The Carman's Helper

BY HUGH K. CHRISTIE

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(Second Edition, Revised)

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TABLE OF CONTENTS.

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

TABLE OF CONTENTS

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

APPENDIX

FOREWORD

The growing recognition of the importance of the Carman's work but brings added responsibility; and as I know the Carmen through long years of intimate and close contact, I know that that responsibility is being accepted in the right spirit and that today, as never before, the Carmen of our American railroads are giving to the service the very best that is in them.

The acceptance of this responsibility and the desire for improvement has reached me more positively in the last year than ever before, through many letters received from Carmen everywhere asking if there are not some books which would help to make them more efficient in their work.

It is hard to say "NO" to any railroad man, but to say "YES" in answer to this insistent and persistent demand for a book which would be of real value to the Carman in his work, has required much time and thought in order that something of real value might be produced.

The Carman's Helper is not intended to give utterance to any theories or ideas of my own. Rather it is a compilation of the best thought as I have obtained it from the hundreds of Carmen whom I count as my good friends. My thought has been rather to take from this one or that one, here or there, something that would be beneficial, and weld it all together in logical order and natural sequence; and put it forth as compactly and as concisely as possible so that it might be something for ready and convenient use of the individual Carman.

Much has been written in regard to cars and car equipment but it has been spasmodic and unconnected utterances that have lacked the continuity and completeness which I trust has been attained in this book.

Far be it from me to claim any credit whatsoever for what appears in the pages which follow. I am under obligations to literally hundreds of Carmen for what appears between the covers of this book. Some of my good friends in the Car Department are too modest to allow me to refer to them by name; and to attempt to give credit to the few would be an injustice to the many. I have been writing to the Carmen direct through a great many different channels for many years. I have had letters from them literally by the thousands which I have always read with the greatest of pleasure and tried in the acknowledgment of them to show my appreciation of the many kindly things which they have said to me and of my work.

The opportunity presented here I welcome, and I say once more to the Railway Car Fraternity at large that I appreciate most deeply their friendship and good will and that in writing, I should rather say compiling, this book I have attempted to reciprocate. I submit this book not as a finished study but rather as a survey. Future revisions of the book will, I trust, be of still greater use and value to the Carmen of America.

As all Carmen know, the methods of making a given kind of repairs to a car vary greatly and depend on the type of car and appliances, the number of men, and facilities at the point where the car is repaired.

For this reason and in order to treat of the Carman's

work intelligently, we have found it necessary to discuss repairs at definite points. We have selected a number of terminals, starting with a very small terminal or a place where one man does repairs on a side track and discussed car work at this point. We have then selected a larger terminal, discussed the work there, and gradually worked up to the larger terminals.

The same kind of repairs may be mentioned in four or five different places in this book. But where different methods for doing the same kind of work are given, they usually show how the work is done under different conditions.

With this in mind, The Carman should be able to use this book to the greatest advantage regardless of whether he is located at a large repair point, a small repair point, or an intermediate repair point.

HUGH K. CHRISTIE.

The Second Edition.

I can only thank the Carmen of this country for the quick and enthusiastic endorsement of my efforts in this book, imperfect as the first edition was. The response was so quick that the first edition was sold out in six months.

This, the second edition, has been enlarged and improved. Criticisms and suggestions from many Carmen have been acted upon in-so-far as is possible without unduly increasing the size of the book. Further suggestions are requested from every reader. H. K. C.

CHAPTER I.

INTRODUCTION.

At the present time there is a general plea for better maintenance of freight cars. Various influences have made the problem more difficult each year. The demands made on the cars have grown so fast that the closest attention to proper methods of maintenance are required.

The general pooling of cars took away the control over maintenance standards of a railroad's own equipment to a great degree. This is particularly noticed in the box car. A few years ago the majority of roads had from 35 to 45 per cent of their box cars on their own road. The percentage has now dropped as low as 7 to 12 per cent.

The tendency has been to slight repairs to cars, not alone for selfish reasons but for the reason that repairing cars of another standard presents difficulties not found on system cars. Material is usually on hand for the home road car, and the men understand these particular repairs.

Some method for better maintenance standards should be devised which would force all roads to maintain higher standards. Unless this is done the general average throughout the country will be lowered still further. It would not be economical to maintain all cars to 100 per cent efficiency, as some lading can be carried in cars in just a fair condition. Figures disclose the fact that 72 per cent of freight requires cars in first-class condition, but 28 per cent can be handled by cars in only fair condition.

Very few cars come to the rip-track for repairs caused by natural wear or the elements. The car body is the first to feel the influence of age, but even in the car body deterioration is effected mainly by switching shocks, starting and stopping, and shifting loads. The repairs to draft gear, trucks and air brakes are necessary because of excessive shocks, improper equipment, improper installation, poor maintenance and faulty repair and inspection.

Figures have brought out the fact that the greater the percentage of "bad orders" on a road, the greater the number of men used for repair work and the greater the percentage of cars repaired annually; whereas a minimum number of "bad orders" produces an opposite effect which goes to show how expensive poor maintenance can be.

A road with a high standard will cut down damage claims due to defective equipment and also reduce delays. This means greater dividends. Classified repairs would go a long way toward making every road do its share for bettering maintenance.

This brings us to the problems of the individual road. It may have an ideal system of rules for bringing out that which is best but when an official in charge of car repairs has a high percentage of obsolete light capacity cars which must be maintained from year to year, he turns instinctively to the working force to end his troubles. Car standards will never improve without a correspondingly higher mental standard in the rank and file which must maintain the improvement.

The progress that has been made in the Car Department in the last few years is a matter of great satisfaction to the Carman of today. Those of you who have

followed the game from the early stages of development to the present time, know that the wooden underframe car is a relic of the ancient Car Department.

Relics as a rule are typical of things not in general use. But we have many thousand wooden underframe cars running today.

These cars must be kept in service for some time to come, and their repairs must be maintained with the repairs to our more modern equipment. To do this our shops and repair points to a certain extent, must be equipped with facilities for correcting defects and rebuilding both wooden and steel cars.

Necessity is the mother of invention. Because it was found necessary to have greater strength for heavier loads and greater buffing shocks, and because of safety requirements, we see the development of the car from the ancient to the modern type.

Modern repair tracks and shops have the facilities for doing repair work well in the shortest possible time. In these days of competition it cannot be otherwise. The man who can keep the cars in service is the man who is recognized and promoted. There are many differences of opinion, however, as to what types of tools, appliances and equipment are the best. This is due mainly to the fact that railroading has developed so fast that it has seemed impossible to keep records and compile the evidence which will show by comparison what methods, what types of tools, appliances and equipment are the best.

THE CARMAN AND HIS WORK.

The Carman, be he a repair man or an inspector, lives a life of his own. In no other branch of railroading is

there the same degree of quiet reserve and resourcefulness as is found among those who inspect cars and repair the defects commonly found. His work is such that his habits of life are regular. If treated with consideration and encouraged in his efforts to work for promotion or better money at a larger point, he will be found to be a steady, industrious and conscientious workman. He possesses not only the qualifications of a

A Real Carman.

mechanic, but also receives the training which fits him to handle a larger station and become familiar with office work. The car repairer repairs parts of the cars found defective by the car inspector. These repairs

may be made in the yards or the car may be carded and sent to the repair track, according to the nature of the repairs to be made. This matter will be handled in detail later on.

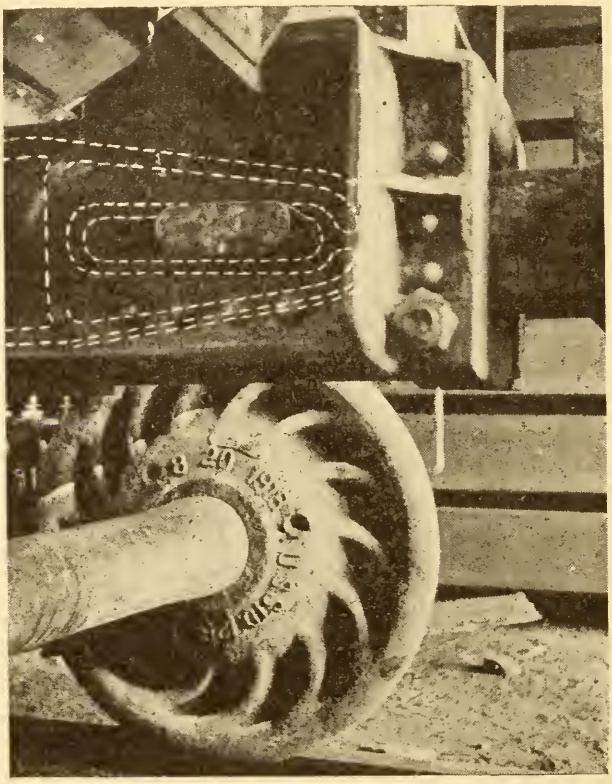
The Carman's work as a repair man should fit him for a place as an inspector by developing his faculties while making repairs on the repair track, as he becomes able to determine the seriousness of the defects found by inspection. He will thus learn what defects can be allowed to run and what must be held.

For instance, a carload of meat, running manifest service Chicago to Suspension Bridge, is found at an intermediate point with one lug strap missing. If the car has cast steel Draft Arms, tie strap is in place, followers are tight and coupler all right for height, the car should not be cut out of the train and held for repairs, because it will run to its destination as it is. The springs, and followers cannot get out of the draft sills and there is very little danger of the other side coming down, at least during the remainder of this one trip. This car can wait for repairs until empty.

But let us suppose that this car had three broken draft bolts in one timber and only two good bolts holding, with two broken bolts in the opposite one; in that case the car must be held for repairs. The draft gear has been weakened 50 per cent and one cannot afford to take chances on a transfer of fresh meat in case the end of that car pulls out.

