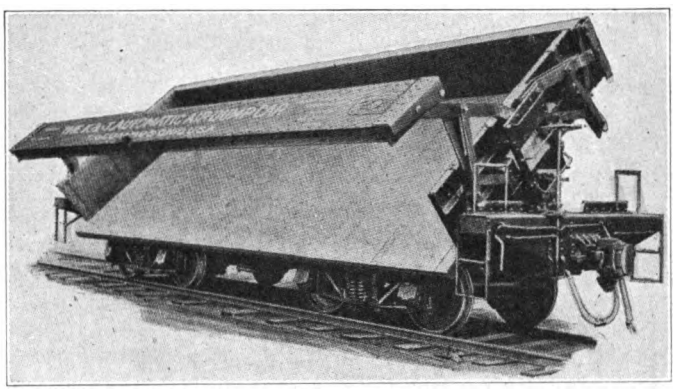


Fig. 40. K. & J. Automatic Air Dump Car.

Snow plows and ballast spreaders having side wings operated by air cylinders.

Many types of dump cars have the dump doors operated by air cylinders and in some types the entire floor of the car can be raised and tilted to discharge the load to either side.

Yard hoists and other air power apparatus of many descriptions are maintained and repaired by the air-brake car man.

Responsibility.

The air brake mechanic receives very little supervision. The great number of cars he is likely to do work upon on some days make it a physical impossibility for his foreman to inspect all of his work. The foreman assigns him certain work to do and he must go to these cars and perform it. He keeps a record of the work done on each car, the condition of the cylinder and triple valve and the date they were last stenciled as cleaned and repaired.

On some roads the air brake man is examined occasionally on his knowledge of air brake principles and repair.

Working Conditions.

All of the air brake work on the car is done in the open under the prevailing weather conditions. The air brake man must pipe cars in the winter and when the ground underneath the cars is wet and sloppy. Practically all of the air brake work on the car is underneath it, therefore he must work in a kneeling or sitting position, regardless of ground conditions. This work is especially hazardous in yards and shops where there is much movement of cars.

Facts Peculiar to Air-Brakes.

When we consider the automatic nature of the air brake mechanism, and the fact that the limit of movement of the triple valve piston is about 1⅝ inches, and that in this short travel it must positively stop and function in six different positions, we begin to realize the accuracy of adjustment needed, and hence the skill and delicacy of manipulation required of the mechanic to properly repair triple valves.

The operation of trains without accident or delay is impossible unless the air brake system is in perfect working condition. Brake efficiency is hampered by the slightest defect in the air brake parts. Unlike any other car parts, the air brake system will not successfully function when slight defects exist. It is a case of good brakes or no brakes, because when defects arise in service the car must be cut out, as only the experienced air brake man can positively locate defects and correct them, and the operation of a car with faulty brakes causes repeated delays and possible accident.

Part IV.

WORK ON LOCOMOTIVES, OTHER EQUIPMENT, AND THE WORK OF THE WRECKING CREW.

SECTION A.

WORK ON LOCOMOTIVES.

The carman does all of the work on locomotives that is included in the construction, repair, application and removal of wooden cabs, pilots, pilot beams, running boards and headlight platforms. The carman applies all of the locomotive uncoupling appliances and repairs and renews wooden sash, doors and floor where found in steel cabs. He cuts, fits and applies all glass for application to cab sash and doors, and assembles and applies side and back curtains of cabs. The carman makes all of the seat boxes, coal gates, soda ash boxes and clothes lockers that are part of the cab and tender equipment. All locomotive tender draft gear work and work on wooden tender frames is done by carmen.

Repairing Tenders.

The carman jacks up the tank from the tender frame and places it on trestles. Where the tender work is done in shops having an overhead traveling crane, the carman fastens the tackle and the crane does the lifting of the tank, and lets it down on the trestles. If the trestles, and the timbers that are a part of them, are not properly placed, there is a liability that they will fall to the floor and perhaps seriously injure some one. The work of repairing tender frames is similar to the work of repairing the sill structure and draft rigging of freight cars. The work on tender trucks is somewhat heavier than similar work on freight cars, as they are usually of greater average weight and capacity. The construction details of the trucks are generally somewhat the same as on freight cars, with the exception that in most instances heavy elliptic springs are used instead of coil spring nests, as on most freight trucks. Some of the larger tenders have equalizer trucks constructed similarly to the steel four-wheeled passenger truck, except that the weight of all of the different parts is greater, and many of them—instead of having one long equalizer per side, have two, and the coil springs are set astride both of them.

Cab Work,

On cab work the carman must remove the cab from the locomotive, and the job is generally done very hurriedly in order to get out of the way of other mechanics who are waiting to do their part of the work on the locomotive. In the loosening up and removal of a cab, the mechanic is working most of the time on a ladder, on the locomotive running board, and on scaffolding. After he has removed the bolts, brace rods and angle bars, etc., that hold the

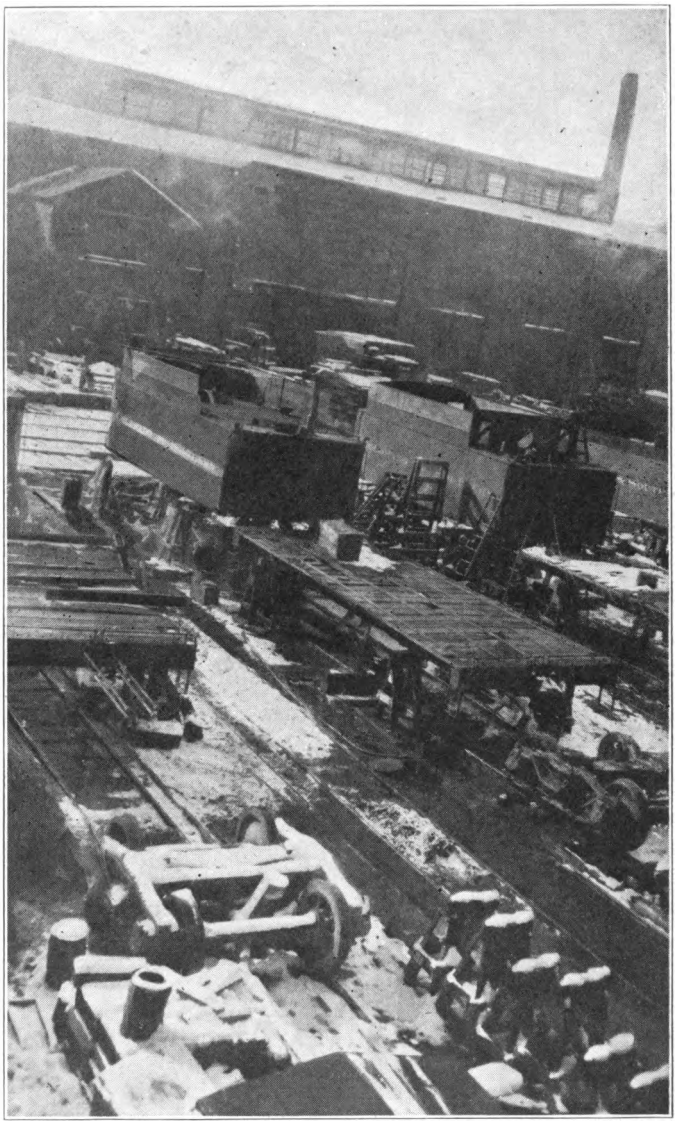


Fig. 41. View of Tender Repair Yard.

cab to the locomotive, the cab is lifted by the machine shop crane, placed upon a push car and transferred to the cab repair shop.

On the arrival of the cab at the repair shop, all of the worn

and decayed parts are removed and renewed by the carman, and as cab parts are rarely of exactly the same dimensions, even in

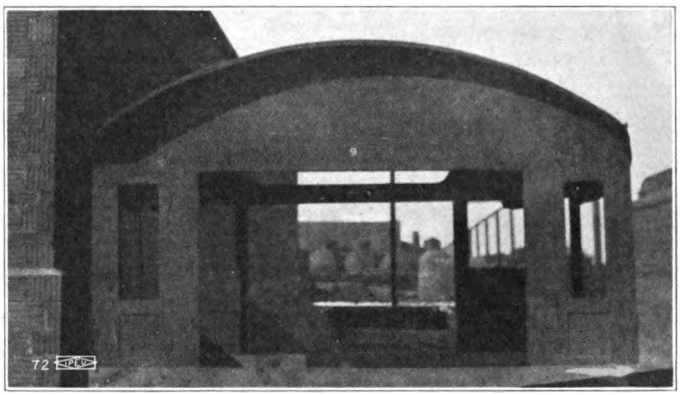


Fig. 42. End View of Locomotive Cab.

engines of the same class, he does considerable framing of the parts by hand. A number of new wooden cabs are continually being

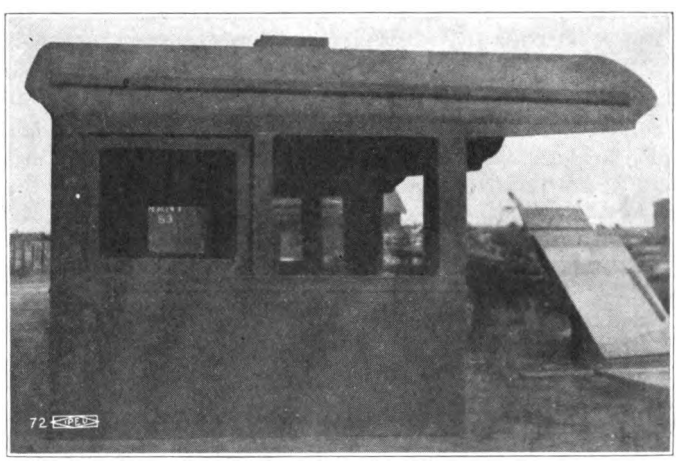


Fig. 43. Side View of Locomotive Cab.

constructed in the cab repair shop. This work is done from blueprints, which are intended to show all of the dimensions of the cab, which dimensions are governed generally by the parts of the loco-

motive that the cab must be fitted around. Very often there are pipes and other parts of the rear end of the locomotive that the blueprint of the cab does not allow for, and the layer-out and the mechanic assembling the cab must use their own discretion and knowledge in these cases.

As the cab admits the entire end of the locomotive firebox, and as the back must be open sufficiently to allow the fireman to easily get coal from the tender, it will be seen that the cab is a structure of but two complete sides, a curved roof, and a front end having only partial partitions. The front end and sides must be equipped with sash and glass, the front end with doors through which the locomotive crew can walk out on the running board.

As so much of the space that could be given to the strengthening of the cab structure is taken up by the locomotive end, it will be understood that the re-enforcement of the cab must be sufficient to enable it to stand the rough service it gets.

After the cab has been repaired the carmen move it to the machine shop and direct the crane operator in letting it down properly on the locomotive, and fasten it securely. Very often the engine carman is required to do rush jobs on cabs of engines that are in the roundhouse and are to be called for service. Very often only a few minutes before an engine is required to be on the road the carman is despatched to apply a new window glass. In these few minutes he must bring his glass to the cab, cut it to fit, apply and hold it in place with the putty and beading.

Pilot Work

The engine carman constructs a great number of new wooden pilots and foot boards. The pilot sills and uprights are mortised and bolted together, and the slats gained into the bottom plates and into the plank at the back of the pilot that is bolted to the pilot beam. Besides being gained, these slats are bolted at each end. These bolts are countersunk, and in framing these slats the mechanic must make the countersunk holes to admit the bolt heads and washers. To fasten these countersunk bolts, the mechanic must use a socket wrench.

Lagging the Boiler

Besides the tender, cab and pilot work, the locomotive carman must apply the asbestos and wood lagging to the locomotive boiler. This wood and asbestos serves as insulation, and is for the purpose of retaining the boiler and firebox heat. This asbestos lagging differs in thickness for the different sections of the locomotive The lagging of the firebox and the front end is generally somewhat heavier than that of the rest of the engine. The firebox heat is so intense that without this thick insulation of

lagging the locomotive crew would not be able to sit in the cab.

Considerable skill and experience is required to apply these sheets and blocks of asbestos and wire them in such a manner that they will not shift under the sheet metal that forms the locomotive jacket, and all of the cracks and seams must be filled in with an asbestos mortar. Particular care is necessary to fit it closely around all of the valves and pipes that project from the boiler's surface.

Hazards and Working Conditions.

The work of the carman, when working on tender frames and trucks, has the same attendant hazards as similar work on freight cars. The work sometimes is done on the outside and sometimes in a shop that is roofed. The ground around the tender frame is sometimes flooded with water which has been used in the testing of the tanks for leakage. In making running repairs to locomotives that are under steam, often on pilot and footboard work the mechanic is obliged to crawl under the pilot or front end, where he is in danger of being scalded by exhaust steam or by being crushed in case some one should start the locomotive. The locomotive carman must have a knowledge of the safety appliance regulations governing the tender and locomotive draw bars, uncoupling mechanism, foot-boards, sill steps and hand holds. If he is assigned to take care of the running roundhouse repairs, he works with no supervision, as the various roundhouse foremen, when they discover existing defects, make a note of it and place the note in a box where the carman finds it, and goes to that engine and makes the necessary repairs. The work of the carman assigned to roundhouse repairs could be described as being one rush job after another.

SECTION B.

THE WORK OF THE CARMAN ENGAGED IN THE BUILDING AND REPAIRING OF MOTOR CARS, VELOCIPEDES, STATION AND WAREHOUSE TRUCKS, ETC.

For the purpose of track inspection and in the quick delivery of repair parts for signal, interlocking and automatic switch equipment, most railroads have a number of light, three or four wheel cars propelled by a gasoline engine. These motor cars have from one to four cylinders, according to the size and weight of the car. Some roads have motor cars that are electrically driven.

The section hands or track repair forces use a small car somewhat similar in size and appearance to the motor car to bring them

to and from their work and from one job to another at the different points in their section. These cars are called hand cars and are propelled by man power through the medium of rods and gears which operate on the same principle as on the child's toy called the Irish Mail Car

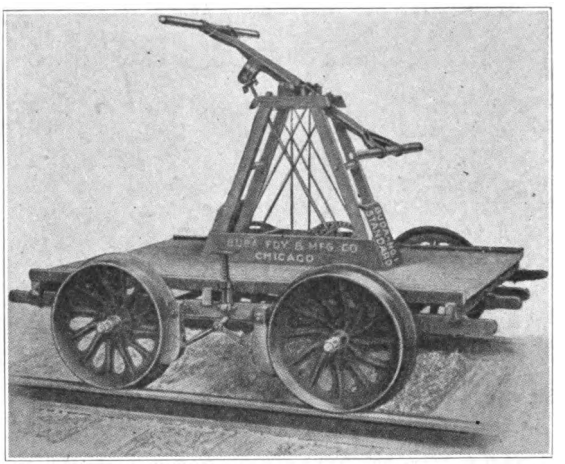


Fig. 44. Buda Hand Car.

At every railroad station there are one or more trucks used in carrying mail bags, baggage, and small freight and express shipments to and from the trains and the station. They are usually of about the same height as the railway car floor in order to expedite the unloading of the shipment. They have generally three or four wheels and are made in a great variety of shape and design.

At freight houses and at shops and stations the common two-wheel warehouse truck is used to carry all kinds of material and parts of equipment. Some of these trucks are of metal and others part metal and part wood. Some have wooden wheels and others metal. Some have rubber tired wheels.

In the most up-to-date passenger shops a small two-wheel device with a straight handle attached is used to carry the heavy hydraulic jacks.