A second instance: slid flat, brake burnt and shelled out wheels are common defects caused by defective air or hand brakes. Wheels slid flat over 2 inches are very dangerous to both car and truck, besides being likely to damage lading, and should be repaired at the earliest

possible moment after discovery. In cold weather the wheels are more brittle, and the frost is responsible for many broken flanges, and such defects must be remedied promptly. A car with a flange chipped or broken where the piece broken out exceeds 1½ inches in length and ½ inch in depth must be taken out of service im-



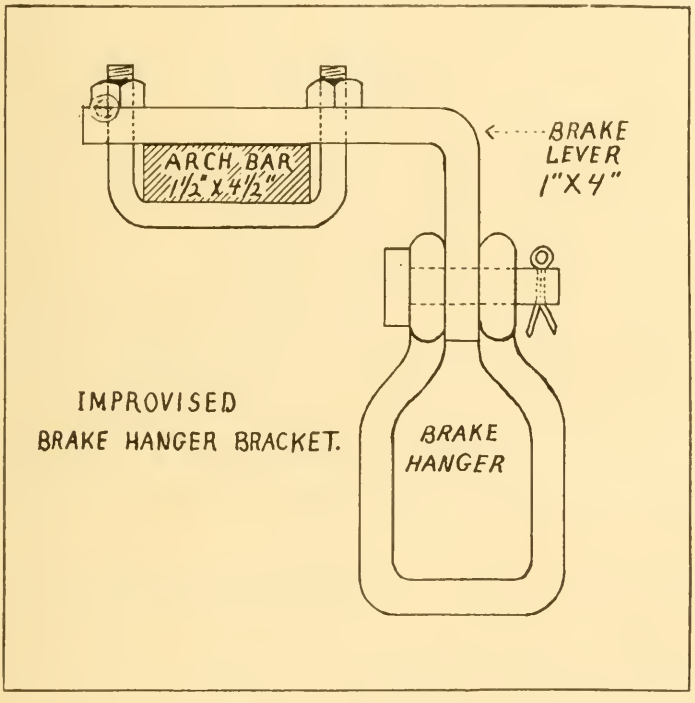
Universal Keyed Yoke (Yoke Shown Dotted).

mediately. M. C. B. Rules declare that under fair usage these are owner's defects.

Another illustration showing how temporary repairs may be made to a car saving a trip to the repair track, is that of a temporary brake hanger bracket. In this

case the brake hanger bracket, which is a part of the column casting, has broken and the car ordinarily would have to be sent to the repair track for the application of a new column casting. To avoid this, the temporary bracket is applied to the arch bar by means of the U-bolt, and the car can proceed to its destination.

This, of course, can only be used on an inside hung brake.

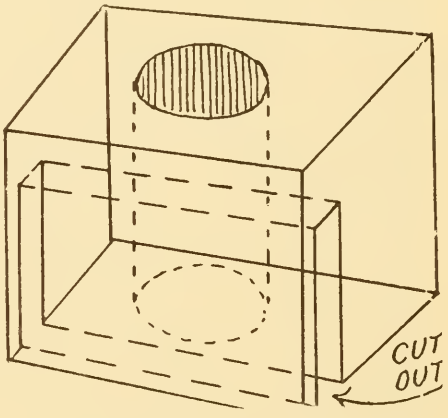


A Temporary Repair Which Can Be Made in the Train Yard.

Still another instance where resourcefulness can be shown is on a car with a missing or broken draft key. Ordinarily this is a repair track job as not many inspection points carry these keys in stock. A truck lever may be used as a key, and a connection pin with cotter

in each end used to hold it in place. Had this same car been equipped with riveted attachments and the rivets broke, the car would have had to be set out and at least sent to a light repair track, where either bolts or rivets could be applied.

Often the shoes for the Wagner Side Door fixtures become lost, and at many points repair parts are not in stock. When such occasions arise a one inch deck washer may be used as a substitute. A slot is cut in



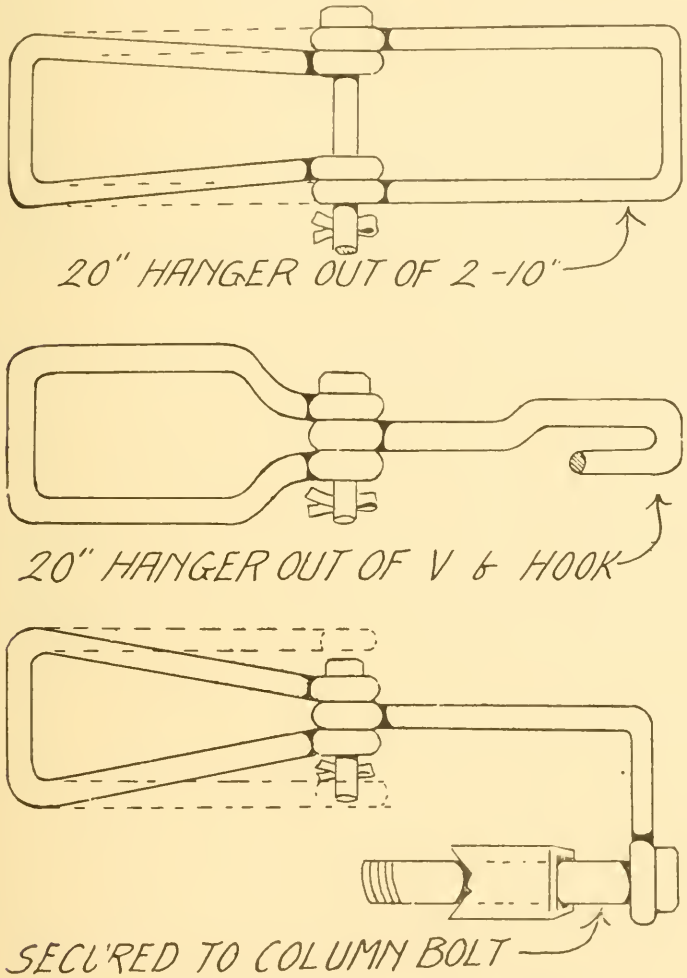
Improvised Side Door Fixture.

the washer as shown and the hole is used for the door rod.

Steel hopper cars, with draw-head yoke rivets broken or missing, when loaded to go forward, can be repaired in any train yard by putting in a 1⅛ x 14-inch bolt and drawing same up tightly. A locking nut should then be applied.

For more permanent repairs on a car of this kind, where two yoke rivets are broken and the yoke is found to be all right although spread, it is not necessary to remove draw-head for repairing. A 1-inch bolt can be used to draw the yoke tightly to the coupler; then

a heated rivet may be inserted in one hole where it can be upset by holding a dolly against the rivet head. The dolly can be braced by means of a wedge. The bolt can then be removed and a rivet inserted in the second hole. A job of this kind can be done in less than 30



Temporary Repairs to Brake Hangers.

minutes whereas the usual procedure would require at least two hours' time.

When low draw heads, due to bent center sills or bent

carrier straps, are found, they can be brought up to the required height by the use of shims. Some of these shims should always be kept in stock. They should measure ½ x ¾ x 1 inch.

Suppose a box car, equipped with outside hung brake beams had a 20-inch box brake hanger missing and there were no blacksmiths, nor even iron to make one. Under such circumstances two 10-inch U hangers can be placed together to make one hanger as illustrated on preceding page. If the hanger requires a hook at the upper end, a hook-hanger joined to a U-hanger whose top ends have been bent the right distance apart, will solve the difficulty.

If a brake hanger casting is missing and the truck is of the arch bar type, a piece of round iron can be bent at right angles and an eye made at each end. The column bolt can be raised enough to slip one eye, partly opened, under the head, when the eye can be closed and the column bolt drawn down tightly again. The eye at the other end of the iron can support the brake hanger. (See illustration on preceding page.)

The Carman should feel it a part of his duties to use his very best judgment, and, in case of doubt, take the safe course. He should also make an honest effort to reduce bad order conditions, and by thought and study of methods of repair, he is bound to become more efficient and resourceful. These qualities are in demand today, especially at the smaller points where but little repair work is done.

Carman have emphasized the Blue Flag Rule so strongly, that it is thought advisable to discuss it in this, the first chapter. It is assuredly the rule that should be put foremost in all car work. The rule is as follows:

A BLUE flag by day and BLUE light by night, placed on a track or at the end of a car, engine or train, denotes that workmen are at work under or about the car, engine or train; and employes must not work at such places unless such BLUE signal is so placed. A car, engine or train thus protected must not be coupled to or moved until the BLUE signal is removed by the person who placed it.

When a car, engine or train is protected by a BLUE signal, other cars must not be so placed in front of it as to obscure the BLUE signal without first notifying the workmen, that they may protect themselves.

In order that there be no possibility of misunderstanding this rule, each man employed to work on or around cars, should be furnished a printed copy, and should sign a receipt, such as:

I acknowledge receipt of a copy of above rule. I have read the rule and understand it.

Name .....

Occupation .....

Witnesses .....

.....

A copy of this receipt should be filed with the employe's application.

"Where the person who operates under the BLUE signal rule is unable to understand the English language, this rule must be correctly interpreted to him by two persons and these two persons must sign and date the following receipt:

"This is to certify that we understand and can read and speak in the English language and can interpret from that language, correctly, into the.....

language. That we correctly interpreted the within rule to ..... and he acknowledged that he understood it and that he signed the within receipt for a copy of the said rule."

Name .....

Address .....

Name .....

Address .....

Dated.....19.....

The above system of handling the BLUE flag rule not only insures its being thoroughly understood by those concerned but impresses its importance upon them.

DEFINITIONS OF REPAIRS.

Inspection and Light Inspection Repairs—Those repairs which are ordinarily made in a train yard during the time of inspection and requiring less than one hour's labor are termed inspection repairs. The following are a few that will come under this class.—Applying missing nuts to all parts of body and trucks, renewing journal bearings, tightening loose nuts, applying brake-shoes, keys, hangers, hanger bolts, knuckles, knuckle locks, knuckle pins, operating levers, clevises, pins, links and castings; grab irons, (single) door hasps, locks, guides, shoes, seal hooks and chains and replacing and tightening loose running board brackets.

Light Repairs—Those repairs which are not usually made in train yards, except upon a "light bad order" track and which require from one to twenty-one hours actual labor are called light repairs. This class of repairs will include renewing journal boxes, column castings, truck springs, arch bars, side bearings, truck bolsters,

body bolsters, wheels, brake beams and connections, couplers complete with or without attachments, deadwoods, side doors, draft timbers, end sills and renewing 2 short intermediate sills on hopper cars.

Heavy Repairs—Those repairs which require more than twenty-one hours actual labor are heavy repairs. They include renewing complete ends, extensive underframe repairs, and general rebuilding of the car body.

CHAPTER II.

ORGANIZATION AND SUPERVISION

The human element plays a greater part in shop efficiency than any other factor. This may readily be noted on railways having many car points with set rules for handling each department. Regardless of the strict adherence to the rules, various shop will range from 50 to 95 per cent efficiency, depending on the one in charge. It is admitted that many terminals are alike in many ways; nevertheless each is enough different to require the maximum of ability from a supervisory standpoint, to maintain the standard under which the work must be performed.

Organization and supervision must be controlled largely by local conditions. What may apply at one point may be found impossible at another. If rules are to be made standard, terminals also should be.

A man in charge must possess two main qualities. He must have mechanical and executive ability. Of the two, executive ability is the most important. An employe often criticises the mechanical ability of his superior officer, never realizing that the broader mechanical vision of the officer is more important than the petty detailed mechanical information which his subordinates find necessary to use. Executive ability will always carry a man considerably farther than mechanical ability.

Every Carman possesses some qualifications which may bring him promotion, therefore it is important for him to know what qualifications are necessary in order

to become a successful foreman. He will find that they are just as necessary for success in his daily work.

The officer in charge must be given the necessary authority, and all orders must go through his hands. He must possess moral courage and be prompt in his decisions. He should be broad in his views, sufficiently so as to be able to co-operate with the heads of other departments. He should be known for his fairness and humanity.

A foreman must be resourceful and must show no favoritism. From the above it is easily seen that success in dealing with men depends far more on moral principles than on mere mechanical ability. It is rare for anyone to possess all the traits but a serious lack of any of them will retard a man's advancement.

The official or foreman needs a strong personality more than anything else. Personality makes a man a leader of men. A man with personality naturally acquires the other qualifications mentioned above.

Because executive ability counts for so much in higher positions, it is sometimes harmful in an organization to promote the man next in line. He may be especially adapted for his present position and yet fail in the next.

Most organizations are successful because their bosses are optimistic and have a sense of humor. One-third of our days is spent in toil, and no one who hates his work can go very far in rounding out an organization. We are all life apprentices and any work gives us the privilege to learn. He who shirks his work pinches his intellectual progress. One can only help himself by helping others.

It is remarkable how the spirit of an official is re-

flected in the spirit of his men. If a foreman is satisfied his men are satisfied. If he is a sluggard his men are sluggards. In an organization there is always a reflex action for every deed committed. It is harmful to be brutal in giving orders. A man who cannot control himself has no business controlling others. Censoring a man in the presence of others has a demoralizing effect. A man who desires a successful organization must put himself continually into his men's shoes. He likes encouragement himself and he should encourage his men. If he has made a mistake in administering discipline he should acknowledge it. And if questions are asked him he should give direct answers.

Many foremen complain bitterly of the attitude of their men. At other points satisfaction seems to reign. The officer who has the least trouble is one who generally is best qualified to lead his organization. The man who has the personality to maintain discipline and still mix with his men is bound to succeed because successful organization depends on close mental intercourse. The closer the Foreman or the under Foreman and the men can get, the better the organization. At every car shop the motto should be "Get along."

At most "efficiency meetings" the whole problem of shop organization has revolved about various detailed codes for hastening work. The assumption has been that labor is a mere machine. The human equation has been ignored, yet 60 per cent of the charges incurred at shop points are direct labor charges. And it is a foregone conclusion that any system of handling work will never produce efficient results without the cooperation of the worker.

The car department has not had the advantages of

other departments. It has been run under split authority. The mechanical man who gives the final decision on car questions is generally a graduate of the locomotive department. This is the reason the car department has occupied a secondary position. No first-class organization will be possible until the ranking car official has the same authority on cars that a superintendent of motive power has on locomotives.

This same split authority finds its way down to the car foreman, who in many cases reports to a master mechanic directly, and to the master car builder indirectly. This is bound to cause poor organization. The car foreman and his inspectors come in contact with the favored department of a railroad—the transportation department. This is the favored department because it brings in the revenue. And the Car Foreman and Car Inspector know full well that they will come out second best in any controversies with transportation men.

Car terminals will never reach high efficiency until the importance of their work is recognized by the transportation department.

In years past there was a tendency to discourage the organization of shop crafts. Although car repair work required skill, the nature of the work was such as to discourage many skilled workers. The antagonism or indifference to the importance of car work in the minds of railroad officials, produced a tendency to maintain a low wage scale in this particular line of work. A low scale of wages invites only cheap labor. Those who have fought against higher wages find that they have got what they have argued for and lost prestige themselves. While both locomotive officials and their

shop crafts openly fought for the apprenticeship sys- for better mechanics, it was not thought necessary to follow out the same course in the car department.

Things have changed for the better in the last few years. Although some shops are still reactionary along these lines, nevertheless there is an awakening. Car officials and the car organizations are getting together, and a course of learning is being mapped out for the carman apprentice. When this has been done a long step has been taken toward better shop organization.

Working schedules are a great aid toward efficient production. Even if they are made too high, they create a goal to work toward. Records also prove invaluable. Time studies produce astonishing results. A foreman may be able to revolutionize his point by the information drawn from his records.

There are some features of such importance in facilitating car work that they deserve mention here. Among these are proper appliances for the handling of various parts rapidly, special tools for quantity production, and jigs and templates for large quantity production. The latter also eliminate errors in laying out by hand.

Machines should have proper feeds and speeds for various metals. Rough material should be selected which has no excess stock. Without having the organization top heavy, let there be enough supervision so that time is not lost by men waiting for foremen nor for work. See to it that the first part needed is the first part scheduled and, also see that the men have proper tools to do their work. And last but not least, check your system from time to time and if found wanting, locate the trouble and fix it yourself instead of blaming some one else. Successful organization means that everyone must carry his share of the load.

CHAPTER III.

LIGHT REPAIRS AND INSPECTION.

In this chapter are described the duties and work of one carman at an outside point.

Being stationed at such a point his work must consist mainly of inspection repairs, possibly on an interchange. While repairs will usually be inspection repairs, some light repairs may be made when necessary. Light or inspection repairs may be made to cars on industrial sidings.

Inspection—The inspection, if on an interchange, should be close and accurate, taking clear and concise records of the condition of each car as found, regardless of responsibility for defects. Subsequent damage to car or lading may call for the records of that particular car at that point.

In making up inspection records the following information should be shown:

Date Month Day Year

Hour: A. M. or P. M. car was received.

Number, initial and kind of car.

The defects found should be described briefly and correct location given according to M. C. B. Rule 14. Conditions of lading should be noted on report if on open cars, such as timbers, lumber, structural iron, billets, stone, etc., and a notation made if box cars show signs of pilferage. Such cases should always be brought to the attention of the agent immediately and repairs made, or temporary protection placed in the doorway and the door cleated if proper repairs cannot be made.

Empty Freight Equipment.—Any car for interchange should be suitable for the load it is to carry and upon this depends its subsequent movement.

Cars for grain or flour should have tight flooring, sides, ends, and roofing, should be clean and free from odors. For merchandise not susceptible to immediate damage, the roof must be free from leaks but ordinarily not to the same extent as a car loaded with grain, flour or cement.

For coarse freight loading, such as lime, ingots, spelter, pulpwood and commodities not affected by weather, the body should be in fair condition.

Open-top equipment in ore loading districts must have special inspection to ascertain whether sides can withstand the lading, and hoppers and attachments should receive rigid attention for defects. All other equipment of the hopper or gondola type for general utility loading may be inspected on the ordinary interchange basis.

Inspection, however, represents only one-half of the work. If proper repairs are not made after located, the inspection is merely a waste of time.

Repairs That Can Be Handled By One Carman—One Carman can handle such work as: tightening loose nuts on bolts or rods on all parts of car body or trucks; nailing loose boards on body of car and tightening screws in running boards; patching holes in decks, sides, ends or roof; (Note: Patch work is not a recommended practice and is money wasted; it is the good solid repairs that a car receives which increases the life of the car as well as makes it possible to keep the car in service daily); replacing worn or broken knuckle pins, brake shoes, brake heads, brake-shoe keys, journal brasses,

knuckles, springs, follower plates, lug castings, lug straps, operating levers, chains, brackets, arch bars, couplers, etc.; making light repairs to door tracks, door stops, door hasps, etc.; taking up slack in brake rigging, repacking boxes, replacing missing cotter keys in key bolts, brake staffs, clevise pins, operating rod attachments or in any style of bolt or rod where a cotter or split key is used; replacing defective or missing air hose and angle cocks, and repairing broken train lines.

In other words, the repairs to which a Carman should devote his time, should as a general proposition, be of a light nature; a class of work that could be handled by one man unaided by a blacksmith or carpenter; and would consist largely of work necessary for the safe movement of cars and contents.

Knuckle Pins.—To replace a worn or broken knuckle pin simply drive the old pin out of the coupler head and replace it with a new one.