All of the above equipment, and similar equipment, is repaired and rebuilt by carmen. The men assigned to this class of work are generally men who have been in the service a great many years and who have, through injury or rheumatism, become unable to work efficiently on ladders and scaffolding. They are, however, usually very good mechanics and skillful in the use of their tools.

Motor Car Repairs.

The repair of the gasoline engines of motor cars is done by machinists, but the carmen remove and apply them to the cars. All of the gears and the rods to operate them are adjusted by the carman. It requires care and mechanical knowledge to make the

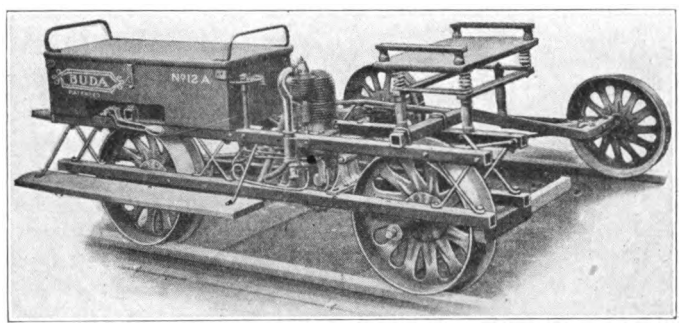


Fig. 45. Buda Motor Velocipede.

power transmission rods of the proper length. The proper repair of the small journal boxes and bearings on this equipment requires experience in this class of work. The sills, cross pieces and floor of all of these cars generally require repair or renewal. All of the material is ordered and generally framed by the carman. By framing, we mean that he is required to do all of the sawing, planing, boring of holes and the cutting of gains, tenons and mortises.

The carman orders and applies the wheels and axles for this equipment. He also presses the wheels on the axle. This operation requires a good deal of heavy sledging. After the wheels are applied they must be straightened and in proper gauge. The frame around the levers on hand cars is sometimes of very light material. By light, we mean that the dimensions, width and thickness are small. This frame work must be very strong and is usually reinforced by light wrought iron rods drawn tight. The joining of these parts must be skillfully done as a poor joint in light work is more liable to fail than a poor joint in larger work; that is, the defect is usually proportionately larger.

The work on this equipment is done almost without any supervision or even inspection when completed, excepting, of course, when the work is paid for on a piece-work basis. The men assigned to this class of work are generally old employes and skillful mechanics and their finished work is satisfactorily inspected by themselves.

SECTION C.

THE WORK OF THE WRECKING CREW.

Personnel.

The wrecking crew generally is composed of the wrecking foreman, signal man, derrick engineer, and from four to eight carmen wreckers. These men all work in the shop at their trade of building and repairing cars during that part of each regular working day that they are not called out on wrecks. Their duties and responsibilities do not, however, cease at the close of the regular working day, because at any time of the day and night they are subject to call. A member of the wrecking crew is requested to be ready for work twenty-four hours of the day, every day in the year. He must at all times be where he can be notified in case of wreck. He must live near by the wrecking outfit station so that it is only a matter of minutes between the time he is called and his arrival for duty. Any time at day or night that he leaves his home he must inform the roundhouse clerk or the call station where he is going and supply the clerk or call boy with the telephone number he can be reached on in case of call for duty. He also informs the clerk of the time he expects to return to his home. This requires the member of the wrecking crew to know the telephone number of his church, dentist, doctor, lodge, grocer, etc., in order that he may supply the number to the call station before he visits any of these places.

The wrecking foreman is usually a man of long experience in the handling of wrecks. This experience is gained only by being a member of wrecking crews. From the time he goes on duty, he is in complete authority over the wrecking outfit, its crew and the engineer and fireman on the locomotive assigned to haul them to the wreck.

The signal man is a carman wrecker of experience who stands outside of the derrick engineer's cabin and gives him the signal for the operation of the derrick as called for by the foreman. These signals he gives by pulling a cord which rings a bell inside of the derrick cabin.

The derrick engineer generally is a licensed engineer and most states require him to successfully pass an examination on his knowledge of the operation and care of steam boilers in order to get this license, without which he would not be allowed to work. The derrick engineer fires his own boiler, watches his steam gauge and water glasses, lubricates his machine and operates his crane in accurate and immediate response to each signal and also watches the work so that he may operate the crane intelligently.

The carman wrecker is selected for this work because of his exceptional mechanical skill and experience, and his nerve, strength, agility and endurance, all of which are required in the handling of wrecks. Quickness of observation and decision are absolute essentials in this service. The wrecking crew must have a knowledge of train schedules on their division as it would not do to have any of the wrecking equipment or crane boom extending over a track on which a train was expected.

The Wrecking Outfit.

The wrecking outfit generally consists of a steam wrecking crane, tender car, truck car, rail and tie car, tool car, sleeping and dining cars.

Wrecking cranes of varied weights and lifting capacities are used throughout the country. They weigh from 150,000 pounds to 300,000 pounds, which is perhaps the heaviest. The lifting capacity varies from 50 to 160 tons. The crane of 120 ton capacity is most generally used. They are usually operated by steam generated in a boiler built on the crane with the cabin around it. The cabin and boom can be turned completely around on a geared swivel. The boom has two hoists—the main hoist and the auxiliary hoist. The main hoist can be operated so as to move along the boom.

In the operation of the crane the engineer has before him 10 levers which are used separately, in conjunction with one another, or opposing. The levers are one throttle lever, one reverse lever to reverse the engine, one lever to raise or lower boom, one lever to swing crane to either right or left, one lever for the operation of light lifting cables, one lever for the operation of heavy cables, one hand brake lever for big cable, one cluch lever and one brake lever for the large cable drum. This gives seven levers on clutches and three on brakes.

Each crane has the following tackle attachments for use on the hoists:

160-ton transom beam (1),
Link (2),
Special shackle(2),
45-ton transom beam (1),
Center clevis (2),
End clevis (2),
Special shackle (2),
Pin (Locomotive lift) (1),
Sling (Locomotive lift) (1),
Sling (Locomotive lift) (1),
Coupler yoke attachment (1) Link No. 12, 2 chains No. 32, 1 yoke No. 13,
Link (1),
Yoke (1),

End sill hook (2) for steel underframe cars,
End sill hook (2) for wood underframe cars,
Side sill hook (4) for steel underframe cars,
Side sill hook (4) for wood underframe cars,
Sling (4),
Sling (2),
Sling (2),
Sling (2),

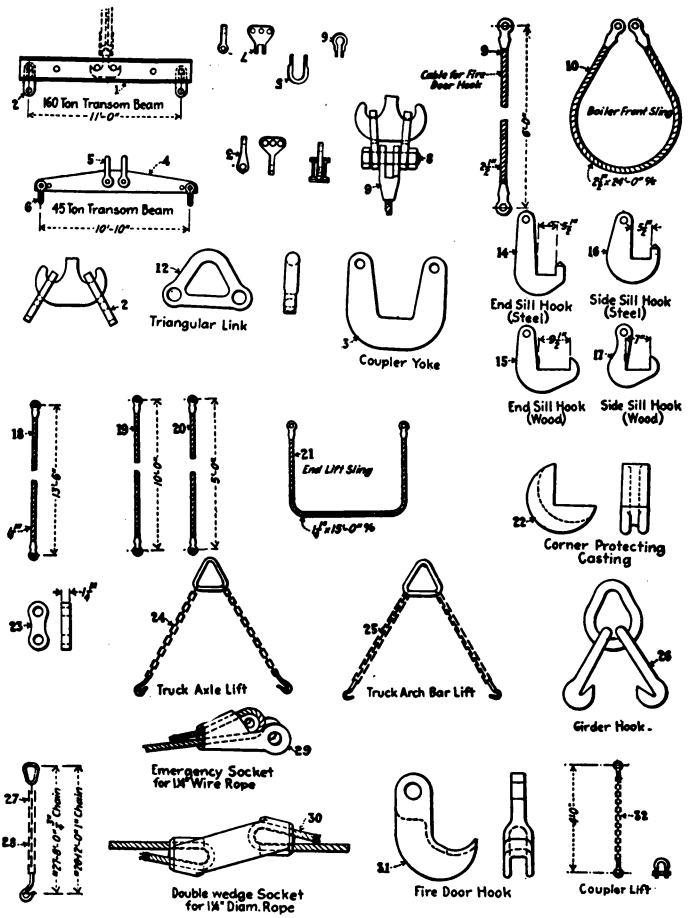


Fig. 46.

Corner protecting casting (2),
Connecting link (2),
Truck sling, axle lift (1),

Truck sling, arch bar lift (1),
Girder hook (1),
Chain sling, ¾" (2),
Chain sling, 1" (2),
Emergency cable socket (2),
Double wedge socket (1),
Fire door hook (1),
Coupler lift chain (2).

The truck car is usually a flat car with 12 inch sides. It carries the following material:

2 80,000 lb.s capacity steel car trucks,
2 60,000 lbs. capacity steel car trucks,
150 pieces blocking,
25 oak wedges,
6 30' cables,
2 1½" cable slings with heavy links at each end,
4 1½" chains, 20' to 30' long, rings each end,
4 kegs track spikes in cellar (under slung box),
30 pairs angle bars,
4 kegs track bolts.

The rail and tie car is also a flat car with low sides and carries the following material:

75 ties,
8 85 lb. rails,
8 72 lb. rails,
12 66 lb. rails.

The dining and sleeping car carries the following equipment:

10 bunks,
10 mattresses,
Complete set of cooking utensils,
1 steel kitchen range,
1 ice box,
1 stretcher, complete with blankets, pillows, etc.
Complete set of porcelain dishes.

The tool car carries a variety of tools, equipment and material that would lengthen this exhibit considerably to list. This equipment includes the following:

10 Jacks,
2,700 feet of rope of varied sizes,
Tackle and snatch blocks,
26 Switch chains,
Emergency coupler, knuckles,
2 Wheel barrows,
Fire extinguishers,
Torches,
Lanterns,
Airhose,
Bolts,
Brasses and wedges,
Rollers,
Shovels,
Picks,
Sledges,
Chisels,
Tarpaulin,
Grain sacks,
Oil,
First aid chest,
Set of carman's tools, and
Acetylene cutting apparatus.

The tender car carriers chain, cable, car replacers and wood and water when necessary.

Duties Enroute.

On reporting for duty when called the wrecking crew generally find that the locomotive that is to haul them is already steamed up and attached to the wreck train. After the crew have all reported, the wrecking foreman orders the engineer of the locomotive to proceed to the wreck telling him, if necessary, at what rate of speed the train is to go. It may be but ten minutes' ride to the wreck, and it may be at the other end of the division, probably 100 miles distant. On the way to the wreck the derrick engineer fires his boiler and lubricates his machine. The wrecking foreman generally has found out the nature of the wreck and while on the way, he assigns the other members of the crew to the task of getting the material and appliances they may need in good order so as to be quickly obtainable when called for.

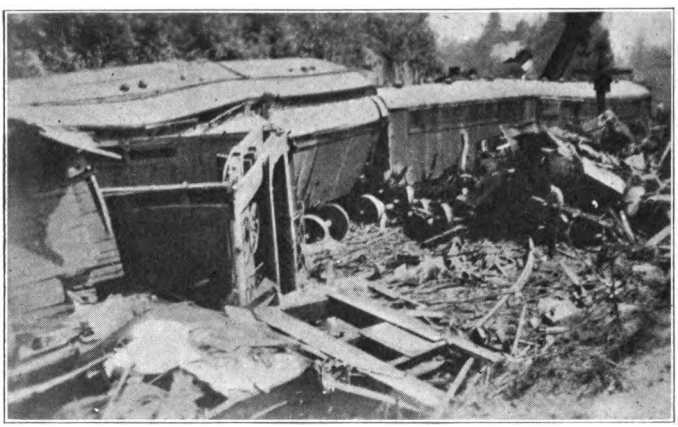


Fig. 47. Passenger Train Wreck.

At the Wreck.

Rail wrecks and the conditions attending them are endless in variety. Passenger trains, cattle trains, freight trains of all kinds, some carrying explosives. Wrecks are caused by collisions or derailment and are sometimes attended by fire. Cars and locomotives are found derailed, upset, or at the foot of an embankment down which they have rolled. In mountainous territory it is sometimes necessary to build emergency track in order to get the crane within reaching distance of some of the wrecked equipment. The incline of the emergency track may be so great as

to prevent the crane from lifting any weight and maintain its position. In this event the wrecking crew must build level that portion of track on which the crane stands.

Fig. 48. A Long Reach.

The First Duty.

The first thing done on arrival is to extricate any persons who have been caught in the wreckage and give them every aid possible. In passenger train wrecks a relief train is generally on hand to take care of the passengers and train crew. In cattle train wrecks the members of the wrecking crew sometimes find it necessary to end the pain of animals badly injured or burned.

Replacing Derailed Equipment.

After taking care of the living things the next duty of the wrecking crew is to clear the right of way and get the damaged equipment in condition to be moved to the shop for repairs. If it has not been already done, the locomotive fires must be drawn and the steam released. The locomotive tender is lightened by removing the coal and drawing the water. (Some tenders carry 14 tons of coal and 9,000 gallons of water.) Another reason for doing this is that the shifting of the water would make the tank an unstable crane load. The removal of the coal eliminates the chances of spreading it around and hampering the work.

The weight of a locomotive and its bulk precludes the possibility of lifting it bodily by one crane and its value requires

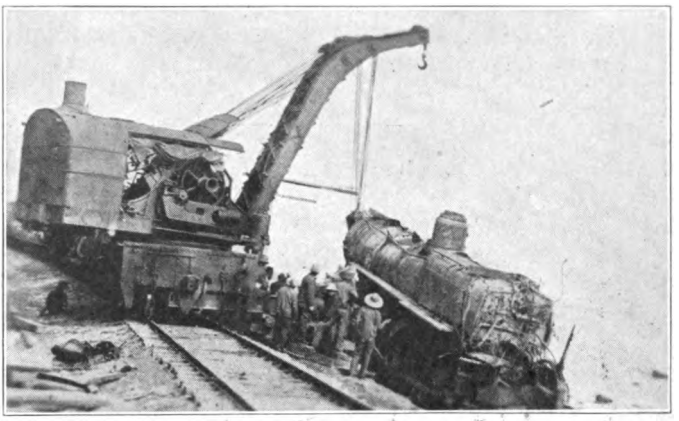


Fig. 49. Bringing a Locomotive to the Track.

that it be handled with care so as not to increase its damage. Generally the locomotive is put in an upright position to roll on its own wheels. Planks and steel rails or flat steel pieces are placed under the wheels. This requires that the locomotive be well blocked and the wheels dug out as its weight has driven

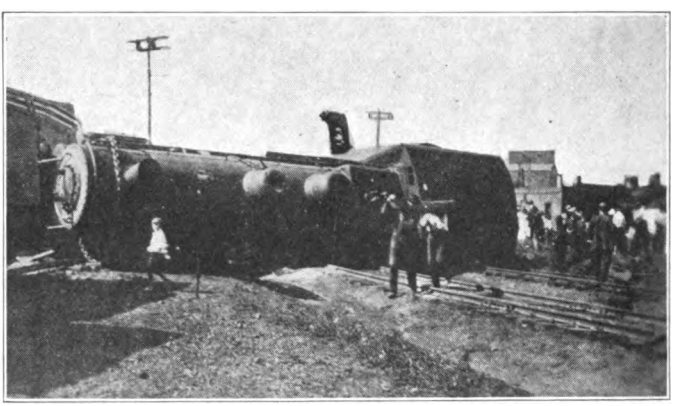


Fig. 50. Laying Down on the Job.

them into the earth. It is then drawn by the crane hoist by degrees to the track on which it is to be set. It is set on the track by the crane aided by the jacks, blocking, wrecking frogs, etc.