Brake Shoes.—Brake shoes are renewed by removing the key, if there is one, in the brake head and inserting the new shoe in the slots in the head, then replacing the key, being sure that the key engages both shoe and brake head; otherwise the shoe will drop out and the brake beam may fall to the rail, if not properly supported.

Repairs to brake beams which necessitate new parts should not be made under a car. The beams should be sent to the repair shop where proper gaging and tension and deflection tests may be made after new parts have been applied.

Journal Brasses—This subject will be discussed under the heading of hot boxes in a later chapter.

Renewing Knuckles—While the operation of

renewing knuckles differs somewhat in different couplers, the principle is the same in all. The car must be uncoupled if in a string, and enough opening obtained to permit a person to work in front of the coupler. The knuckle lock is raised, the knuckle pin removed and in the majority of cases when the knuckle is turned toward the open position it will fall out of the coupler. To apply a knuckle the operations are simply performed in the reverse order.

Renewing Springs or Followers—To renew springs or followers on either the single or tandem spring gears the coupler pocket must be lowered to allow the plates or springs to be removed. This is done by removing the nuts from the lug strap bolts, and loosening the carrier iron bolts. The pocket will drop far enough to allow the broken parts to be removed and new ones applied. The pocket is then jacked or raised into place and lug straps replaced and nuts tightened.

Renewing Lug or Draft Castings—To renew a broken lug casting the coupler and attachments are removed, and after cutting off or removing the lug bolt nuts the broken pieces are removed and a new solid casting is bolted in place. The coupler, springs and followers are then replaced as described.

Lug Straps or Gland Straps—To apply a gland strap, a jack is set on the coupler pocket to raise the springs and followers up in the lug castings, and the strap is slipped over the lug strap bolts. The nuts are then applied. A wrench to finish tightening the nuts can be used to better advantage if the jack is then let down and taken out of the way.

Repairing Arch Bars—To repair a set of arch bars the weight of the car must be taken from the truck.

Then the car should be placed on trestles as it may take several hours to finish repairs of this nature, unless it is a system car and such repairs are carried in stock.

Using trestles not only makes the car more secure, but leaves the jacks free to be used for other repairs, should they be needed. On certain types of cars, such as tank and self-clearing dump cars, it is not necessary to run out the truck as these cars have sufficient clearance above column bolts to permit their removal; while on other types it is impossible to jack them high enough at one setting to remove column and box bolts. To hold the bolster and sand plank in place, a chain is placed around the bolster and sand plank, and both are raised slightly to remove the bottom arch bar. The broken or bent parts can be removed by taking out the two column bolts and all four box bolts.

To apply again, the bottom arch bar is placed in position first, the top arch bar next and the tie bar or stretcher strap last. Before allowing the weight to rest on the truck, all journal boxes should be examined to see that brass and wedges are in correct position.

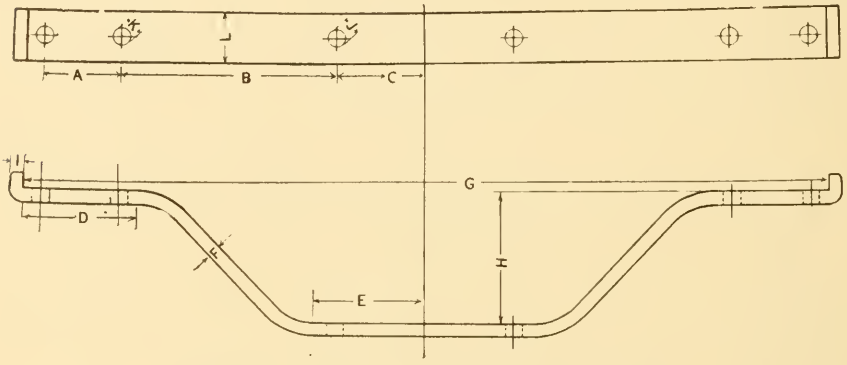
At outside car repair points some roads supply blue prints as shown in the sketch with the brief instructions regarding arch bar repairs mentioned below given on the print.

"Inspectors in ordering arch bars by wire or letter will be governed by this sketch, following each letter with the dimensions between the point indicated by the arrowheads:

"Example:—Send one lower arch bar for B. & A. Box No. 1032. 60,000 capacity A-8", B-17", C-9", D-11", E-10", F-1", G-5'-9", H-10½", I-No lug, J-15/16", K-1 3/16", L-4".

"Any unusual shaped arch-bar not covered by the sketch would require further explanation or special sketch."

Tightening Column Posts and Oil Box Bolts—Tightening bolts on trucks is an important operation from



Sketch Used for Ordering Arch Bars

the standpoint of safety, and it is an operation which can be handled economically by one man. Because the Carman can do the work from the side of the car, it is an operation carrying with it little risk. The principal trouble experienced in tightening the nuts is that the bolts turn. This can be prevented by placing a wrench, or a specially designed cap fitting over the arch bar and head of bolts in a manner which will hold the bolt from turning. Accidents sometimes result from this operation because the wrench, which is placed on top of the bolt, slips and strikes the Carman. It is essential, therefore, that the wrench be so placed on the head of bolt that it will not slip; and if it does, that it will hit the wheel or body of the car.

Sometimes box and column bolts will twist off when tightening them, necessitating renewal. On heavily loaded cars, or where it is not possible to jack the car,

the bolt may be removed by cutting off the head, digging a hole in the ground, and removing the bolt from the bottom instead of the top.

With autogenous welding, where nuts twist off or heads snap off of bolts, it is possible to weld on a nut without removing the bolt. Of course this would not be possible at a small point. Carmen should remember that kerosene poured freely on nuts or bolts soaks in around the threads and tends to loosen the nuts, making it possible to remove nuts which seemingly are immovable.

Where possible, the threads of oil box and column bolts should be of sufficient length to draw the arch bars up to their respective positions. If the threads are not long enough, the bolt should be removed and the thread run back. As a makeshift, however, washers can be used to offset the lack of thread. All oil box and column bolts should have some form of grip nut applied. A square box wrench made from spring steel is a very satisfactory wrench to use in tightening up bolts, because it is light and strong, although the S-wrench is the more common type.

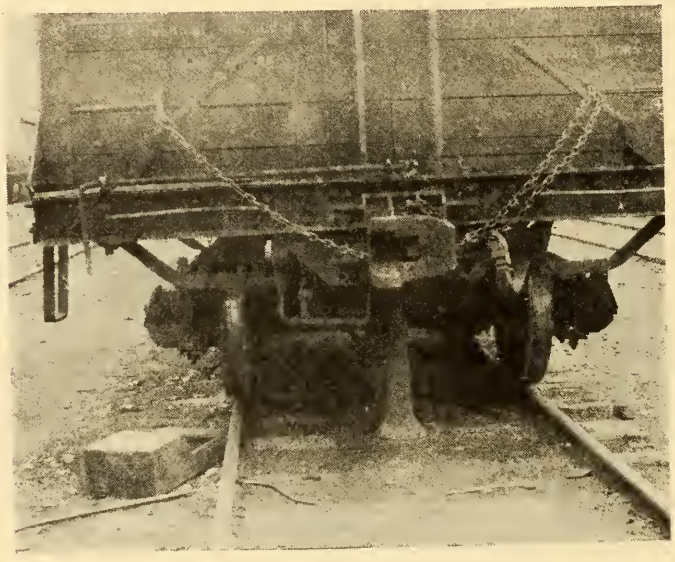
Renewing Riveted Coupler—In renewing couplers the operation depends upon the type of draft gear and attachments in use. There are two kinds of yokes, riveted and keyed. To renew or replace a coupler with riveted yoke, both coupler and yoke must be removed from the car and a good coupler and yoke of the same size applied in its place. This is difficult work, but in an emergency can be done by one man.

To renew a coupler with a riveted yoke, first, disconnect the pin lifter from the knuckle lock; remove all

the nuts from the carrier iron bolts except one on each side of the coupler shank.

Second. Remove the tie plates, etc., under the yoke and other parts depending, of course, on the kind of gear.

Third. Remove knuckle and using a bar in the end of the coupler—bear down until the lug straps can be removed, then let the end of the yoke rest on a plank, of which one end rests on the car axle, the other end on the ground.



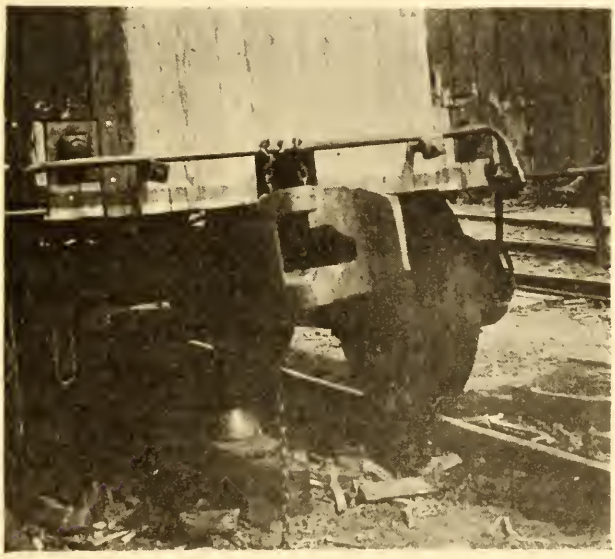
One Way to Chain a Coupler for Swinging

Fourth. Raise the coupler body, remove the carrier iron and let the coupler rest on the board and slide it from under the car.

To replace the coupler and yoke lay them on the board and slide them up onto the axle and into position to raise; when ready, lift the coupler into place and apply the carrier iron; or hang the coupler on a light chain

suspended from the operating lever or the carrier iron bolts in the deadwood. Next place a draw bar jack on the yoke and raise it to the required height in the sills or use a bar and bear down on it, as in removing the coupler. The lug straps and tie plates are again applied and the jack removed to allow a wrench to be used in tightening the nuts on these parts. Replace the pin-lifter chain or connection to the knuckle lock.

Renewing Keyed Coupler—To renew a keyed



Chaining a Coupler to Operating Lever When Changing

coupler is much simpler. It is only necessary to remove the coupler key, the carrier iron and then the coupler, the yoke remaining in place. To apply the new coupler, enter the shank squarely in the sleeve and replace the key and carrier iron. On some types of cars the removal of the carrier iron is not even necessary, as enough room will be found between the carrier iron and end sill to give the coupler a quarter turn and slide it into place.

This depends, too, on the size of the butt of the coupler.

Light Repairs to Side Door, Tracks, Door Stops, Door Hasps, Locks and Guides—The repairs at this point consist mainly of tightening nuts on door-track bolts or applying new bolts where broken. Renewing broken door stops is work that can be done to better advantage at larger repair points, as that class of material is not usually kept on hand at smaller points.

The application of door hasps, locks and guides is work that can be done here if the Carman's duties are such that time permits. To renew a door hasp the bolt is removed from the door hasp hook and the broken hasp taken off; then the hook and hasp are replaced and bolted again. Door locks and guides are removed in like manner. On some types of cars the door lock is bolted to the door stop and must be removed to renew the lock.

Taking up Slack in Brake Rigging—This subject will be taken up in detail in the chapters on air brakes and brake rigging. It is an important item of repairs.

Repacking Boxes—At this point where the Carman is stationed alone, not a great deal of time, perhaps, will be found to repack boxes except those absolutely demanding attention. It is important, though, that where possible every box on every car be examined, dirty and worn out packing removed, and good packing stirred up in the boxes and brought up to the journals. The use of a packing which is more permanently resilient than the ordinary wool and cotton waste will reduce this work.

If every Carman could repack the boxes on one car complete every day, there would be over 90,000 cars repacked each day. This would help to relieve the hot box situation.

Replacing Missing Cotter Keys—By carrying a few different sized cotters on a wire, or in the pocket, the Carman can replace many missing keys. Simply driving a self-spreading cotter into the pin, brake mast or hanger bolt completes the repair.

Missing box-bolt nuts have become so prevalent even though the bolts are drilled for cotter keys that particular stress is laid on the importance of giving this matter close attention. Men on light repairs and running tracks should key these bolts, if they have a hole, opening keys properly. If there is no hole for a cotter or spring key a locking nut should be used to protect the nut.

One-inch bolts should always be used with journal boxes on the Fox trucks as the yoke and frame are likely to break and cause a wreck without their use.

Repairing and Replacing Defective Air Hose, Angle Cocks and Broken Train Lines—In renewing missing air hose, the new hose is screwed into the angle cock and tightened snugly with a wrench. When set to correct position, the coupling of the hose should point toward a central line with a vertical plane of the outside edge of knuckle and center of coupler with knuckle open. This will insure a correct coupling and avoid twisting the hose and causing undue wear on gaskets.

To change an angle cock, turn the angle cock handle at right angles to the brake pipe. Remove the air hose and turn the angle cock handle in line again. Next remove the angle cock from the brake pipe and replace it with a good one. Screw it on tight, being sure that none of the threads are crossed. When set correctly, at an angle of 30 degrees to the right from center vertical line of brake pipe, the air hose will couple properly.

In repairing broken train lines the methods of work depend largely upon the location of the broken parts; one Carman will usually be called upon only to repair that most frequent and simple break, one at the angle cock nipple.

On a great many roads it is common practice to place a 10 or 12-inch nipple immediately back of the angle cock to facilitate repairs when breaks occur here. Assuming that the train line is broken at the coupling between the nipple and brake pipe proper and that the threads on the nipple inside the coupling have been damaged proceed as follows: Loosen the pipe clamp, remove the air hose, angle cock, nipple and coupling. If threads are good on brake pipe, apply a new coupling and a new nipple, and replace the angle cock and air hose; tighten up all joints and be sure that the clamp is secure and in proper position. A flexible protector of proper design will greatly decrease the frequency of nipple end defects.

The subject of further repairs to air brakes and brake rigging will be covered in later chapters.

Material Required at One Man Station—The stock of material carried at this point should not be large, but should be neatly and compactly arranged under shelter and in suitable bins. It should include air and signal hose and gaskets; 1¼ angle cocks and ¾ and 1¼-inch cutout cocks and extra handles for all; bolts ranging in size from ⅜ by 2 inches to ⅜ by 7 inches for repairs to doors and door track; other bolts in ½, ⅝, ¾, ⅞, 1, 1⅛, 1¼ and 1½-inch sizes in suitable lengths to take care of repairs; a stock of nuts from size ⅜ inch up to 1½ inches; brake hangers, pins, shoes, keys, ratchet wheels, brake wheels, brake masts, beams, levers, rods

and guides; a few of each size of brass and wedges; couplers with and without pockets; knuckles, pins and locks; car chains; steam hose and extra gaskets; various pipe fittings and nipples; castings such as draft lugs, journal boxes, column castings and guides; truck springs; door hooks, hasps and locks; draft springs, follower plates and lug straps; grab irons, sill steps, operating levers, clevises, pins, links, lag screws, operating castings and cotter keys in several sizes; a small stock of lumber, such as roofing, siding, lining and a few pieces of dressed pine of 8 or 10-inch width for patching floors and boarding doorways; a supply of car paint and nails and a small stock, at least one pair, of mounted wheels of each size journal for emergency cases.

Tools—The tools for the Carman should cover all special wrenches necessary for certain special service cars which may be assigned to his district, and tools such as 2⅛-inch wrenches for Cardwell Friction Draft Gear, S-wrenches from ⅜ inch to 1⅜ inches (the 1⅜-inch being the wrench for the column bolts on 100,000 capacity cars), 10-inch and 18-inch pipe wrenches, 1¼-inch Calumet die starter, 12-inch monkey wrench, cape chisel, flat chisels, round-nose chisels, diamond-point chisels (for cutting out broken pipes in angle cocks, etc.), wood chisels, 2 hammers, 2 saws, screw driver, nail puller, 8-pound sledge, steel drift pins (various sizes), nail set, 25-ton journal jacks, two 50-ton car jacks, one draw bar jack, two sets packing irons and packing hooks, packing bucket, inspector's lantern, blue flag, blue lantern, pinch bar, assorted size blocking, chisel bar, tool for removing air hose gaskets and center punch.

CHAPTER IV.

POINTS WHERE A SMALL FORCE IS EMPLOYED

In the foregoing chapter, the Carman's work and methods of inspection and repairs are dealt with under somewhat limited conditions. Without help and having both the inspection and repair work to do, it is impossible for the Carman to engage in extensive repairs to any except light, bad order cars; or what are frequently called inspection or running repairs, such repairs as require less than one hour actual labor.

In this chapter we take up his work under better conditions, for many hands make light labor; and at this point a small force of men, possibly eight including the foreman, are employed. We will assume that the standard eight-hour day is being worked and the force is divided as follows: Foreman and three men on duty 8 A. M. to 4 P. M. and two men on duty each of the other shifts.

The hours of work should be arranged to suit the station as there may be certain times during the night that only one man is needed on duty. The foreman must use his best judgment in these matters.

This point we will assume is a watering station where all trains, both freight and passenger stop possibly 5, 10 or 15 minutes. It may be a meeting point for local freights and switch runs and a few industrial plants are likely to be located here, and we assume it is a good grain country.

Under these conditions there will be plenty of work for all and a small repair track will be set aside for the

use of the Carmen. This track should be straight, level and with a good gravel ballast covered with cinders and suitably drained. It should be long enough to hold six cars with cuts of 6 to 10 feet between, and should clear all other tracks at least 8 feet between car sides so that men can operate jacks and work without danger of being struck by passing cars or engines.

Inspection for safety will be given all freight and passenger trains and if time will permit light repairs may be made such as box nuts, brake shoes, keys, clevises, etc. Any serious defects should be reported to the train crew and request made to set the car out for repairs or transfer as the case may be. Local freight and switch trains remaining for several hours at this point offer an excellent opportunity for careful inspection and further light repairs and repacking of boxes.

The trains of course, must not be delayed or flagged, that is, using the blue flag; and repairs should be confined to those parts of the car outside the rail or only in places where the Carman will be in no danger while making repairs. The subject of light repairs and methods of doing the work has been covered in the previous chapter and we will pass on to a class of work that is usually done on the repair track where more help is provided.

The following defects may be repaired at a repair point of this size very satisfactorily, missing or broken brake-beams or brake rigging, car body in need of trussing, missing or broken truck springs, cars off center, defective wheels, broken grab irons, sill steps, side ladders either wood or metal, running boards, missing draft bolts, center plate and box bolts, shifting and transferring loads; these in addition to other repairs

of a lighter nature which were covered in the preceding chapter.

By working in pairs the work is made much easier and is more quickly performed.

Repairing or Replacing Missing or Broken Brake Beams or Brake Rigging—When a car is spotted for repairs or renewal of brake beams, the repair man must determine whether new beams are necessary or whether that which is broken can be repaired. If only a head or a fulcrum is broken, the beam may be taken down and new parts applied if they are in stock or if they can be obtained from scrap bins. But if the body is badly bent or broken, a good beam should be applied in place of the broken one.

Second-hand material should always be used in making repairs to delivering-line defects, except on the authority of a defect card. In the latter case new material should be used as bill can be rendered for it. In the case of the repairs, "one missing and one broken beam," two secondhand brake beams that are standard to the car should be used. One beam will be a right hand and one will be left hand. Standing behind the beam and assuming that the truck lever is in place, the side to which the top of the lever leans, marks the beam right or left. This is a universal understanding among all brake beam companies and repair men.