The heaviest part of the work of replacing a locomotive occurs in getting it into an upright position and drawing it to the track on which it is to be placed. This is because the load is far out on the crane boom and when lifting the weight is sometimes so great that the crane tips even though its frame is blocked and clamped to the rails and the outriggers in use. The outriggers are heavy structural beams that slide out from either side of the crane frame and under which blocking is placed to prevent the crane from tipping over under load. In lifting great loads these outriggers are blocked up on one side and chained down to the track ties on the opposite side.

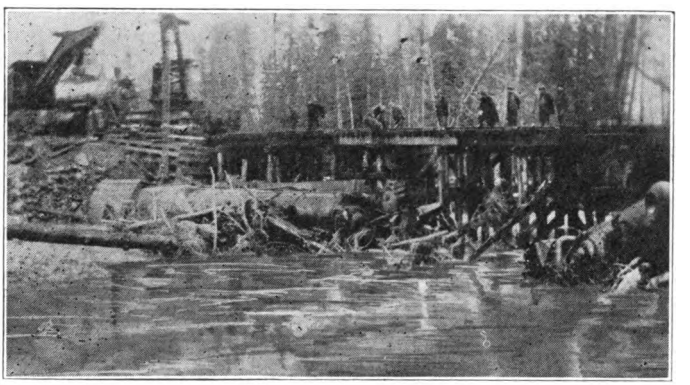


Fig. 51. Double Header too Heavy for Bridge.

Crane Operation.

The derrick engineer **must know** the capacity of his crane when lifting at different angles and with the load at different places on the boom. **The wreck is not the place for experiment.** He must always be aware of the direction his engine is running for if in reverse it will make the movement of the load opposite to requirements and endanger the members of the crew.

The wreckers must know the tackle to apply to various parts of the locomotive and the correct manner of securing it. Improperly applied tackle would probably slip, causing a jerk of the load on the hoist cable perhaps breaking it, damaging the load and endangering the members of the crew. He must know the tool or appliance needed in every emergency and be able to get it quickly.

After getting the locomotive back on the track they have repaired to receive it, the crew gives it and the cars concerned in the wreck the temporary repairs needed to get them back to the station.

A Roundhouse Accident.

All of the wrecks the wrecking crew are called upon to straighten out do not occur on the road. Sometimes at night a locomotive will find its way into the roundhouse turntable pit. An instance of this occurred a short time ago in a Chicago roundhouse. The locomotive had its head buried in the bottom of the pit, but its tender and rear end were left on the track. The crane was brought as close to the edge of the pit as possible, in order to reach the front end of the engine. Before the lift was made two members of the crew had the crane outrigging out to be blocked, but the wreck foreman said it would not be necessary. The men in this instance blocked the crane without orders. When the locomotive was lifted, the turntable moved away from the load, leaving the entire weight on the crane. The men watching the blocking saw the outrigging bite into the solid oak at least an inch. If it had not been blocked, the locomotive and the crane would both have turned over into the pit. This is one case where experienced wreckers saved thousands of dollars' damage and probably the lives of two men.

Fig. 52. In Mountainous Territory.

Wrecks Cleared Quickly.

The work of clearing a wreck is continued at top speed until the right of way has been cleared. Strength and endurance are required to carry jacks and heavy blocking up and down over wreckage and rough ground. Wrecks often require from 24 to 48 hours continuous work to clear. The work is especially hazardous and requires nerve under the prevailing high pitch of ex-

citement to set blocking under suspended loads when, if the cable should break, the wrecker would be crushed. The wrecking crew works all hours and in all weather conditions and wrecks are most frequent in severe weather.

Care of Shipments.

The wrecking crew must transfer cargoes from badly damaged cars. Frequently valuable shipments are strewn about the right of way and on the intelligence and conscientious care of the wrecking crew depends a great amount of the railroad's liability for damages.

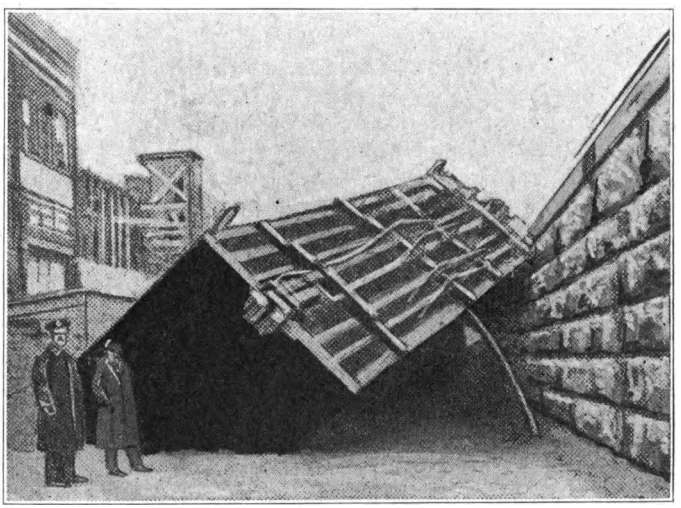


Fig. 53. Off the Straight and Narrow.

Personal Requirements.

A number of railroad officials are generally spectators at the clearing of a wreck and the members of the wrecking crew must not allow their presence to embarrass them in their work. The members of the wrecking crew must accept orders from the Wrecking Foreman only, and the Wrecking Foreman must not allow the variety of suggestions from the spectators to slow up his work or to waver in his decisions.

Good wrecking foremen are men of the type that are said to be born and not made for their position in life. The members of the wrecking crew hold positions which many men aspire to,

but few have the qualifications to hold. The romantic glamour of the service attracts but its rigid requirements disillusion the aspirants.

SECTION D.

THE WORK OF THE CRANE AND HOIST OPERATOR.

The locomotive cranes in use in the different railroad shops vary in capacity from ten to forty tons. The lengths of boom in most general use are 35 and 40 feet. In construction work a 45 foot boom is used. These locomotive cranes have vertical tubed boilers of a size to suit the crane capacity. The cranes are operated and fired by one man. Most states require him to have a license, to get which, he must stand examination on his knowledge of steam boilers and crane operation.

The crane is used most frequently to load and unload cars. Some of the equipment and material handled by these cranes is very heavy and in making these lifts the crane must be clamped to the rails and sometimes swinging outriggers are used. These cranes are used with hoist blocks, grab buckets, drag line buckets and lifting magnets. The use of the lifting magnet requires the operator to have a knowledge of its electric generating apparatus. The travel speed of these cranes is about 600 feet per minute, and they are sometimes used to move cars short distances.

The operator of the crane must use care in lifting and letting down heavy loads, and in carrying them he must see that they do not strike against cars or other obstructions in the line of travel. There is always danger in some types of cranes that the careless or inexperienced operator will, in changing clutches, allow the boom or the load to fall with probable injury to anyone underneath and damage to the load and the crane. The crane operator supervises and is responsible for the attachment of the lifting tackle to the load which work is generally done by a helper.

Part V.

GENERAL SHOP WORK.

SECTION A.

THE WORK OF THE CARMAN WELDER.

The oxyacetylene welding apparatus is a system of valves, hose and torch, attached to two tanks—one containing acetylene gas and one containing oxygen. The operator causes each of these gases to flow through its hose connection to the torch in the proper quantity to suit the work he intends to perform with it. The mixed gas flowing from the end of the torch is lighted, and produces a cone-shaped flame of intense concentrated heat. The temperature of the flame is estimated to be about 6,300 degrees Fahr.

Use of Oxy-Acetylene Apparatus.

This apparatus is used by the carman for cutting parts from steel cars that are to be renewed, for cutting heads off of rivets, for the cutting up of steel for scrap and in the filling in of cracks, fractures and worn parts of all classes of cars and their appliances. Some of the car parts that become worn and are filled up by the welder are: car axle journals, brake levers, coupler pockets, coupler heads and knuckles, truck column posts, endsill buffer castings, and, in fact, any part of the car that has been exposed to friction sufficiently to wear away part of the metal. In some of these parts, such as the coupler, which are worn out of contour, the welder must build up the metal, and while welding it, must gauge its contour from time to time, in order that he may bring it up to exact M.C.B. repuirements. Brake levers are continually found that have the connection pin holes enlarged and these the welder fills in to proper size. Much expense to the railroad is saved by the re-building of parts of this character by the carman welder.

Connecting the Apparatus.

To do the above work, the carman welder must first know how to connect up the various parts of the apparatus, how to adjust it properly and give it the proper care. Acetylene is received at the railroad shop in metal cylinders containing from 100 to 300 cubic feet of the gas under pressure of approximately 250 pounds to the square inch. The oxygen is furnished in tanks containing from 100 to 250 cubic feet of gas under approximately 1,800 pounds pressure per square inch.

The pressure of the gas in these tanks is much too high for the work, and for the purpose of getting the correct pressure, two regulator valves, one for each gas, are part of the apparatus.

These valves are very delicate and care must be taken in handling that they are not allowed to fall. Before attaching the regulator, the tank valve should be opened and closed again easily, so as to insure that it can be opened slowly after attaching the regulator valve. The oxygen regulator valve, hose and torch are then connected to the tank. The tank valve is then opened slowly all of the way and then the needle valve at the torch is opened all of the way, after which the regulator valve is adjusted to admit the proper gas pressure to the torch. The needle valve at the torch is then closed.

This method of procedure has brought the flow of oxygen to the torch valve where it is now retained at the proper pressure. The same procedure is repeated with the acetylene gas which, after being adjusted to proper pressure, is lighted, and burns with a white smoky flame. The torch valve for the oxygen is then opened slowly which, when added to the flame, reduces its outline to a cone of great heat.

Test for Excess of Oxygen.

The operator then tests the flame for an excess of oxygen. He slowly turns off the flow of oxygen until a shadowy point shows from the cone. Then with extreme care he turns on the oxygen again until this shadowy point just disappears into the cone. This test must be given from time to time as the drop of pressure in the tank may affect the regulator and a slight excess of oxygen pressure will be discovered only by this test.

Filling in Axle Journals.

The filling in of axle journals requires a great deal of skill and experience, as the built-up metal must be perfect in texture, in order that when the journal is re-turned, it will be perfect and without rough spots, bubbles or defects of any kind.

Preheating.

Best results are obtained in the repairing of the axle journals, if they are pre-heated before the actual building up of the metal is done. Methods of pre-heating form a most important part of the training of the oxyacetylene welder. These axle journals are sometimes pre-heated by the oxyacetylene torch, and sometimes in a small furnace. The welder must know the exact degree of heat that is proper for the work that he must do on the journal, and must avoid an excessive heat that would be detrimental to the proper temper of the journal.

Movement of Torch.

The movement of the torch over the work must be rotary, with a slight upward and forward movement as part of each rotation. The flame should be swung in wider circles as the work progresses, in order to distribute the heat well and avoid burning. The metal is heated to a soft, plastic state, and where fusion occurs, metal is added from the welding rod.

Use of Welding Metal.

The welding rod is a stick of metal, the composition of which is suitable to the work in hand. The surface should be thoroughly fused before metal is added from the welding rod, and the latter should be held close to the work. The metal from the welding rod must not be dropped through the flame, as it might be burned. The journal should be allowed to cool slowly.

Welding Castings.

When heavy castings are cracked they generally are prepared for welding by chipping the metal on one or both sides of the crack to a bevel. One side of the crack must not be heated more than the other, because each side would cool at a different speed and probably crack the weld. The radius of the heated portion must be greater on heavy than on light metal parts. When the metal does not flow easily under the flame, a little flux compound is added by dipping the welding rod into it occasionally. Flux should be used sparingly because it has a tendency to make the weld brittle. The weld and the part should be homogeneous.

Other Uses of Apparatus.

When using the oxyacetylene apparatus to cut rivets, the operator must take care that he burns only the rivet head and does not injure the hole in the sheet. In cutting up condemned steel cars, care must be taken that the large, heavy portions when cut off, do not fall on the operator or any of the workmen around. The oxyacetylene apparatus is sometimes used in straightening metal parts not removed from the car.

Working Conditions.

Often cracks are found in the steel underframe of cars, and the welder must crawl under the car with his torch and work at times with its heat close to his face. In fact he often works in such close quarters that his features become scorched, and his expenses for overalls are greatly increased for the same reason, because of the sparks that are continually falling and burning holes in his clothes.

The work of the welder is hazardous to the extent that he must use care that no flame comes in contact with the gas tanks, as explosions of this kind have serious results. Occasionally there is a "flash back" in the torch. When this occurs the oxygen must be shut off at once and the acetylene will burn alone at the tip of the torch. Although he uses red goggles, which are intended to supply the red rays that are missing from the light of the acetlyene torch, there exists other influences detrimental to his eye-sight in doing his work. In fact, after using the oxy-acetylene apparatus continuously all day, the operator is unable to read the newspaper after his arrival home at night. Welding has such a serious effect on the eye sight that few men care to remain a great length of time at this work.

Variety of Work.

The weight of the metal that is repaired by the welder varies from parts the size and weight of axles to the thinnest metal roof sheets. Besides a knowledge of the operation of the oxyacetylene apparatus, the carman welder, to perform his work intelligently, must know the requirements and conditions attending the use of the material that he repairs. This knowledge is possessed by most carmen welders because it is secured from experience as mechanics repairing cars.

As the work of autogenous welding carries a differential over the rate paid other mechanics, the position of welder, when vacant, is generally filled by a mechanic whose seniority gives him best title to it. This practically insures the obtaining of experienced carmen to make these repairs that must be done with the oxyacetylene equipment.

SECTION B.

THE WORK OF THE LAYER-OUT.

The duties of the carman layer-out are to plainly mark the location and dimensions of mortises, gains, holes and grooves on all material used in the construction of passenger and freight cars and locomotive cabs, pilots and tenders. On some work he obtains these measurements from blue prints, and on other work he must obtain the measurements from the equipment to which these parts are to be applied.

Why Material is Laid Out.

The purpose of selecting and marking the material is to guide the carman machine hand in machining these parts to suit

requirements. To expedite the work the layer-out maintains in stock, templates for all standard parts. These templates are boards of wood on which are shown the locations anl dimensions of all the mortises, gains and holes in these parts, the principal ones being in actual size. Some of the standard parts for which the layer-out has templates are end sills, end plates, posts, carlines, body cross ties, draft timbers, body and truck bolsters, truck sides, platform endsills and various other parts of cars and trucks, both wood and steel.

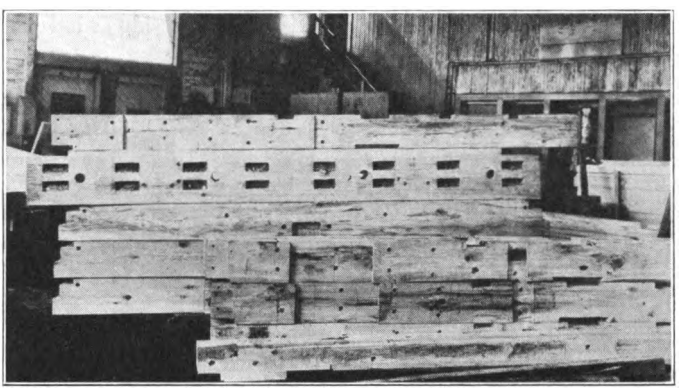


Fig. 54. Parts Marked by the Layer-Out and Milled by the Machine-Hand.

Knowledge of Car Construction.

To perform his work intelligently, the layer-out must have a thorough knowledge of the construction of the equipment for which he lays out the material. This knowledge he has derived from actual experience in building and repairing.

Laying Out Passenger Car Side Sill.

In laying out the material for the parts of the passenger car that are to be renewed, the layer-out marks all of the material for which he has standard templates, and the dimensions for any other parts he must get from the car or from blue prints. One method of taking the measurements from the car is given in the following description of the laying out of a passenger car side sill. The layer-out takes to the car a finished pole of square wood of about one and one-half inches stock and about thirty feet long, or slightly over half of the length of the car. After the sheathing has been removed from the car, the layer-out takes

this pole and working from the center of the car, he marks the exact location and dimensions of all mortises and holes for side posts and post rods on one side of the pole. On another side of the pole he marks the location of mortises for the bridging blocks and holes for body crosstie rods. On the third side of the pole he marks the location of holes for bolts which carry the truss rod anchors, body bolsters or transoms and crosstie timbers. He then takes the pole to the planing mill and lays out the sill, using this pole as a guide in marking the mortises with a marking gauge, and center-punching the exact location of all holes for bolts and rods, marking plainly each hole and mortise with its dimensions.

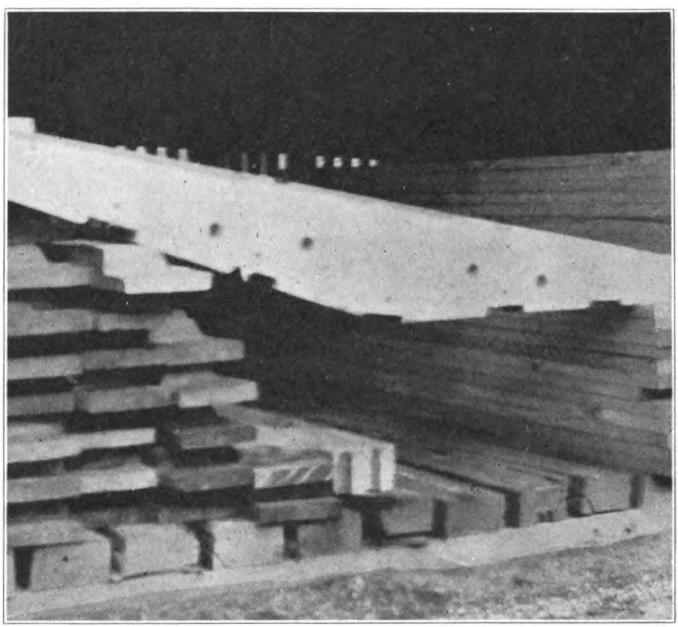


Fig. 55. Box Car End Plate.

Marking the Timber.

The layer-out locates these mortises and the center of all these holes by the use of a steel square, and marks their outline with a scratch-awl. He center-punches all of the holes so that the swelling of the wood between the time it is marked and the time that the machine hand is ready to do the work does not make the scratches and marks invisible. The dimensions for the

holes for bolts and rods on cars and cabs are generally in sixteenths of an inch, in order that the holes may be one-sixteenth of an inch larger than the bolts or rods which are to pass through them. Therefore in marking the dimensions on the material, it is necessary for the layer-out to mark only the first figures of the fraction in showing the dimensions of the holes. The machine hand operating the boring machine, upon seeing a hole marked with the figure thirteen, bores a thirteen-sixteenths inch hole which, on the car, is for the admission of a three quarters inch bolt or rod.

Making Templates.

In the making of a template usually for parts which the layer-out believes will be needed often in the future,

Fig. 56. Some of the Templates Made by the Layer-Out.

the layer-out selects a plank of well seasoned wood and cuts it to the actual dimensions of the side of the material that requires

the greatest amount of framing. He drills the holes and cuts the mortises for this side of the material on the template in actual size, and any mortises, holes or gains that are needed on the other sides of the material he marks in the same way as in marking the pole. He gives the template a coat of shellac and places it in the template rack for further use when required.

Consideration of Operations to Follow.

The layer-out must at all times take consideration of the conditions that are liable to confront the mechanic assembling the car. The experienced layer-out marks all holes for bolts and rods on the side of the timber that these bolts and rods enter. This is because the bit of the boring machine in drilling these holes may be somewhat deflected after drilling part of the way through the timber. This is especially true on work of large dimensions where the bit used is very long and liable to bend slightly.

Other Layer-Out Work.

The work of laying out the material for freight equipment and for tender frames is practically the same and is done in the same manner as laying out passenger car material. Similar methods are used in the laying out of cabs, but the materials handled are generally much shorter. There is a great deal of layer-out work done on cabs because there are nearly always new ones in the process of construction. The layer-out is always a thorough mechanic, and is generally selected for his position because of his experience and skill in the actual performance of car work.

SECTION C.

THE WORK OF THE MILL MACHINE-HAND.

The mill machine-hand dresses and frames all of the lumber used in the construction of freight and passenger cars and locomotives and tenders. He also mills the lumber for all general purposes, for the shops or the various points on the system.

Machines.

Many different machines are used in the milling of this lumber in its variety of required shapes. The setting up, operation and care of these various machines is the major part of the work of the mill machine-hand. A partial list of the woodworking machines in general use follows:

Cut off saws, large and small, for cutting material to length. Wooden blocks are fixed on the work table by the mechanic to gauge the length of each piece.

Rip saws, large and small, used in ripping lumber to required widths. **A rabbit saw,** with combination teeth, can be used in the same machine to cut grooves the full length of car posts for the insertion of post rods, or similar work.

Band saws are used in cutting and framing timber exactly according to the markings placed upon it by the layer-out. The band saw can be put to an enormous variety of uses. The skilled machine-hand can use it in cutting off, ripping, cutting gains, tenons, and a variety of grooving and shaping.

Large four-side planer, or timber sizer, used in the dressing of the four sides of large timbers in one passage through the machine. This machine has four cylinders or heads, one on each side, one on top and one on the bottom. The side heads have four knives, 14¼ inches long which make 3,600 revolutions per minute. The top and bottom heads have four 24-inch knives each and are speeded to 3,750 revolutions per minutes.

The **gainer,** a machine for cutting all sizes of gains. The cutting is done by knives revolving at 2,000 revolutions to the minute.

The **tenoner** operates with revolving knives and cuts tenons for car posts and other parts.

The **mortiser** is a machine having spindles to which are attached hollow steel square sleeves of the width of the mortise desired. Inside of this sleeve an auger bit revolves at the rate of 1,600 revolutions per minute. When brought against the work, the auger makes the hole and the sleeve chisels it square. The mortise is a cavity, generally rectangular, in which tenons are fitted.

The machine-hand operates various sizes of **boring machines,** some with vertical spindles and some with horizontal spindles which are pulled towards the work and the operator.

The **jointer** is a small planer used for straightening and squaring edges for joints. The work is pushed by hand over a revolving spindle having four knives which project above the machine table to the height set by the operator.

The **matcher** has four revolving heads and is intended for the milling of articles of special and curved designs such as moulding and other work where the parts must be decorative as well as useful. Each of the four heads can be set up with four knives, and revolve at the rate of 3,800 revolutions per minute.

The **turning lathe** is for the shaping of any article that must be perfectly rounded, such as chair legs and rungs, jack sticks,

knobs of all kinds, plugs, pulley bushings and round pattern work. The material is revolved in the machine at the required speed, from 400 to 1,500 revolutions per minute. The material is shaped with cutting tools in the hands of the mechanic.

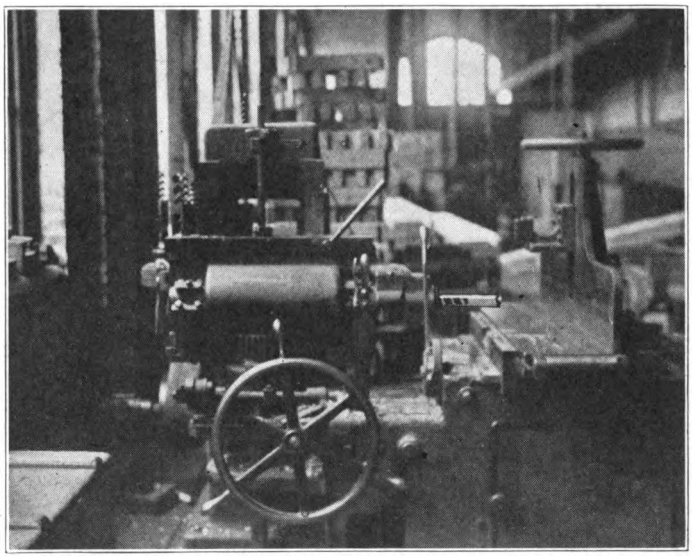


Fig. 57. The Mortiser.

The **shaper** has two knife heads projecting vertically up through the machine table. These heads make 4,280 revolutions per minute. This machine is used to shape an enormous number of the curved car parts. Whereas the matcher does the work on straight parts requiring a curved surface, the shaper does the work of shaping parts on which both body and surface are curved.

Duties of the Mechanic.

The machanic must know how to set up and operate all of the machines listed above and also the many others that are part of the equipment in large shops. He has frequent occasion to use all of them and he often carries the material or parts from one machine to another, as each requirement of the job is filled. The work on these machines is generally performed by one mechanic and one helper except in the machining of lumber too heavy for two men to safely handle, when, one or more additional helpers assist.

Care of Tools.

The mechanic is required to be able to sharpen all of the saws and cutting knives used in the different machines. The up-to-date shop has power-driven machines that, when adjusted properly, and set in motion, automatically file and set bandsaws and circular saws, and others grind the different shapes and sizes of cutting knives.

The variety of work done on the various machines requires that each have a large complement of knives differently sized and shaped. About 500 knives are kept for the use of the matcher or moulding machines alone. The greatest of care must be exercized in the sharpening of knives and the sharpening and setting up of saws, because woodworking machinery operates at a much higher rate of speed than metal working machinery, and these tools must have the correct edge, set and temper or they will not stand up under the wear and shocks when worked at a speed of from 3,000 to 4,000 revolutions per minute.

Kinds and Sizes of Lumber.

The machine-hand is required to work the different kinds of wood that have been listed previously as going into the manufacture and repair of freight equipment and passenger train cars. The size of the wood which he is required to handle varies from the larger sills 40 to 50 feet in length, to the smallest block or wedge or bracket, probably but 1 inch square, which he fashions on the band saw. He must fashion this material to various shapes and curves, such as the making of the different styles of fancy molding, the mortising of the parts that go into the making of sash and doors and the cutting of tenons on posts for passenger and freight equipment. In all this work he must allow for the physical quality of the material, the hardness, frequency of knots, quantity of rosin, etc., all of which qualities he must understand, not only to accomplish his work well, but to insure his safety in the operation of machines running at high speed.

The Operation of the Rip Saw.

The mechanic selects the saw best suited to the work in hand and fastens it securely to the mandril. The machine-hand raises the saw by means of a wheel and screw attachment until it protrudes above the saw table at the required height to suit the thickness of the material upon which he is working. He then moves the sliding table, which has an upright flange, smooth and flat on the saw side, to the proper distance from the cutting edge of the circular saw. This distance is determined by measuring from the teeth of the saw to the upright flange which must

be exactly equal to the width of the piece which he must turn out. The saw revolves against the work—that is, towards the operator. He must place the timber flat on the work table and squarely against the face of the upright table. Care must be taken in moving the material against the rapidly revolving teeth of the saw, and the timber must be firmly held so as not to allow the movement of the saw to wrest it from the grip of the mechanic and throw it about the shop with probable injury to himself and others.

The helper works on the opposite side of the machine, and when the plank of material reaches his side of the saw, he takes hold of it and assists the mechanic in pulling it against the saw.

Much of the safety of the machine operator depends on the care and attention which the helper gives to his work, as it can be understood that if he pulls a long piece, that is being sawed, up from the table or out of line so as to give the saw teeth a purchase on it across the grain or at the wrong angle, the piece cannot be held in the machine and will fly usually with great force in the direction of the operator.

Many serious injuries occur in wood machine shops in accidents of this kind where the rapidly revolving saw (2,300 revolutions per minute) causes the wood to split or a defective portion of it to break loose, throwing it at the operator who is standing in the direct line of fire.

In moving his material against the circular saw, the operator must pay close attention to his work, so that he will hold the wood firmly down to the table and also not allow his hands so far forward that they are cut by the saw.

The Operation of the Matcher.

In the full operation of this machine, the mechanic must set up cutting knives on four revolving heads. Like the timber sizer, these heads are arranged one to each side of the work. Occasionally two sets of knives are used on one head. These knives are fastened to the head by bolts. A groove in the machine head holds the head of the bolt. The knives have grooves that fit around the bolts. After fastening the knives, the mechanic sounds them with a tap of the wrench to determine if they are fastened well. He is able to tell by the ring of the metal whether they are bolted in too tightly or too loosely. If fastened too loosely, the blade when in service will fly from the rapidly revolving head, and if fastened too tightly it will in some service be liable to break into pieces. The selection of the knives and the proper adjusting and setting up of this machine sometimes takes a half day of the mechanic's time.

When placed in the machine, the square or oblong shaped piece of material first strikes the set of knives protruding up through the surface of the work table, which plane it to required thickness. It then comes under the knives of a revolving head operating horizontally above the material and which partly

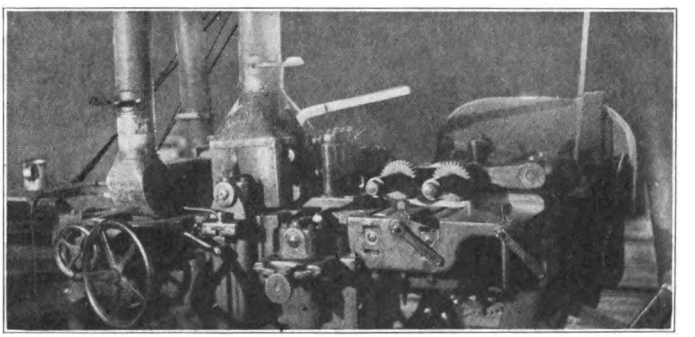


Fig. 58. A Small Matcher.

fashion the material. The pattern desired is completed by the knives on two vertical heads revolving one on each side of the material. This machine manufactures moulding from a plain piece of lumber in one operation.

The material when placed in the machine is held down to the work table and driven against the blades by rollers. The ma-

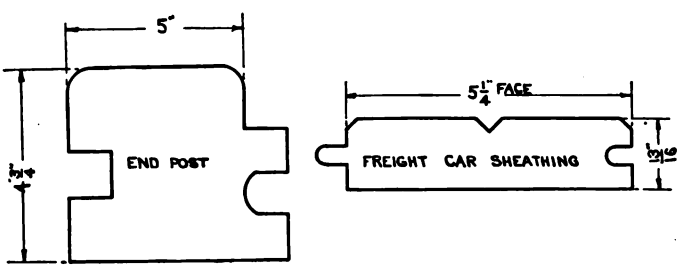


Fig. 59. Word Done on the Matcher.

chine hand can at any time pull a lever, lifting these rollers and stop the progress of the material against the knives. This machine requires considerable belting to operate the four different revolving heads and three or four rollers.

Working Directions.

The machine hand does most of his work from shop sketches submitted by the foreman. Many of them are poorly drawn and the dimensions are sometimes illegible to anyone but the machine hand, who from experience, is able to decipher the characters and tell what is wanted. Some of his work is done from blue prints and some from wooden samples. He must have considerable skill in the measurement and laying out of his work in order that he does not have to reset and readjust his machine a number of times.

Hazards.

The machine hand is continually in danger of serious accident, generally resulting in the loss of parts of his fingers and in some cases his entire hand. In fact, a machine hand can generally be known by a glance at his hands, as most machine hands who have spent some years at their trade have portions of their fingers missing.