To apply the beams, assuming that all hangers are in place, note the location of the free end of the floating or cylinder lever, (if the top brake rod is missing) and proceed to hang the beam nearest the center of car first; being sure to get the right throw of the fulcrum to make proper connections. Now apply the opposite beam and both truck levers and connect the truck dead

lever to the dead lever guide. The bottom connection may now be applied (if the beams are inside hung) making sure that both truck levers stand at an angle of 30 degrees toward the truck bolster.

Measurements may now be taken for the top connection rod after pushing the cylinder lever back firmly against the brake cylinder. This insures a piston travel that is not excessive. Both brake beams should be pulled up snug against the wheels when measurements are taken. After all connections are made, suitable cotter keys should be applied to all pins. Brake should be tested and piston travel adjusted if air is available.

Trussing a Car Body—A car body may be trussed up in two ways: (1) Set jacks in the center and take the weight of the car, then with truss rod wrenches tighten the nuts on ends of rods: (2) Tighten the turnbuckles in the center of the truss rods. A specially designed, long handled wrench, the handle end made from double strength pipe, makes an excellent wrench for tightening truss-rod nuts.

A specially designed ratchet wrench is a good tool for tightening the turnbuckles; it is possible to use a bar, but very inconvenient.

Renewing Truck Springs—Where the roadbed is soft, truck springs require frequent renewals. While it is possible to fill in with blocks instead of renewing the springs outright, this makeshift causes additional strain on the truck parts. Besides, permanent work should always be done if at all possible. Temporary work at the very least must be DONE OVER and MAY result in additional damage to other parts of the car. In removing the spring, jacks should be set at each side near the end of the car, and a chain should be

placed around the truck bolster and transom or body bolster; then as the car is raised, the truck bolster also raises and frees the spring, which can then be removed and a new one inserted.

While the above method is the recommended practice, the spring may sometimes be removed by setting a jack under the end of the bolster. Usually there is little chance of getting a hold on the bolster and setting the jack securely enough to do this.

Car Off Center—Cars off center may be replaced by setting jacks under each corner at one end of car and raising the body until the truck can be placed in position. Sometimes the car body will have shifted out of line with the center line of track, and it is then necessary to move the car body. This may be accomplished by setting the jack against the rail at the bottom with the top resting against the coupler or draft timbers, and jacking the car into proper position. Or a car may be set over by simply tilting the jacks in the direction opposite to that the car is to be set over; and when weight is taken the jacks simply straighten up and the car body moves over.

After a truck is moved in proper position in relation to the center plates, the center pin (or king pin) should be applied. The Carman must keep his hands from between center plates to prevent injury in case the jacks slip.

When a car is knocked off center, the center pin is usually bent and it is necessary to straighten it before it will enter the bolster. The autogenous welding method can be used to heat the pin, and straighten it; but we do not always have this, neither do we always know the contents of the car, and whether it is safe to

use the flame. A method practiced by many is as follows: A heavy box wrench or a heavy wrench opening at the side is hooked onto the bolt, one end of the wrench is rested on the block or truck, the weight of the car is let down and the center pin will straighten out.

Carmen at this point may never be called on to handle the above operation but if a car is knocked off center, it must be repaired before it can be moved. Things of this kind are continually coming up where the Carman is called upon to do that for which he is poorly equipped in tools and materials. As a rule he works his way out with little assistance, accomplishing results with the most antique class of tools. His training sharpens his thinking capacity and he evolves ingenious methods of doing work.

Closing Hopper Doors—The drop bottoms of loaded coal cars are sometimes left carelessly or improperly fastened and blocked. If it is not possible to put the locking device in its correct position, and if the drop bottom cannot be blocked so as to guard against loss of lading, the car should be held for instructions, which no doubt will order a complete transfer of lading or of a sufficient amount to permit the closing of the doors.

Carmen should realize that there is a certain amount of deterioration when transferring lading. Many of the companies customers (especially coal consumers) refuse lading after a transfer. With this fact in mind the Carman will appreciate the importance of, at times, resorting to other than standard methods, if by so doing he can save money for the company.

Changing Wheels—The job of changing wheels

varies in detail with the kind of truck upon which the work is done and upon whether the pair is "inside" or "outside" as we express it.

Before raising the car from the truck be sure that the wheels on the opposite truck are securely blocked both ways to prevent the car moving; the action of the jacks moving the car upward tend to draw it toward them.

More arch bar trucks are in use today than any other type. For applying a pair of "outside" wheels in this truck a space of 8 ft. at the end of the car is necessary. Set the jacks on secure blocking at the body bolster and raise the car high enough to clear the wheels on the end sill as thy are rolled out. Remove the packing from the journal boxes and remove the box bolt nuts. The box bolts may then be lifted or driven out, and a small screw or brass jack placed under the sand plank or column casting on each side of truck near the wheels that are to be removed. The weight of the truck is then raised from the journal boxes allowing about ¼-in. clearance.

The wheels may now be run out with the journal boxes on the axle. Next remove the journal boxes, brasses and wedges and clean the boxes out thoroughly. The wheels may now be removed and taken to the scrap track. A record of the wheels and axle should be made showing the following information:

Date Month Day Year
Car Number Initial Kind End
Location of wheels, viz: R&L 1-2-3-4.
Why removed, viz: Cut journal, worn thru chill, etc.
Maker of wheel—date cast—shop number.
Initial of road shown on wheel and wheel number

together with any other special markings which may be found.

The record of the axle removed must show:

Whether M. C. B. standard or not.

Size of collar.

Diameter of Journal.

Length of Journal. Show the smaller dimension where two are accessible.

Diameter of center of axle.

Diameter of wheel fit.

Length of axle overall.

A similar record should be taken of wheels applied.

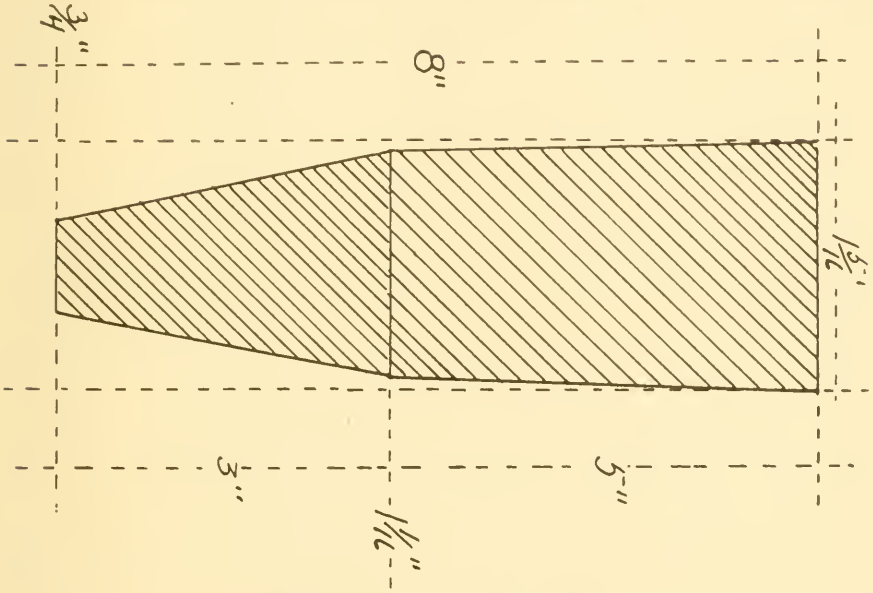
The journals on the old pair of wheels should be painted with a coating of car oil and graphite to preserve the finished surfaces. Some roads take extra precautions by using circular pieces of tin, old galvanized roofing or some other rust preventative as an added protection against damage to journals.

In applying the new wheels after they have been placed upon the track opposite the truck, clean the journals thoroughly and see that they are free from rough spots or seams; place the journal boxes on the axle and apply the brasses, first having given the brass a coating of oil. This will preserve the finished surface of the bearings and furnish lubrication until the car has moved far enough to draw oil from the waste in the box. The wedge is next applied and the wheels are ready to be placed in the truck.

Holding the journal box level, the wheels are rolled toward the truck, entering the journal box between the arch bars. When in the correct position, the box bolts are driven down and nuts drawn tight. The boxes are then repacked with good packing and the car lowered

to the trucks, making sure that all wedges and brasses are in proper place.

The illustration shows a very handy tool for lining



Drift pin for lining arch bars.

box bolt holes in arch bars that are slightly sprung. Every car repairer knows that, in trying to enter the bolts through the two arch bars and journal boxes, if the holes do not line up right, it is impossible to line them up without destroying the threads on the bolt. By driving this drift pin in the outside hole, the arch bars are lined up and will remain so while the bolt in the second hole is applied and tightened. The drift may then be removed and the front bolt applied.

Changing Wheels in the Fox Truck—This truck is better known as the pedestal truck having a solid truck side, and we will assume that the wheels to be changed are the outside pair. Before raising the car from the truck, two light chains are passed from the body bol-

ster round the truck side, just ahead of the cross bearing on each side, drawing them tight. Next remove the packing from the boxes, remove the two pedestal bolts, and the spreader castings. Jack the car up. As the car raises, the truck sides come up with it, and by the time the pedestals will clear the journal boxes, the wheels will clear the end sill.

The balance of the operation is the same as for the arch bar type trucks.

Changing Wheels in the Bettendorf Truck—In this type of truck the journal boxes are cast integral with the truck sides and there are no arch bars. In a change of wheels this truck must be run out and a space of 12 ft. is necessary to work in. The car is raised to clear the wheels and the top brake rod is disconnected. The whole truck is moved out far enough to permit working on all four boxes and the packing is first removed after which the brass and wedges are taken out of the boxes.

The truck springs are removed and the sand plank blocked up just inside the rail. The truck sides, if not rusted fast, can now be lifted off over the ends of the journals, using jack bars or something similar under each journal box at the same time. Sometimes the parts get stuck or rusted together. It is difficult to loosen them if this has happened and hours are sometimes wasted. The entire truck is dismantled and rebuilt in this operation.