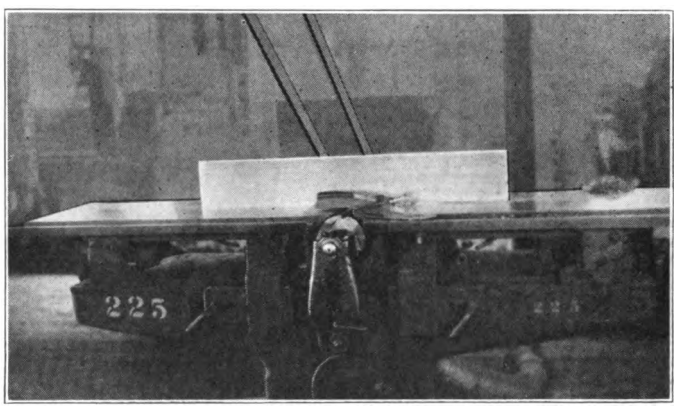


Fig. 60. The Jointer.

The majority of accidents occur from the flying of slivers and pieces of material from the machines, and from contact with the revolving knives, which means the severance of the portion touched. One instance in example of this kind of accident occurred to a machine hand operating a small jointer which requires that the piece planed must be pushed by the operator directly over the knives of the machine revolving at the rate of 3,900 revolutions per minute. After the planing had perhaps reached the middle of the small piece of mahogany, it broke in

two, allowing the left hand of the mechanic, which usually is first, to drop on the revolving blades of the machine, with the result that his hand was severed between the knuckles and wrist.

The writer has, in the mill shop, picked up portions of the fingers of a machine-hand, whose hand had come in contact with the blades of a shaper because of an unexpected jerk or yielding of the material he was holding against them. The shaper is one of the most dangerous of machines to work with, as the nature of the work done on it and its construction prevent the application of adequate safeguards.

A machine hand is sometimes endangered by the flying of knives that break loose from the revolving head of the various machines. In one instance in operating the matcher, four steel cutting blades flew from the machine in rapid succession, luckily striking no one. These blades left the machine with a velocity approaching 10,000 feet per minute, which is sufficient to cause a fatality, were they to strike a workman in a vital spot.

Injuries from slivers result very often in blood poison, which puts the machine hand out of work for a long period of time. He usually receives no compensation for this time lost until after he has returned to work some time.

Responsibility.

The machine hand is responsible for the work that he turns out as he rarely receives directions as to the method to be used in performing it. The supervisor gives him the order and sketch received for the material from any of the departments, and the machine hand fills it without further instruction. The foreman, however, knows the length of time it should take to finish each job, and when giving the order to the machine hand he makes mental note of when it should be completed.

At some small points where there is no large power house, the wood-working machinery is run by a 15 horsepower gasoline engine, which must be taken care of and adjusted by the mill machine hand. At all shops he is responsible for the cleaning, oiling and general care of the machinery and also of his own tools, which are as follows: Various sizes of wrenches from ¼ to 1 inch; monkey wrenches; large and small oil can; hand saw; a large and small square and a bevel square; a divider and compass; a 2-foot and a 6-foot rule; a large and a small hammer. Most machine hands have at some previous time been car mechanics, and usually have a set of tools for that work. In the performance of work on the turning lathe the mechanic must use a set of special turning tools. The set of tools used by some mechanics in doing this work is valued at approximately $55.00.

The machine hand feels the sense of responsibility for his own safety and the safety of those around him. The machine hand helper shares greatly in this responsibility. In fact, a careless helper is an additional hazard in the mill machine shop.

Besides being a thorough mechanic and exceptionally skilled in the art of measurement, the machine hand must possess the power of concentration, clarity of vision, and the habit of close, careful attention to his work.

SECTION D.

THE WORK OF THE CARMAN MILLWRIGHT.

The carman millwright hangs shafting, applies and keeps in repair the pulleys and belting through which power is transmitted to shop machinery. New machines from time to time are installed and the millwright lays out and constructs the forms for the concrete foundation these machines are placed on. He erects and takes down scaffolding used in the tearing down of tall structures, such as smoke stacks and the like, when such work is done by the shop forces. When pipes, for the conveyance of shavings from the mill machines to the syphon that draws them, are built, the millwright erects and takes down the great amount of scaffolding needed to assist the sheet metal workers in putting this piping together. In many cases the millwright designs and applies suspension for pipes of this kind.

Laying Out Machine Foundations.

The millwright needs especial skill and experience to properly lay out the concrete foundation on which the larger machines are set. Sometimes blue prints are furnished in doing this work, but often the millwright himself decides the size and depth of foundations required. Most of the machines are bolted down to the concrete foundation by means of steel bolts which are set in the concrete base by the millwright.

Accuracy in Bolt Setting.

It is not difficult to understand that the setting of these bolts must be perfectly accurate, because of the fact that after the concrete is set they cannot be moved, and, the holes that are part of the machine casting cannot be moved nor additional holes be drilled. Therefore it will be seen that the bolts must be set in precise position so that when the machine is let down on them, they will perfectly strike the holes in the machine they were intended to pass through.

One other and very important requirement is that these bolts must be so placed that the machine when in position will be exactly parallel to the shafting from whence its power is to come. If the machine is even a fraction of an inch out of this parallel, its pulley or gears will not be at right angles to the shafting and when in operation, the belt will continually slide off from the pulleys. Very often the machine will be some distance from the shafting which distance increases the difficulty of accurate measurement.

Other Work.

The millwright often designs the size of the pulleys and the dimensions of the belting the machine must have, and to do this he must have a knowledge of the speeds at which the machine is required to operate and the strain and stress of the load the belt must carry.

The speed of the machine is determined by the speed with which the shafting rotates and the size of the shaft pulleys that the millwright applies. The size of the pulley or gearing on the machine must also be taken into consideration by the millwright in designing the size of the pulleys that will fit on the shafting. The work of the carman millwright is not confined to the car department, but he erects machines and takes care of the shafting, pulleys and belting over the entire shop. Every good sized shop employs one or more millwrights.

Hazards.

The work of the carman millwright is extremely hazardous at times, as he must climb to the top of the scaffolding which he is erecting in order to raise it higher, and often must work close to the roof of the inside of the forge, foundry, and similar shops, where he is in danger of being overcome by the fumes of the coal gas, and falling to the floor of the shop. He must at times work on the outside in severe weather and his services are often required in emergency. An instance of this is cited. In one of the railroad shops a tall, wooden scaffolding had been erected close to the smokestack. During the night a heavy rain and wind storm came up and the scaffolding was blown against the smokestack. As the smokestack oscillated with the wind, every time that it moved away from the point of contact with the scaffolding, the frame work of the scaffolding served somewhat as a pawl, and if heavy and strong enough, would have prevented it from returning to upright position. Of course the weight and power of the smokestack prevented any immediate detrimental effect, but the condition was considered so dangerous that the

millwright and his assistants were called out as soon as possible, and, during the height of the rain storm, fastened blocks and tackle to the scaffolding and pulled it back into position and secured it. The climbing at night time on wooden scaffolding wet with rain and in a high wind, with the possibility that the scaffolding might collapse, made this an extremely hazardous job.

Responsibility.

The millwright is responsible for the proper operation of the shafting, pulleys, belting etc., that he erects. In the moving of new machines into position he supervises the work, and of course is responsible for the safety of the machine while it is being set into position. The value of these machines used in the railroad shop runs into the thousands of dollars. In the erection of scaffolding he is responsible in so far that it must be substantial and safe for himself and other workmen to do their work upon. He feels the responsibility and the care that he must take in applying belting, as the safety of the operators of the various machines depends on its security.

Personal Qualities and Training.

The carman millwright generally has had long experience as a layer-out, where he receives the training necessary to accurately lay out templates and poles which he uses in gauging the position of bolts to hold down the machines to their foundations. He also has had considerable experience in the planing mill, where he has become familiar with the methods of suspending shafting, the application of pulleys and the care of belts. The great number of machines set in the planing mill has given him an opportunity to study the relation of the size of pulleys to the speed of the machine, and the weight of belting required to carry the different loads. He must be able to compute the ratio of the revolutions of one pulley to another, and must understand the strain and stress that shafting must withstand, and apply the proper number of suspension brackets to hold it. He must understand the application and lubrication of the bearings in which the shafting rotates. He must understand the different methods of fastening pulleys to the shafting. He is often required to pass judgment on the type of pulleys required by some machines—that is, whether they should be of wood or steel. To be a successful millwright the mechanic must have a taste for engineering and mathematics, knowledge of each being necessary in order to lay out the proper foundation for each machine, set it properly in place and give it the proper pulleys, shafting and belting for the transmission of the power required to operate it.

SECTION E.

THE WORK OF THE PATTERN MAKER.

The patterns for the casting of all of the machinery that is part of the equipment of the railroad are made by the pattern maker. This includes patterns for every part of a locomotive and every metal part of cars and work equipment. He also makes patterns for castings used on bridges and buildings, patterns for rails, rail fillers, tie plates, frogs and every casting required on the right-of-way. These include castings for switches and block signal equipment. Some of the standard patterns made by the pattern maker are for castings of the following: cylinders and cylinder bushing for all classes of locomotives,

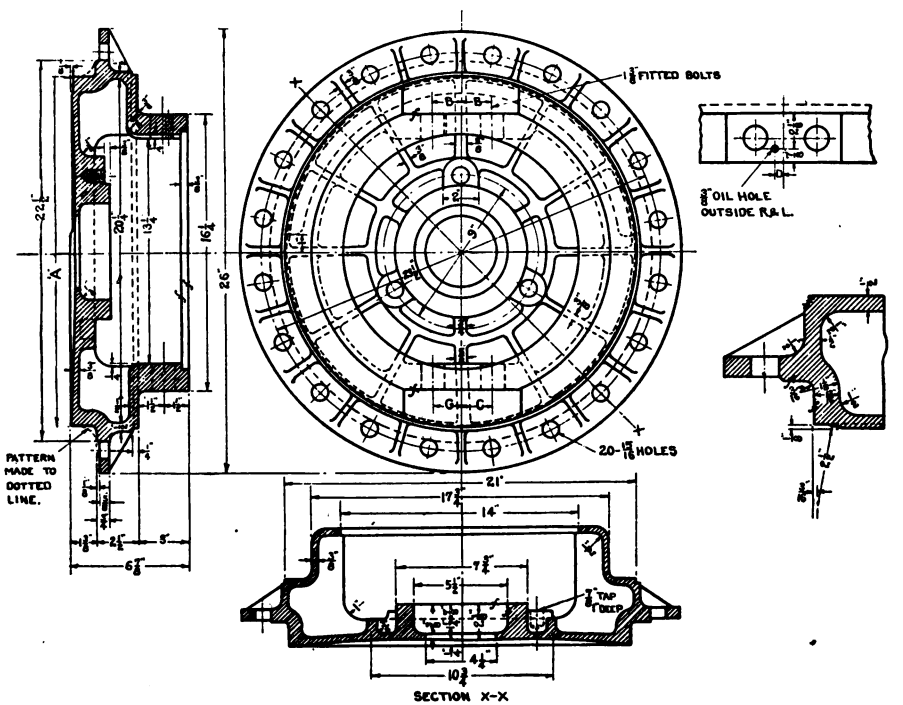


Fig. 61. Sketch of Pattern for Locomotive Cylinder Head.

cylinder snap rings, main rod bearings, journal bearings, valves of all kinds, cross heads, steam pipes, gas pipes, smoke stacks and extensions, grate rods and cylinder heads. The pattern maker makes patterns for castings of grey iron, steel, brass and aluminum.

Before constructing the pattern the pattern maker must have in his mind a picture of the finished casting and must build something that will produce it. He does all of his work from blue prints, but very often they do not go into sufficient detail, and the pattern that would result from working precisely according to the blue print furnished would, in many cases, not be practical for use in forming the mold. In the construction of the pattern the pattern maker uses a set of tools somewhat similar to those used by the passenger carman, with the exception that he must have a greater number of gouges, paring tools, and also a set of tools used in turning material in the turning lathe. The pattern maker does all of his own lathe work and band saw work. Some of the patterns which he constructs are very large, such as a pair of locomotive cylinders or a large driving wheel, and others are very small, such as small die or stamp castings.

Pattern making is a distinct trade, requiring great skill in wood working, combining, as it does, the finest joinery work with the art of wood carving, and the ability to read and interpret the most complicated mechanical drawings.

Knowledge of Moulding Essential.

In constructing the pattern, the pattern maker must have a knowledge of the methods used in moulding. He must understand the nature of the metal, as the rate of shrinkage when cooling is different in the different metals. Besides allowing for shrinkage, the pattern maker must allow sufficient metal for the finishing of the machined parts, and where, in his judgment, it is necessary, he allows stock for holding the casting in the lathe, planer, or shaper. He must construct the pattern in such a manner that the moulds for the casting can be made in an expeditious manner. Always when practical, the pattern should be so formed as to enable its casting to be performed with a mould parted in one place only. There is often a great difference in the time required to make moulds from a handy pattern and from a pattern made by a pattern maker who does not fully understand the conditions attending the making of the mould.

Knowledge of Metals.

The pattern maker must know when it is necessary to make core prints, which are projections of the pattern used to make a recess in the mould to accommodate a corresponding projection on the core of the casting. He must understand the rapidity with which the different metals cool so that internal stresses in the body of the casting will be avoided.

Pattern Joining.

In the making of large patterns it is necessary for him to glue together planks of wood to the required dimensions before beginning to form the pattern. White pine wood is generally used in the construction of patterns, and the different parts are held together by dovetailing, nails, glue, rapping and dowel plates.

Metal Patterns.

Patterns that are used continuously are often made of metal. The pattern maker constructs the pattern from which these metal patterns are cast. Often times the pattern when completed, will have but little resemblance to the casting it is intended to produce.

The pattern maker must have a knowledge of mechanical drawing in order that he can make a sketch of the working details of the job from the blue print so that he may have a comprehensive idea of the pattern he is to build. The pattern maker makes every part of the pattern himself, and when finished, he shellacs or paints it. Besides the construction of new patterns the pattern maker repairs old patterns, and alters them to meet changed conditions or new developments. He works under no specific supervision, as his work receives its inspection and test when actually used to produce molds. In fact, very often the foreman from the department in which the pattern maker works is not a pattern maker and has very little knowledge of that work.

The work of the pattern maker is not particularly strenuous, but it requires the greatest of skill in the use of edged tools. He must be able to concentrate and give strict attention to his work, as it is of such accurate nature as to require it.

The patterns made by the pattern maker are generally used in making castings that are manufactured in outside foundries. that is, few railroads do all of their own foundry work. The patterns made by the railroad pattern maker are greater in variety than those made by pattern makers in any other industry.

Part VI.

THE WORK OF THE CARMAN PAINTER.

SECTION A.

WORK ON PASSENGER TRAIN CARS.

The painting and varnishing of a passenger car is done in a shop designed exclusively for that purpose. At the time the painter begins work, the repairs have been completed with the exception of the car trimming.

Removal of Paint.

Burning Off With Torch.

The first work of the painter is to prepare the car surface. The condition of the outside of the car is often such that the old paint must be entirely removed. This is done on wooden equipment with the aid of a gasoline blow-torch and steel scrapers. The apparatus generally used is called a "Hauck burning outfit." The painter heats a small part of the surface and when the varnish and paint blisters, he can scrape it off. An inexperienced man on this work would probably burn holes in the lighter portions of the outside woodwork or char the edges of the molding so that when scraped or sandpapered, it would leave a hollow. He must also use care when completing his work that no spark of the torch has ignited any of the concealed parts of the car, such as the paper and felt that are sometimes found behind the panels and the woodwork of some cars. He is responsible for the care that he gives the blow-torch, hose, couplings, and the tank that is used.

Burning Off With Lye.

The torch method of burning off the paint and varnish is not used, however, on steel equipment. The paint and varnish on these cars is burned off with a strong solution of lye, which is made very thick and sticky so as to adhere to the side of the car. This solution is allowed to remain on the car over night, and then washed off the next day by a stream of water from a hose, which takes all of the paint and varnish with it. The man using the lye solution must take care that he does not get much of in on his clothes or that some of it does not splash and strike him, possibly in the eye. He must also wear rubber boots when cleaning the car with the hose.

Sand Blasting.

On some roads the paint and varnish is removed from the outside surface of steel cars by sand blasting. A special grade

of white, flinty sand is blown against the surface by a powerful stream of compressed air. In doing this work the painter wears a veritable gas mask, as he uses both respirator and goggles. It is very uncomfortable work, as the showers of sand work their way through his clothing and next to his body.

Surfacing.

After the burning off, the outside of the car is gone over with sandpaper and any surfaces that are not smooth are made so, after which the priming coat of color is applied. This priming coat is generally cut in by rubbing with sandpaper for the purpose of making it smooth for the application of the following coats. The painter requires experience in doing this sandpaper work, as he must make the surface smooth without cutting through the coat of paint so as to expose the bare wood. This priming coat must be applied carefully, so that it enters all of the crevices, cracks, scaled parts, nail holes, etc., on the surface of the car.

After this priming coat had dried, a coat of surfacer is applied, usually on the succeeding day. This coat must be carefully applied to all of the surface defects in order that when putty is applied, it will hold it into place. If a hole or a crevice is not primed or sized or touched with varnish, there is nothing to bind the putty with which the painter fills all of these holes, with the result that after the car has been completed, the putty will fall out or loosen, and disfigure the car after all of the coats of paint and varnish have been applied.

Puttying.

In applying putty to the holes or disfigured part of the surface of a car, the painter must use the proper kind of putty and it must be of the proper body, that is, it must have the proper proportions of wet or dry. In some cases he would use a lead putty or a hard-drying putty, which, when the oil with which it is mixed is evaporated, will become almost as hard as cement; whereas in other places he would use a soft putty, which does not dry as quickly and when dry is not as hard.

Application of Color.

After the application of the putty a second coat of surfacer is applied and after it has dried, the surface is sandpapered smooth, especial care being used on the spots that have been puttied. The priming and surfacing colors are generally flat, and dry quickly. After the surfacer has dried out sufficiently, two

coats of varnish color are applied. When these coats of color have properly set, the car is given two coats of varnish.

Varnishing.

In varnishing the outside surface of the car the painter must first be certain that the shop is of the right temperature and that the doors of the shop are closed so as not to have a draught on his work. The varnishing of the car, when the surface is cold or the car in a draught, will cause the varnish to crawl. This crawling could be likened to an attempt to spread water evenly on a greased surface, as the varnish runs into bubbles and streaks, and will not spread evenly on the surface of the car. No work is done in the paint shop that would be liable to raise dust, which would disfigure the cars that are wet with paint or varnish.

Care in Varnishing.

The painter finds it necessary to use scaffolding of horses and planks in order to reach the top of the letterboard of the car, and in applying the paint and varnish, he must be careful to do it in such a manner that no laps or brush marks will show. It requires considerable skill and experience to secure the best results in varnishing a passenger car with its irregularity of surface and the mouldings, outside windowsill and other projections. The varnish must be applied level, that is, the thickness of the coat must be uniform over the entire surface. It must also be considered that it must be of the proper consistency—neither too thick nor too thin, and care must be taken in getting the best results that it is not brushed too much nor too heavily, for when the outside skin of the varnish begins to coagulate, which it does quickly when applied, any heavy brushing at that time will cause scratches on its surface that cannot be removed.

Mistakes Due to Inexperience.

The work of painting is done entirely by mechanics and regular apprentices working under the supervision of the mechanic. At the beginning of his day's work he is generally given a list of the cars in the shop to which he must apply the necessary coat of color that is the next in order, or the first or second coat of varnish as is necessary. It depends entirely on his judgment whether the last applied coat of color or of varnish is dry and set properly before he commences his work. As these separate coats of color dry at different speeds, an inexperienced man would sometimes make the mistake of applying a fast-drying coat of color before the preceding coat has dried. This means

that when the first coat of color does dry, the glaze of the following coat will probably crack. An inexperienced man would not be able to apply varnish properly, as he would not understand its properties and would brush it too little or too much, with results disastrous to the appearance of the car. He would not apply the varnish evenly and where heavier it would sag or fold over the portion with the lighter coat. He also would not understand the order in which to paint each part of the surface so that no brush laps would be visible at the completion of the job.

Treatment Given the Average Car.

A car given general repairs is usually given a priming coat, two coats of surfacer, two coats of varnish-color and two coats of varnish. A day or more is allowed to elapse between each coat in order that the previous one may properly set and dry. The inside finish is painted, stained and varnished and the floor, trucks and roof given two coats of paint. The painter works continually as he is required to move from car to car performing the work needed on the outside, inside, trucks or roof of the car.

Brushes, Pencils, Etc.

The painter's tools consist of two putty knives, one brush for dusting the surface of the car after sandpapering, one large, one medium and one small paint brush, one large, one medium and one small varnish brush, and a set of striping pencils. The railroad company usually supplies the brushes. The mechanic generally has his own set of striping pencils which, as they become worn out, are replaced by the company.

SECTION B.

STEEL CAR PAINTING.

Puttying and Priming.

In the painting of steel cars the problems met with by the painter are somewhat different than in painting wooden cars. Where the outside steel surface of a steel car has rusted or scaled, it is much harder for him to apply his putty properly, as the indentation would perhaps be but one sixty-fourth inch deep. He must sandpaper these indentations and spots from where the scale has been removed so that all of the rust, if possible, is removed from the cavity. He must then size the hole with a priming coat of paint, or if, in his judgment, the priming will not suffice to hold the putty, he will place some varnish in the cav-

ity. He may find it advisable to use a hard-drying putty that has been impregnated with varnish, in preference to the hard-drying putty that has been mixed with lead and oil. These decisions, however, are left entirely to the mechanic. It requires considerable skill to place the putty in the cavity so that it binds firmly around the edges. After it has dried, it must be securely enough in position to stand sandpapering.

"Knifing In" a Panel.

Often a panel or section of the surface will be found to be so badly rusted and scaled that ordinary methods will not greatly improve its appearance. In cases of this kind the painter builds up an entire new surface of putty. A good job of "knifing in" putty cannot be done unless the putty is exactly suitable. When completed the surface must show no knife marks. A job of "knifing in" must be perfectly done because the following work will more often magnify rather than conceal any defects.

Painting and Varnishing.

In applying the various coats of color, it requires care and experience to eliminate drops and lumps around the rivets of the car, as he must combat the tendency of paint and varnish to sag at the bottom of the rivet head and in the case of the varnish, drawing its covering from the upper half of the rivet head.

SECTION C.

INSIDE PAINTING.

The floor of the car is given one coat of paint after the drying of which the painters commence work on the inside finish of the car. In treating the inside finish of a passenger car a great variety of conditions are met by the painter in preparing the surface for the stain or varnish. There are nicks and dents in the finishing, and sometimes the veneer is cracked or bulged so slightly that the inside finisher has not extensively repaired it and it is left to the skill of the painter to cover the defect. Some of the inside finish is new and must be treated from the bare surface of the wood, whereas other parts have been painted and varnished before and require the removal of the bad spots before being restained and varnished.

Surfacing.

In preparing a partition of new veneer, sometimes of oak and sometimes of mahogany, the painter must have a knowl-

edge of the differences in grain and the surface of the woods in order that he may apply his first coat of stain or shellac properly in order to bring out the grain and natural beauty of the wood. In some shops wood filler is used, and in others a stain of the same color as the wood is applied. In doing this to get the best results, the painter must know how to get this filler into the small cracks and fissures that make up the grain of the wood. In mahogany the grain is one continuation of slight scratches and slight pores. The painter must manipulate his filler and rub it with white waste before it is thoroughly dry in order to force it into all of these scratches and hollows, as the proper filling of them brings out the natural grain of the wood. In the event that the wood filler or the stain is not applied properly; after the varnish has been applied, the grain will not seem to be on the surface of the finished product, but will rather appear to be behind a glaze, and indistinct, thereby losing the value of the beauty of the grain of the wood.

Varnishing.

After the stain has dried properly, the painter applies a coat of rubbing varnish, which is rubbed down by means of a piece of coarse cloth and powdered pumice which is wet with oil, usually banana oil. The surface is rubbed until the coat of varnish and the filler appear perfectly smooth to the experienced eye of the painter. After it has been cleaned down with white waste and allowed to dry perfectly, the last coat of clear varnish is applied and the work is done in such a manner that the varnish is spread evenly over the surface and no brush laps or other disfigurements appear.

Skill in Varnishing.

In the varnishing of molding and the numerous designs and scrolls that are found on the inside finishing of the different classes of cars the varnish and stain must be so applied that the hollows and indentations made in the carving are not filled with the varnish or stain, which would cause the carving to stand out with a dark or black line at the bottom of each hollow. That is, in a skilful job the grain of the hollow of the piece of wood carving will stand out as clear as the surface of the wood.

Special Treatment.

As all of the inside finish of the car is not new and has been stained and varnished previously, it is left to the discretion of the painter assigned to the car whether or not each piece of molding or other part of the finish requires that the varnish be

removed, and that it be restained and revarnished. Often the surface of the last coat of varnish appears so well that a good job will result by the application of another single coat of clear varnish. Where knots occur on the inside finish, the painter must know the best method of preparing the knot so that the varnish will not slide off of its usually smooth surface. In some cases stain will not serve as a surfacer for knots and the painter will then use shellac, which has better binding properties after drying to hold the varnish on the knot and prevent it from sagging.

There are many instances in the inside finish of a coach that some of the parts are made of poplar and to correspond with the rest of the inside finish, the painter stains and varnishes it so that only the experienced can tell it from mahogany.

Steel Car Finishing.

In steel cars having steel inside finish it is generally the practice to have that steel inside finish stained and grained as mahogany, and only the expert eye can sometimes distinguish the difference between the finished mahogany wood and steel finished as mahogany. The majority of railroad passengers riding in cars of steel finished mahogany never perceive that the inside finish is metal and is not wood. When it is called to their attention they are sometimes incredulous, and it can only be proven to them that the finish is of steel by tapping it with some hard object. The substitution is found not by sight, but by hearing the difference in sound.

Graining.

Where the steel panels or partitions are in bad condition it becomes necessary to remove entirely the stain and varnish, which leaves the bare steel. This steel is prepared with a priming coat and painted, usually the color of the wood to be imitated, and is followed by a coat of stain which is grained by the mechanic sometimes with combs, but more often by the expert use of a simple bristle brush. The grain brought out is so skillful an imitation of the real wood that only the experienced can sometimes tell by sight that the finish is metal. After the graining and stain has dried, the surface is covered with a coat of clear varnish.

Work on Sash and Doors.

While the outside and interior of the passenger car is being prepared in the shop, the sash and doors are undergoing a similar treatment in a room assigned for that purpose. The prob-

lems met with in preparing the surface of the car inside and out are the same in preparing the sash inside and out respectively.

Glazing.

The painter cuts and fits the glass for all car sash. He needs special skill and experience to cut and fit prismatic glass and to fit together the colored art glass that is applied to Gothic sash.

Proper Method of Varnishing a Door.

In preparing the door with its panels and cross braces and rails, the mechanic must know the proper method of doing the work to avoid brush marks and laps. In this respect it would be well to mention herein that when painters apply for a working card in the painters' union on buildings, the applicant is usually given a door to finish and the examining committee of the union judges his skill and his right to the title of a painter by the method in which he does this work on the door. An inexperienced man will generally paint or varnish the different parts of the door in any order that it comes to him. In other words, he is not familiar with the order in which these parts of the door must be finished to procure the best results. In varnishing a door the proper method is to varnish the panels first, which leaves the lap or finish of the stroke of the brush on the side rails and cross rails of the door. The cross rails are then varnished and brushed, which eliminates the laps on the top and bottom of the panels and leaves only the laps on the side rails of the door. As the side rails of the door extend completely from top to bottom when these are brushed out completely over the edge of the door, no laps are left by the experienced mechanic on the finished door.

SECTION D.

LETTERING AND STENCILING.

The passenger car painter must be able to do the lettering and stenciling. On the outside of the car the letterboard usually shows the name of the railroad; the side sheathing near each end of the car gives the car number, and in the case of mail cars, buffet cars and dining cars and the like, the title of the car will be lettered on the outside of the center of the car.

In the inside of the car sometimes is shown the name of the railroad, and the car number is shown on the doors. The electrical mechanism is stenciled with the date of last inspection and oiling, and the trucks on the outside of the car are stenciled with the size of the journals; the weight of the car is stenciled on one of the cross tie timbers; the description of the air brake mechanism, together with the date last cleaned and oiled, is stenciled on the air cylinder and triple valve and reservoir. The gas tank is stenciled with its capacity and the last date of inspection. The amount of stenciling differs with each type of car, and the painter must be able to determine the size of the journals, the capacity of the gas tank, and the description of the air brake mechanism on each car in order that he may stencil the car correctly and stencil it in every place where required. The cutting of stencils is usually done in the varnish room where the sash and doors are treated, but all painters are required to be able to cut stencils if called to do so.

POUNCING.

The method of applying the lettering is as follows: The pounce pattern—sometimes for each letter and sometimes for a word or a number of letters—is placed against the surface of the car and brushed with a solution of chalk, which goes through the holes in the pattern, leaving the outline of the letter on the car.

SIZEING.

The outline of the letter is then filled in with a varnish size. It requires care in order to make the outline of the letters sharp and get the curved portions of the letter correct. The letterer then presses gold leaf, directly from a book in which it comes, on the varnished surface, to which it adheres, and after he has the varnished surface well covered with the gold leaf, he cuts and brushes the overlapping edges of the leaf from the outline of the letter. He must be familiar with the type of lettering that is standard to each car, and must know what parts inside and out of each class of car requires to be lettered. It will be understood that all of the gold leaf lettering is done before the two coats of varnish are applied to the car

Filling in the outline of the letters requires careful use of the small brush that the letterer uses. If he applies any of the varnish size outside of the outline of the letter, it will be difficult to remove it without leaving a sticky surface to which the gold leaf will adhere when applied, thus making the outline of the letter irregular instead of clear cut. Before applying the gold leaf the

painter must be certain that the sizeing has the proper tack, that is, it must have the proper degree of set. If the size is too moist, the leaf when applied will mix with it, and if too dry, the leaf will not adhere at the edges.

Applying Gold Leaf.

The gold leaf used in lettering is probably the thinnest substance handled by man. It is said that it requires 25,000 sheets of gold leaf to make a volume one inch thick. In applying it, the mechanic must use care in catching the particles that he cuts or brushes off, because of its value. On certain classes of cars the lettering is not done with gold leaf, but the outline of the letters is filled in with paint of various colors, according to the style on that road. Painters, when lettering, do not receive specific instructions as to the kind or the type of the letters, the location they must be put in, nor how much lettering each style of car requires. All of this information must be part of his shop knowledge.

Making Pounce Patterns.