Changing Wheels in the Vulcan Truck—The Vulcan truck is a cast steel truck, built along pedestal lines. The journal box is fastened to the truck frame by the interlocking of the frame and box and a horizontal bolt through the two castings at the top of the box.

The change of wheels is similar to that of the pedestal type but much quicker. Before raising the car body, chain the truck sides to the frame of the car ahead of the body bolster, if the wheels to be removed are the "outside" pair. If not, do not use a chain at all but jack the car to clear the truck, remove the center pin and brake connection pin, and run the truck out after placing suitable trestles under the car. There should be at least 8 ft. clearance between the truck and car.

Remove the packing from the boxes, remove the journal box bolts, and set a track jack on each side just back of the journal box on the frame. Raise the frame to clear the boxes and run the wheels away from the truck to remove the boxes, brasses and wedges. The wheels may now be taken to the scrap track and new ones brought to replace them.

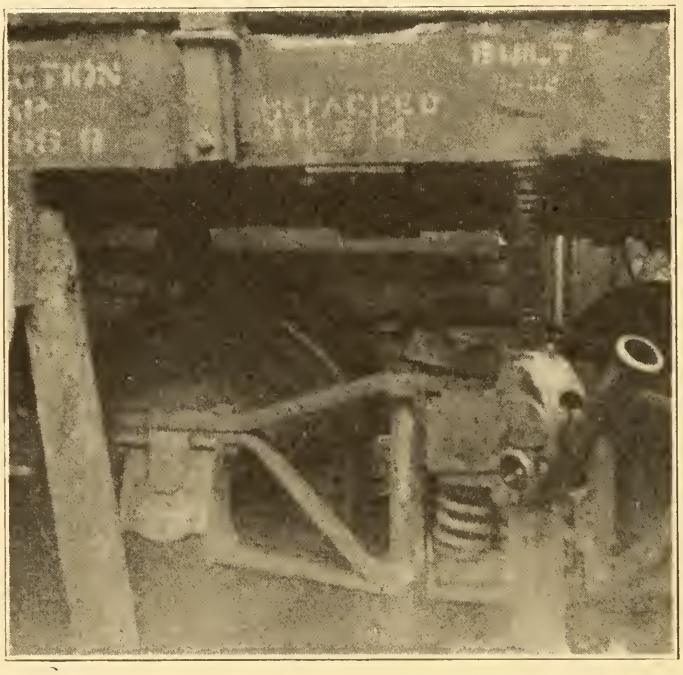
After the good wheels have been placed on the rail be sure they are in line with the truck before applying the journal boxes. Apply the journal boxes, brasses and wedges and hold the box level while the wheels are rolled into position. Now lower the two track jacks, apply the two box bolts and repack the boxes. Run the truck under the car and let the car down after which the brake rigging may be connected again.

The thing to remember is, keep everything clean, and be sure that all parts of the journal box are in correct position before leaving the car. Many hot boxes have been caused by repairmen not looking to see if brasses and wedges were in the proper place.

Jacking Up Cars for Repairs—After raising a car on jacks the only safe practice is to set a trestle under the car and lower it until a proportion of the car's weight rests on the trestle. Then if the jack fails to

sustain the weight imposed on it, the trestle will hold the car steady.

Wheels—There are two kinds of car wheels in use at the present day; chilled cast iron wheels and steel wheels. There are three types of steel wheels; the cast



Trestles for Supporting Cars

steel wheel, the forged or rolled steel wheel, and the steel-tired wheel. The last mentioned is gradually becoming a thing of the past. The chilled iron wheel was the first used, and is still used more than any other on account of its low first cost.

Wheel Failures—Wheel failures or defects which justify renewals are as follows:

Sharp flange or worn flange, shelled out, burnt chill, either from sliding or from brake application, worn tread, worn through the chill, chipped flange, chipped

rim, etc. The most common causes necessitating removal are worn flanges; next, worn tread, tread worn hollow; then, brake burn, brake slide, shelled out, worn through tread and cracked flanges.

Worn flanges are often caused by mismating of wheels when first mounted. Wheels should not be mounted on an axle when tape size does not correspond. A truck out of square will also cause sharp flanges. Side bearings exert an influence on sharp flange wear. If the car rests heavily on the side bearings, the truck is not able to adjust itself readily to the tracks. Too much space between the car body and side bearings will cause the car to sway. This is bad on the truck, axles, wheels and rails.

Brake Burn or Burnt Chill—A wheel which is brake burnt is distinguished by cracks across the tread of the wheel. Sometimes they are only hairlines, but in other cases there is a distinct separation of the metal 1/16 inch or more in width. This is caused by a long brake application heating the tread of the wheel.

Chipped Rims—This occurs from the wheel tread being worn hollow, the high part of the rim striking on switch frogs or switch points, breaking off the rim of the wheel.

The heating of the treads is also responsible for cracks occurring in flanges, particularly so if the brake shoe crowds against the flange of the wheel, the flange not being large enough to carry away the heat, causing unequal expansion.

Shelled Out—A shelled-out wheel is one where the metal of the tread has shelled away from the center, leaving it higher than the surrounding spots. Often a

burnt chill is reported as a shell-out, but there is a decided difference in the cause.

Cracked Plates—Cracked plates are caused by expansion of the wheel tread through heat generated by the brake shoe. The heating of the tread produces a strain on the wheel at the juncture of the front and back plates.

Brake Slide—A brake slide can do more damage to the equipment and the rails than any other wheel defect. It generally ends the life of the wheel. Worn through chill spots have a close resemblance to brake slides but are easily distinguished. The brake slide will have a flat spot with more or less sharp edges, whereas worn through chill will have the edges worn over or rounded, leaving no well defined flat spot.

A common cause for brake slides—and the causes are numerous,—is defective brake rigging due largely to lack of inspection of the air brakes.

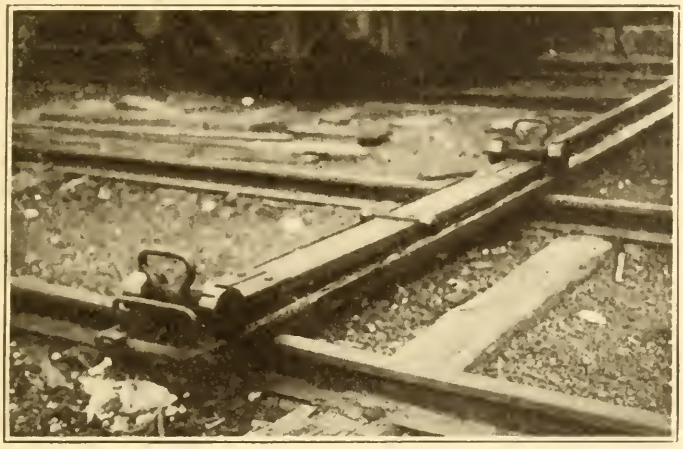
Wheel Transfer—In changing wheels at any repair point, wheels removed must be shifted before new wheels can be applied. Ordinarily this is a big job.

The accompanying photograph gives an idea of how wheel transfers can be made quickly from one track to another with but little labor. The device is made of two 2x3 inch boards of sufficient length to lay across two tracks and extend 6 inches beyond each outside rail. These boards are lined top and inside with angle iron and they are securely fastened about 8 inches apart. At each end there is an iron handle extending upward, for carrying the shifter from place to place.

On these boards is placed a truck having four small wheels. When car wheels require changing the transfer is laid across the rails. Wooden wedges are placed

on the rail against the strips, and wheels are rolled onto the low-hung cart. Wedges are then removed and the cart is pushed to the other track where the wheels are run off. The cart is also supplied with grab irons at each end for easy removal.

Applying Draft Bolts—Drafts bolts are those which fasten the draft timbers to the center sills. They vary



"Wheel Shifter"

in size from ⅞ to 1⅛ in. and in length from 13 in. to 21 in. Ordinarily the repair man knows the draft bolts to be ⅞ by 18 or 19 in. according to depth of sills and timbers.

These are often broken in wooden underframe cars, and if loaded the car is sent to the repair or transfer track. The load must be shifted if it covers the bolts, and the stubs driven out and new bolts applied. Assuming that the car is loaded with merchandise, and the car has been switched to the dock for shifting the load, the boxes that are in the doorway are moved out and a pathway cleared through the center of the car

down to the end. Center plate bolts should be renewed at this time if broken. The load is again replaced and the car locked and sealed.

Transferring Loads—There is no operation in car work which requires any more thought than that of transferring loads and this duty usually falls on the Carman, either to personally do the work, or to supervise it.

Transferring can be greatly reduced by investigation. On one railroad a study of the transfers on lumber and logs showed that a big percentage of this lading was loaded on cars of light capacity so one hand brake could not be operated, and so that the weight was improperly distributed. Before the car could move from the first inspector's station, a rearrangement of the load was necessary.

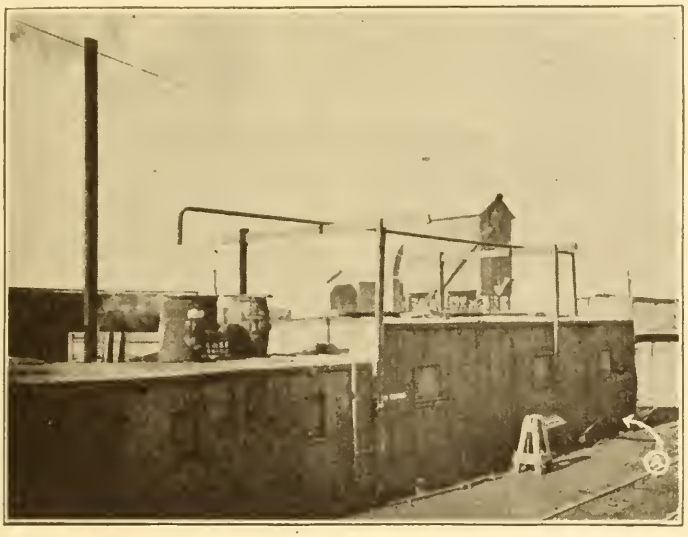
Again it was found that in order to cut down the number of bad order cars at a certain terminal, the B. O. tags were removed and the cars permitted to move to the loading district in such condition that when loaded and returned, they required repairs which necessitated transferring the contents. It must be remembered that it is better to delay an empty car and put it in a safe and serviceable condition rather than to delay a loaded car.