The painter must make the pounce patterns used in lettering. In doing this he first ascertains the length of the space into which the required lettering must be placed, and makes the pattern accordingly. On the pattern paper, he makes the outline of each letter roughly with chalk and follows by making it more carefully in pencil. Using the pencil outline as a guide, he punches the outline of each letter by making a series of small holes in the paper. Although this work is done freehand, it would require careful measurement to discover any inaccuracies in the spacing of the letters.

Special Work.

Everyone at sometime has seen a circus train—every car with fancy lettering and fantastic scrolls. This work of lettering and ornamentation is often done on these cars by the carman painter. Very often in work of this description the painter receives no specific directions. For example, in the decoration of the cars of the Sells Floto circus, the owners gave the painters only a verbal idea of what was wanted and every detail was left to the originality and art of the painters.

In dining cars, buffet, cars, parlor cars, observation cars and private cars, the painter is required to finish all of the furniture, chairs and tables that are part of the equipment for these cars. The treatment of chairs and tables is exactly similar to that described for the inside finish. The results of the job are the same, and this work requires the same skill as does any house furniture finishing.

Working Conditions.

The Passenger Car Painter's work is not done with an excess amount of speed, as an excess of speed would tend to hurt the finished quality of each job. In most shops, however, the output is so great as to require that the painters work very steadily.

The work is generally done in a well lighted shop as free from dust and draughts as is possible. The temperature of the shop is maintained as equally as possible at about 70 degrees. The work in the paint shop in the winter time is agreeable, but in the summer the painter suffers at times from the heat, as the doors of the shop are required to be closed on account of draughts, when varnishing a car. The fumes of the turpentine are much more obnoxious in the summer time than in the winter, as more of the oil evaporates. The discomfort from the fumes of the turpentine is experienced more by the painter on the inside of the car than on the outside, because of the fact that the air is very close inside of the car—that is, the car inside the shop is a house within a house, and there is little movement of the air inside of it, which aggravates the fumes from the turpentine. The effect of the turpentine on the worker is to make him drowsy, and in some cases the men suffer from headache.

At some shops the painters are examined by a physician once every month to determine whether or not they are suffering from lead poisoning or some other disease peculiar to their occupation. At present most railroad shops use less lead in their painting than they did in former years, and this lessens the danger of lead poisoning to the employes.

Our observation is that painters are generally more anemic, have poorer appetites and a more unhealthful color than any of the other car department employes.

The painter uses a great deal of waste, which becomes saturated with paint and oil, and he must use care at the close of each day that none of this waste is left lying around the shop, as it would undoubtedly cause fire by spontaneous combustion. In some shops the apprentices are required to go from car to car with a bucket and collect all of the waste from the painters.

Personal Requirements.

Among the personal requirements that the painter must have are deftness of touch and a considerable degree of control of the muscles of the forearm, wrist and hand. He must be able to vary the pressure of the brush, control the direction of its sweep over strokes of varying length, and must be able to guide the brush carefully, both freehand and following lines. He must be able to direct the point or edge of the brush care-

fully enough so that when painting corners, he does not leave brush marks. He will have to know how to vary the brush pressure, according to whether he is working with paint or varnish. Take it all in all, it is clear from this that a man who is by nature awkward in his muscles, cannot become a good painter, and even a person with the usual accuracy of control requires a great deal of training and practice before he becomes a painter who can be classed as a mechanic.

SECTION E.

WORK ON FREIGHT EQUIPMENT

The freight car painter paints and stencils all of the freight equipment, the general divisions of which are: box cars, gondola cars and flat cars. He also must paint all of the work equipment, such as snow plows and derricks, and similar machinery, and must paint the trucks of all of these cars. He must apply the paint to all of the cars in a very quick manner and also see that it is brushed well into all the cracks, crevices and corners. The body, trucks and the roof are generally given two coats of paint. To reach to the top of the sides of a box car, the freight painter is required to carry large horses, about 12 feet in length and between 9 and 10 feet in height. He must lift these horses over all the debris that litters the freight repair track and place it carefully alongside of the car to be painted, so that when he mounts it, it will not tip over. His work must be done quickly and thoroughly, and in all kinds of inclement weather. When raining hard, his painting must be confined to cars that are under roof, although, in some instances, freight cars are painted in the open while it is snowing.

Painting Box Cars.

The painting of the roofs of house cars is generally done with a long-handled brush by the aid of which the work is done very quickly. In some shops the paint is applied to the surface of the car by a spraying machine. This machine operates similarly to an atomizer, and by compressed air blows the paint against the car. In other shops long-handled brushes are used to paint the sides and ends of the box cars, which eliminates the carrying of the heavy horses from car to car. In most shops, however, in order to economize on the use of the paint, it is done with a small brush by the painters. On some of the cars the bottom is painted, which requires the freight painter to crawl under and around the car and paint overhead, with the result that he gets a great deal of paint on his features and his clothing.

Painting Trucks.

In painting the trucks of freight cars, he must take care that he covers every part thoroughly, as a patch unpainted would be found by the foreman on inspection. The purpose of painting the trucks and the bottoms of the car is to prevent rusting and the purpose would be defeated if the job was not done thoroughly.

Painting Foreign Equipment.

In painting the freight equipment of his own railroad, the painter must be familiar with the parts that are required to be painted on each car and the color of the paint which he must use, as he does not receive specific instructions as how to paint each car. In the painting of foreign cars he must judge from the appearance of what paint is left on them, what color he must mix and apply. He applies two coats of paint to the interior of cabooses and other work cars.

Freight Car Stenciling.

The stenciling on the freight car is larger and in more detail than the stenciling of the passenger car. The freight car painter must know the exact position the name of the car and the numbers of the car must be placed in. Usually the initials and number of the car are placed high up on either end and also in about the center of each side. As some of the freight cars have five and six numbers, he must be intelligent and careful enough to apply them in their correct order, as a car with the correct number on one side and an incorrect number on the other would cause considerable confusion when in service, as the way bills and destination reports are required to show the number of the car and its loading; also it would cause confusion by perhaps having two cars of the same number.

Number of Stencils.

In addition to the name of the railroad and the number of the car, a great deal of other stenciling is applied. This stenciling gives the capacity of the car in pounds—its light weight—at what station and in what month it was weighed—the style of draft rigging—type of coupler and draft springs—last date of re-building—length, width and height of car—its cubical capacity—type of triple valve—type of brake beams and that the car is up to U. S. Safety Appliance standard.

Some of this stenciling is required by the rules of the Interstate Commerce Commission, some by the Rules of the American Railway Association (M.C.B.) and some by the railroads

to which these cars belong. The painter who cuts the stencils must know the type and height of letters required in each stencil. The painter applying the stencil to the car must know the exact place each stencil must go. Blue prints and sketches furnished by the Company show the exact location of each stencil when applied. These blue prints give this location by showing the distances from the sides or ends or from sill or eaves which determine its place.

Knowledge Required.

The freight painter must know just what stencils each car is required to have, as he receives no special instructions as to the stenciling of any one car belonging to his own road. To apply the correct stencils he must be able to tell by sight the various types of draft gear with which the different cars are equipped. To correctly stencil the car's capacity, he must be able to tell by sight the size of the journals of the car. In order to stencil the great number of cars that he is required to do quickly and correctly, the painter must have a great deal of shop experience. He must also stencil the grain line marks on the inside of all cars used to carry grain. He must know and be able to measure the distance from the floor on the inside of the car where each grain line must be placed, as the line for oats or wheat or corn would be at different heights from the floor of the car, and each are at different heights on different cars. These lines are generally stenciled alongside of the car door and are for the guidance of shippers and others loading the car so that they will not load it to more than its capacity. The painter must know at what height each stencil must go, and an inexperienced man would probably mix the stenciling so that when in service the car would not be loaded to the limit of its capacity for that kind of grain, or be overloaded.

Variety of Stenciling.

The following from the "Railway Review" of January 31st, 1920, gives an idea of the work of the freight painter stenciling cars:

"No one item enters more into the expense of painting freight cars than does the making and upkeep of stencils. It necessitates the employment of a high rated employe in the first place to make the stencils and keep them in repair, and when we stop to consider the fact that most repair yards are obliged to give nearly as much attention to the repairs of foreign equipment as to system cars, some adequate idea may be had of the amount of time and material necessary to maintain stencils which of necessity must be kept in stock in order to replace standards of the various railroads.

"It might be said in passing that no two roads have the same standard, either in style or shape of letters or numeral, although they are of Roman or Grecian style. This necessitates an enormous outlay when

figured in dollars that could be eliminated if a **standard** could be agreed upon."

The freight car painter is required to make new stencils for nearly every foreign car that requires extensive re-stenciling. When only a part of the stenciling has been removed, he sometimes fills in the missing portion freehand.

SECTION F.

WORK ON LOCOMOTIVES

Surfacing and Painting.

The method of preparing the surface of the locomotive and tender for painting is similar to the work done on steel passenger cars. After the surface has been primed, it is given a coat of flat lead surfacer. The cavities and scale marks are puttied and sandpapered. This is followed by two more coats of lead surfacer and rubbed down to a smooth finish with pumice stone. Sometimes the surface is sponged and wiped with a mixture of turpentine and oil. Two coats of locomotive black are then applied and after the lettering is done two coats of varnish are applied over all.

A locomotive to the casual observer, appears only to be painted black. He overlooks the fact that the brass piping and tubing are covered with paint prepared especially for these parts. The cooler parts not subjected to heat are covered with mineral paint while the fire box, smoke box and front end, on account of the intense heat they are subjected to, are finished with a graphite paint or plumbago mixture.

Lettering.

In lettering and numbering, the locomotive painter uses aluminum, or goldleaf. On some of the tenders emblems or monograms are stenciled in various colors. The painter cuts stencils of paper, sheet iron and sheet brass.

Varnishing.

The varnishing of locomotives and tenders is done under difficulties, as the temperature of the roundhouse or shop in which the work must be done is continually changing, and as these departments were not intended primarily to be used as paint shops, no one but the painter seems to take care that the work is protected from drafts, steam, smoke and dust.

Part VII.

THE WORK OF THE CAR INSPECTOR

SECTION A.

FREIGHT CAR INSPECTION.

In order to avoid confusion in explaining the work of the car-inspector we will divide it into two classes—freight car inspection and passenger car inspection. At many points the same carman does the inspection on both classes of equipment. The car inspector usually has had years of experience building and repairing cars.

The duties of the Freight Car Inspector are to inspect all cars that are carried in freight trains.

First: To see that these cars have no existing defects which render them unsafe for movement.

Second: To see that lading is in proper condition and loaded in accordance with the A. R. A. loading rules and that cars carrying perishables are properly iced or ventilated.

Third: To see that no cars have safety appliance defects.

Fourth: To see that every car will pass the clearance limit over the route on which it is to travel.

Fifth: To make necessary light repairs when possible that will expedite the handling of shipments and improve the condition of equipment.

Determining Defects.

To determine whether or not a car has defects which render it unsafe for movement, the car inspector must scrutinize every part of the car, giving particular attention to the wheels, arch bars, truck sides, foundation brake gear and brake hangers, connection pins and cotter keys, draft gear, doors and roofs, journal bearings, and all the bolts and nuts on these parts. A nut or cotter key missing from some of the parts enumerated would cause it to fall to the track, causing probable derailment damage and delay.

Arch bars and truck sides often develop dangerous cracks that superficial examination does not detect, but the car inspector finds them by knocking the scale and dirt from places they are most likely to be. Often coupler carry irons are loose or badly secured, which the inspector remedies by tightening up the bolts that hold it.

Brake Inspection.

The inspector must see that air hose, brake pipes, etc., are in good order; that cylinder and triple valves have been cleaned, oiled and tested within twelve months, and that all trains have at least 85 per cent of the air brakes coupled up and in operative condition. Every car must also have an efficient hand brake. The inspector must understand the importance of proper brake cylinder

piston travel. The proper piston travel on the freight car when running is eight inches. To insure the proper piston travel on the car when running, the piston travel on the standing car should be adjusted to about six and one-half or seven inches. The car when moving has a greater piston travel than when standing because the movement of the car develops slack in the brake rigging and allows more truck movement.

Results of Unequal Piston Travel.

Long piston travel requires that the engineer make a heavy brake pipe reduction in order to apply the brakes, and the braking power will be much lower than on cars with shorter piston travel. On cars having short piston travel the brakes are heavily applied by only a small brake pipe reduction, and the brakes will not release promptly. This is true because generally brake pipe reductions are continued after the short travel brakes are fully set. The result of unequal piston travel on cars in a train is, that the motion of cars with long piston travel is not as greatly nor as quickly retarded as the motion of cars having shorter piston travel. The harsh and sudden brake application on cars with short piston travel causes the brake shoes to quickly prevent the rotation of the wheels causing brake burn, and as the cars having longer piston travel are still in motion, the wheels of the car with the short piston travel slide on the rails, causing that defect known as slid flat wheels.

Another result of unequal piston travel is severe draft gear strain and shock. Unequal piston travel gives unequal braking power, which tends to stop the cars of the train at different speeds. The shocks and strains due to this tendency must be disseminated by the draft gear.

Transfer of Lading.

Besides detecting the defects that exist on the cars, the inspector must make a written record of them and take the necessary steps to correct them. He must decide whether or not the car is in condition to go forward. If he decides that the lading of a car must be transferred and the car set out for repairs, he must make out the proper transfer card as per Rule 2 of the American Railway Association M. C. B. code of rules. The transfer of lading necessarily causes some delay to shipments. The car inspector must avoid these delays as far as possible using his judgment as to whether the car will safely carry the lading to its destination. In making these decisions he must consider the character of the defects, the distance the car must travel, the type of car, character of the train, its position in the train, conditions likely to be met over the route it is to travel and the character of the lading.

The Defect Card.

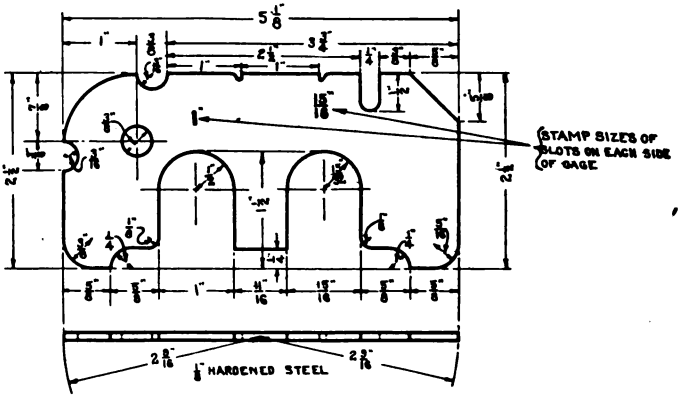
When cars or trains are offered by another line to his road for further handling he must see that he receives defect cards on cars having defects for which the delivering line is responsible; and oppositely, he must issue defect cards for defects on cars for which his line is responsible when he delivers these cars to another road. The primary purpose of the defect card is to aid in maintaining a record on each car of where its defects originated and to fix the responsibility for such defects.

Handling Cars in Interchange.

To properly handle cars in interchange, the car inspector must be thoroughly familiar with the A. R. A. (M. C. B.) code of rules, the American Railway Association loading rules, the Interstate Commerce Commission Safety Appliance regulations and the Interstate Commerce Commission regulations covering the transportation of explosives, etc. He must refuse to accept cars offered in interchange having safety appliance defects, cars not loaded as prescribed by the American Railway Association loading rules and open cars when dimensons of their lading are in excess of published clearances of roads over which shipment is destined. He must make certain that none of the lading is missing from cars offered in interchange, particularly grain and coal cars.

The inspector must be able to judge whether defects on cars offered in interchange are due to fair or unfair usage. He must know for what defects delivering line is responsible and for what defects owners are responsible. Car owners are responsible for loss or failure under fair usage of any part of car, except as provided for in A. R. A. Rules Nos. 32, 36, 56, 57, 58, 65, 68, 70, 84 and 99.

The car inspector not only must secure a defect card for all defects for which the delivering line is responsible, but must also obtain defect cards covering any wrong repairs for which delivering line is responsible. The car inspector must be expert in the use of the A. R. A. wheel gauge and be able to quickly determine the wheel defects for which he must procure defect cards and those which render the car unsafe for movement. The wheel gauge above mentioned is used as an aid in detecting and determining the extent or seriousness of wheel and axle journal defects as outlined in Rules No. 68 to 85 of the American Railway Association (M. C. B.) code of rules. It is also used to determine if couplers exceed the limit of wear as per rule No. 18 of these rules.



WHEEL DEFECT, WORN COUPLER LIMIT, WORN JOURNAL COLLAR & JOURNAL FILLET GAGE.

Fig. 62.

The wheel gauge gives twelve points of measurement and to use it the inspector must know them and for what purpose they are intended.

Inspection of Refrigerator and Tank Cars.

The car inspector must see that cars carrying perishables are properly iced or ventilated. It is very important on Refrigerator cars that he see that the ice box drains are not plugged up, as that would prevent the ice from draining properly and would, in some cases, cause the flooding of the car and damage the shipment. On tank cars, especially in the warm weather, he must make certain that the tank safety valve is operative.

Instructions Given the Inspector.

From time to time there are changes or additions made to the American Railway Association Code of M. C. B. rules and Loading rules with which the inspector must acquaint himself. Circular letters of instruction are written frequently advising the car inspector of cars that require special handling. The letter may instruct that all cars of a certain series found, that have not yet been equipped with friction draft gear are to be assigned to a certain shop for repairs. Another letter may instruct him to card all cars fit for sugar, flour or grain loading to a certain point on the line. Another letter may instruct him to be on the lookout for A. M. A. car No. 1001 loaded with remains of Penn. car No. 61361 which has been destroyed in wreck and sent to this point for rebuilding. When he

finds A. M. A. car No. 1001 it is sometimes the case that it will be loaded with the remains of two cars and not one, or loaded with the remains of a car that is obviously not Penn. car No. 61361. However, the car inspector must make accurate record and report of exactly what he finds.

Some of the instructions issued in these letters remain in effect a year or perhaps two years and others are effective for but a day or a month. The car inspector must surely be familiar with and interested in his work or he never would be able to catalog in his memory the variety and number of instructions he receives via letter.

SECTION B.

PASSENGER CAR INSPECTION.

The work of the Passenger Car inspector is performed at terminals and coach yards where trains lay over between runs and at the important stops on the run where the train is delayed a few minutes, during which time the inspectors go over it to discover defects that may have developed since it left the terminal or place of last inspection.

At the terminal and at coach yards the inspector makes the necessary light repairs that are required to maintain the equipment in safe and serviceable condition. He is responsible for and must see that any damaged parts such as door and sash locks, seat movers, door holders, checks and stops, all broken glass, upper berth fasteners, signal cords, signal valves, conductor's valve and valve cord are replaced. On the outside of the car he examines the buffer rigging, draft rigging, couplers and trucks. He orders changed defective wheels, worn knuckle pins and any other parts of the truck and draft rigging liable to fail in service.

The Detection of Defects.

The detection of defects that render the car unsafe for service is not easy. Some of the most dangerous defects are the most difficult to find, such as loose wheels and sharp flanges and cracked plates and flange seams on cast wheels. Nearly all first class passenger cars are now equipped with the clasp brake, which means that brake shoes about fourteen inches long are in contact with each side of every car wheel. These two brake shoes cover a twenty-eight inch portion of the circumference of the wheel and may cover a serious crack in the flange or a slid flat spot of sufficient size to cause derailment when the car is running at high speed.

Car wheels are fixed rigidly on the car axle and they rotate

together when the car is in motion. A wheel that becomes loose and therefore has some movement independent of the axle is certain to cause derailment, or worse. The detection of loose wheels is exceedingly difficult because the pedestal and journal box cover the wheel fit from sight on the outside. He must determine whether or not the wheel is loose from sight when he glances at the inside of the wheel fit. The condition of the brake shoe is often, to the carman, evidence of wheel defects. A badly burnt brake shoe may indicate flat spots, lose wheel or wheels out of gauge.

To enumerate the parts of the car that the inspector must scrutinize would mean the listing of almost every part on every car. Every nut, pin and cotter key is a potential risk in the operation of a fast passenger train. The car inspector by rigid, careful inspection cuts this risk to a minimum. Car inspection must be done thoroughly. The car inspector programs his work so that in going over a train he sees every nut, pin and cotter key. He needs only to miss one that is defective to leave possible cause for accident. His inspection must be done with equal thoroughness by night as by day.

Journal bearings must be inspected, as journal bearing defects cause many journal defects, hot boxes, cut and broken journals, cut and broken collars. The safety appliances on each car must be in perfect condition. The heating and lighting system must be thoroughly inspected. The train should have 100 per cent of its air brakes coupled up and operative. The air signal equipment must be in perfect condition. Every car must have an efficient hand brake.

Brake Inspection.

Piston travel is an important point in passenger car inspection as well as on freight cars. In the inspection of the air brakes, the inspector first sees that all air hose are properly coupled, and not crossed with signal line, that the angle cocks between each car and the cut out cocks under each car are open. He closes the angle cock at the end of the train.

From the last car on the train he signals the engineer to apply the brakes. He then goes over the entire train, noting the piston travel and the amount of air leakage. He then signals for the brake release and must note that the brakes on each car release promptly. If the brakes stick on any one car, he should ascertain the cause and correct it. He corrects air leakage and must have the knowledge of air brakes necessary to find the causes of defective brake action.

Hazards.

The car inspector's work is done where cars are being constantly moved. Before beginning inspection he places a blue flag or blue lantern at the end of the train he inspects. Records of accidents to car inspectors prove that this precaution does not wholly eliminate the liability to injury. A great percentage of injuries to car inspectors result in loss of limb or life.

Personal Qualifications.

The car inspector must be physically active and possess the endurance and strength to continue his activity throughout his entire working hours. He must have unusual perceptive ability and good eyesight. People often possess good eyesight and lack perceptive ability. The car inspector must have both in order to quickly discern car defects.

No hard and fast rules can guide his work. The quality of the decisions he must make depends upon his common sense and good judgment. He must be able to write legibly and have a memory retentive enough to remember instructions and retain the knowledge of the M. C. B., Loading, Safety Appliance, and other rules that he must use each day in his work.

To inspect passenger equipment well, the car inspector must have the intelligence necessary to arrange the performance of his work in such order as to be able to inspect a train thoroughly and quickly. He knows the liability of failure of any part of the equipment because he knows the conditions under which every part must function. He is able to keep accurate record of the results of his inspection and any repairs made. He must be able to successfully pass the examination most roads prescribe for all car inspectors. He has sufficient skill as a car mechanic to make any necessary repairs quickly and well. As stated before, perceptive ability and good eye sight are requisites of the profession.

Working Conditions.

At some points the car inspecting is done in one daylight shift; at most points there are two shifts of car inspectors, and at other points three shifts. His work must be done quickly and well, without regard to weather conditions. The statement made herein that he must scrutinize every part of the car does not bring to the mind's eye an adequate picture of the car inspector doing it. He must climb to the roof to make certain it is in good order and entire, and that no portion of the running board is missing, and must crouch under the car to examine the wheels and draft rigging. In fact, the positions he must assume and his speed in performing his work

are responsible for the derisive appellation applied to him by some who do not understand the importance of his work.

In some sections of the country passenger trains arrive at terminals in the winter time after a transcontinental run literally covered with snow and ice. Sometimes ice up to a foot deep covers parts of the running gear. This must be thawed away with live steam, for only by exposing all the surfaces can proper inspection and repairs be made that will assure a safe journey for the train and its passengers on the next trip.

Responsibility.

The car inspector is an important cog in the machinery that keeps traffic in motion. He is the judge as to whether a car is to remain in service or be withdrawn for repairs. He determines and is responsible for the performance of cars that have passed his inspection. His supervision consists of censure for mistakes made some time previous and the circular letters of instructions above mentioned. No one could follow him and directly supervise the actual performance of his work.

The car inspector is as responsible for the safety of passenger trains and all who ride them as is any man or set of men on the railroad. The car inspector is a man of intelligence and feels this responsibility. He works under little supervision, because no supervisor could share in his responsibility. He is the sole judge and assumes the responsibility as to whether or not a car is fit to run. No man on the road dares to move a car in service against his authority. He and his fellow carmen keep the trains in a safe condition night and day, year in and year out and the safety of passenger train travel is sufficient testimony as to his capability.

CONCLUSION

The future holds many opportunities for the railway carman to improve his department of the railway industry.

He can influence the improvement of shop facilities and the methods of repairing car equipment.

He can minimize the hazards attending his work and can bring about the improvement of conditions that affect the quality and quantity of his work and those that affect his personal comfort while performing it.

By educating himself along every line connected with or in any way affecting his craftsmanship, he can improve the quality and widen the scope of his service to society.

EVERY CARMAN SHOULD READ

HERE ARE BOOKS ON A VARIETY OF SUBJECTS THAT CAN BE OBTAINED AT COST

Car Anatomy Directory	$2.25
Carman's Helper	2.25
Up-to-Date Air Brake Catechism	2.25
Painter, Gilder and Varnisher's Companion	1.75
Oxy-Acetylene Welding Practice	1.30
Car Interchange, Guide and Ready Reference Tables	.65
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Car Inspector's Guide	.45
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Freight Car Safety Appliances Pictured	.45
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NOTE:—For Book Descriptions see following page.

Book Descriptions

Car Anatomy Directory—A book by Hugh K. Christie, measuring 9x12 inches with a flexible cover and containing 28 pages. Seven charts are displayed on double pages. These charts cover box car bodies of different kinds, roofs, doors, ends, trucks and air brakes. All parts distinctly numbered and named. Twelve pages devoted to Recommended and Standard A. R. A. Practice. A book for which thousands of Carmen have been waiting. List Price $2.50. **Brotherhood Price $2.25.**

The Carman's Helper—(Third Edition Revised and Enlarged). A book on car repairs and car maintenance by Hugh K. Christie, assisted by Carmen of wide experience. Twenty chapters of compact information for both small and large repair points. Profusely illustrated. List Price $2.50. **Brotherhood Price $2.25.**

Up-to-Date Air Brake Catechism—This is a standard book on the Air Brake written by Robert H. Blackall. It is the only practical and complete work published. Treats on the equipment manufactured by the Westinghouse Air Brake Company, including the E. T. locomotive Brake Equipment, the K Triple Valve for freight service; the L. High Speed Triple Valve; the P. C. Passenger Brake Equipment, and the Cross Compound Pump. The operation of all parts of the apparatus is explained in detail and a practical way of locating their peculiarities and remedying their defects is given. The book contains 2,500 questions and answers and is fully illustrated with colored plates. Just the book for Carmen. Present price $2.50. **Brotherhood Price $2.25.**

Painter, Gilder and Varnisher's Companion—A cloth bound illustrated book by William T. Brannt, measuring 5¼x7½ inches and containing 395 pages. This volume gives a clear, concise and comprehensive view of the principal materials to be used and the operations to be conducted in the practice of the various trades of painting, gilding, varnishing, etc. It covers the manufacturing and test of pigments and details the arts of painting, graining, marbling, staining, lacquering, japanning, bronzing, polishing, sign writing, varnishing, glass staining and gilding on glass, together with coach painting and varnishing. The principles of harmony and contrasts of colors also are shown with the addition of many useful receipts and miscellaneous related subjects. List price $2.00. **Brotherhood price $1.75.**

Oxy-Acetylene Welding Practice—A cloth bound, profusely illustrated book by Robert J. Kehl, measuring 5½x8½ inches and containing 102 pages. This volume, written from a practical standpoint covers the principals of both ox-welding and the electric processes. It also details methods of welding with oxy-acetylene and describes method of filling fissures and cracks. The subject of cutting receives considerable attention. The use of tools, and their maintenance is gone into thoroughly and preparation of work and the use and treatment of different metals and costs of operation are discussed in detail. Just the book for Ox-Welders. List price $1.50. **Brotherhood Price $1.30.**

Car Interchange Guide and Ready Reference Tables—An up-to-date book giving prices of A. R. A. Couplers, Wheels and Axles, Journal Bearings, Air-Brake Parts, Metal Brake Beams and Steam Hose. Gives the weights of Bolts, Nuts, Washers, Flat Bar Iron, Sheet Iron and Steel and Nails. It details parts of Freight Cars, Labor and Material. Includes a complete list of A. R. A. Springs, Friction Draft Gear, Steel Wheel changes (how to change), Lumber Computing Tables, Depreciation Tables for computing value of destroyed cars and tables of Labor Charges. List Price 75c. **Brotherhood Price 65c.**

Abstract of A. R. A. Rules and Sample Repair Cards—An up-to-date pamphlet 6x9 containing A. R. A. Rules, Interpretations and Decisions arranged alphabetically under the separate headings, making it a ready reference for any man engaged in car repair work. The sample repair cards, covering several hundred items, are filled out to show the proper charges for repairs of all parts of freight cars. All items have been revised in accordance with the latest rules. List Price 75c. **Brotherhood Price 65c.**

Car Inspector's Guide—(Third Edition)—A book for those interested in car inspection. 79 questions and answers for freight car inspectors, and 100 questions and answers for passenger car inspectors. Pocket size with a durable cover and contains 58 pages. List Price 50c. **Brotherhood Price 45c.**

Foundation Brake Fundamentals—(Second Edition)—A book for the air brake Carman written by Hugh K. Christie. A catechism containing 135 questions and answers on leverage, brake rigging, piston travel, cause of slid wheels and many other interesting things in connection with the brake rigging. Pocket size with durable cover. List Price 50c. **Brotherhood Price 45c.**

Freight Car Safety Appliances Pictured—A pocket sized edition of Safety Appliance Laws covering the freight car, compiled by Hugh K. Christie. Contains 18 drawings to illustrate the simply written laws more clearly. Just the book for Carmen who wish to advance. List Price 50c. **Brotherhood Price 45c.**

Catechism A. R. A. Car Interchange and Loading Rules—A valuable book for Inspectors and M. C. B. Clerks. Includes Questions and Answers on the Rules of Interchange and the General Instructions of the Loading Rules, also on the care of Air-Brakes and Steam Heat Equipment of passenger cars. List Price 50c. **Brotherhood Price 45c.**

Brake Beam Identification Schedules—This pamphlet contains illustrations of forty-nine different kinds of metal brake beams, also the illustration and table covered by Rule 101. The use of this schedule will enable car men to show on repair cards the required information as to kind of brake beams removed from foreign cars. List Price 50c. **Brotherhood Price 40c.**

Kinks, Jigs and Devices—A pocket sized book containing 48 pages covering short cut methods for making the Carman's work less laborious. This book, written by Hugh K. Christie, simply decribe the short cut methods by means of plain reading and it also contains 28 illustrations to aid the reader. List Price 50c. **Brotherhood Price 40c.**

Brake Rigging Facts—A 38 page book published by the Brotherhood Railway Carmen of America. As its name implies, it gives important information regarding the brake rigging, dealing on leverage, percentage, piston travel and maintenance. This is the Brotherhood's first book to be handled by the Trade Educational Bureau. It was printed and bound by the Brotherhood Printing plant and should receive the endorsement of every Carman. List Price 50c. **Brotherhood Price 35c.**