Instructing Shippers on Proper Method of Loading Cars—The rules for loading should be placed in the hands of each and every shipper, agent and Carman. If only one or two transfers can be saved by educating those concerned on the proper method of loading cars, they will pay for the circulation of the standard rules for lading.

On one division of a railroad operating in a lumber

territory a man was put on the road to instruct the loaders as to the proper manner of loading logs, long poles, etc., so that the cars could be moved safely and be acceptable at all transfers.

Transferring Long Poles—Long poles are loaded on single cars or on two cars with an idler between them. With this class of lading the logs or poles may be chained together and rails put under the ends. By



For Transferring Oil

means of heavy jacks the load is raised and the cars can be transferred or changed end for end in such a way as to correct the improper loading.

Lumber in box and stock cars may be transferred by passing the lumber through the ends of the car.

Where loaded coal cars are bad orders it is sometimes found cheaper to buy the coal and set it on the local coal chute than to pay the cost of transfer, and an added expense occurs for the reason that the de-

terioration in value through transfer must be paid by the railroad company.

Various methods are used in transferring loads in open cars, for instance mechanical hoists of the portable or stationary design.

Transferring Oil—Occasions frequently arise when, through defects, oil must be transferred from one oil car to another. At most points the methods are so crude that the car repair force would rather handle any other load than that of oil.

One railroad makes the exchange in the following practical manner. A shed containing a force pump run by steam stands beside the transfer track. The defective car is spotted near the end of the shed and a connection is made at pipe fitting "A" shown in view. The car to receive the oil is then switched behind the first car and the long horizontal pipe resting on the wooden supports over the shed's roof, is swung over and connected to the second car. The pump is then started and the oil is forced from one car into the other.

Repairing Broken Side and End Ladders—Many wooden cars are being equipped with metal side and end ladders. In repairing these appliances, the United States safety appliance laws and specifications governing their application must be conformed to, at the same time maintaining the standard of the car.

At small outside points it is impossible to keep on hand a stock of metal ladders, and where a metal ladder is raked or cornered and is unsafe, it should be replaced with some grab irons or a wooden ladder and the car sent to a larger terminal for proper repairs. The standard of safety can be maintained in a wooden lad-

der, and if the car is loaded, will pass all interchange points if properly carded with a defect card.

Repairing Running Board—In repairing a running board, material standard to the car should be used if possible. The use of smaller sizes not only constitutes wrong repairs, but it decreases the strength of the original structure and should be avoided. All parts must be fastened with screws of suitable length and size. No dimensions are given in the safety appliance specifications as to the size to be used, but it is common practice to use 4 inch No. 20 for fastening saddles and 2 in. No. 14 for securing the running board to the saddles and blocks. They may be set to within 1 in. of the surface with a hammer and the balance of the distance with a screw driver or air motor.

Taking Records of Repairs—In each case of repairs a clear record should be taken which will give the following information:

Date Month Day Year

Also car number, initial or name and kind, the end on which repairs are made, and whether new or second hand material was applied. Do not fail to show all information requested in M. C. B. rule No. 8.

CHAPTER V.

THE INTERMEDIATE TERMINAL

Intermediate Terminal and Repair Point Defined—An intermediate terminal is one having limited shop facilities and located at a point midway between two larger terminals which have complete shop equipment.

Experience is the best teacher. The Carman at the small repair point, however, may learn much about repairs at a larger point through reading. And when he, through study of the work, is promoted, he is in position to grasp the lessons of experience much faster than he who is uninformed. Even to the Carman who knows, reading gives a more thorough foundation and leads to the development of new and still better methods.

Train Yard—This being a terminal, large yard facilities will be required for handling cars and switching trains. The force of Carmen in the yard will include inspectors, oilers, safety appliance and repairmen and air brake inspectors.

Inspection of Incoming Trains—Some authorities question the need of incoming inspection except to facilitate movement of cars at a point of interchange.

Others claim that cars should be thoroughly inspected upon arrival at any terminal and again when placed in outgoing trains. Certainly the cars cannot be watched too closely, but the aim should be to reduce inspection costs through proper repairs and the care of journal boxes, oiling, and stirring up the packing. If through this book, the importance of lifting the packing in each box at *every* terminal, can be emphasized to all Car-

men, in such a manner that a campaign will be started to prevent hot boxes, the efforts of the author will have been well repaid.

Light Bad Order Tracks—At this terminal there should be tracks set aside in each yard, assuming that there may be two or more as at a junction point, for the repairs to light bad order cars, which do not have to go to the repair track or shop; but which cannot be repaired in the train yard. These light bad order tracks would be used for cars having the following defects: Broken journal boxes; bent or broken grab irons or operating levers; bent, broken or missing brake beams on rush cars such as meat, perishable freight, grain and merchandise; bent brake masts and other hand and air brake defects; renewing box bolts and column bolts and replacing loads shifted at side doors; to relieve as far as possible the repair track proper of this light repair work.

The inspection at this point should be careful and thorough, especially if only an incoming inspection is given, as cars are often made bad order by a little rough handling on the part of the switch crews. With the exception of "hump" yards the majority of switchmen are careful in the handling of cars.

It is very important that the hand brakes should be tried on all cars placed on shop tracks, to see that they are in working condition. This will help to protect the car in hump yard switching.

Too much is being said about the rough usage the car receives in switching. The Carman must give the car the necessary attention before it is switched or he is to blame for much of the damage.

The yard force will be divided according to the num-

ber of cars passing through the yard each day of 24 hours. Assuming that an average of 120 cars pass through these yards each hour of the day, there are 2,880 cars being handled in and out. There should then be two inspectors, four oilers, two safety appliance inspectors, two safety appliance repairmen, two light inspection repairmen and two air brake men on the daylight hours on each shift, to handle these cars through the train yard; and with properly located supply boxes or material racks they can do so readily. It should be remembered that every car that is inspected will not need repairs and the inspector should be instructed to properly chalk the important defects for repairs in the train yard—and to properly card the light or heavy bad order car and mark it for light or heavy repair track.

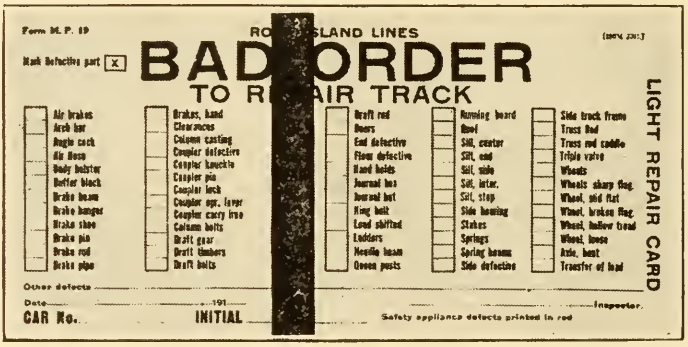
The illustration shows a form of bad order card in use on some roads. On one side of the card a single heavy red bar denotes the car as a "light" bad order for the repair track and on the opposite side, two bars denote the car as a "heavy" bad order. The nature of the defects and the facilities of the repair track would denote whether the car should be repaired there or sent to the car shops, the inspector to be the judge.

The methods used in making light inspection repairs have been covered in the discussion of repair work at other points and the same methods would be used at this terminal.

The Car Oiler—The car oiler plays an important part in the affairs of this terminal and his work should not consist merely of opening the box covers and pouring oil into the box and allowing it to run through under the journal and out the back of the box; but he

should know the causes and cures for hot boxes and the proper and efficient use of the oil can. He should also have an M. C. B. Standard packing knife and know how to use it, why to use it and when to use it.

Most hot boxes are caused by lack of wick contact and if the packing knife is run under the dope on each side of the journal at the bottom of the box, and then



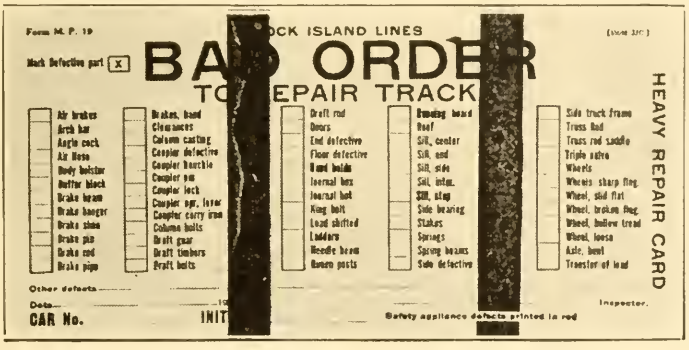
Light Bad Order Card.

given a quarter twist to the center, the packing is raised and oil channels are cut through the bottom of the dope. The car is then good for another one hundred miles at least. Time freight must be kept going and on every train there are boxes which require attention even though they give no symptoms of running hot.

Not all boxes that are dry need the packing stirred up in them. Some roads are stingy in the use of oil.

They are the ones which are having the most hot boxes. Not all boxes that need stirring up, need oil. Perhaps the waste has become water-soaked and has lost a bit of the former resiliency. Stir up the packing good if it appears to have fallen away from the journal but leave the oil can alone. Where the waste is extremely black and grimy looking, repack the box with clean

waste and insure that car against a hot box on that journal, at least. A few trips out on the road to repair a car that the oiler should have oiled or repacked and did not will teach him to give more than a passing glance at the journal boxes. Keep a lookout and use your influence to get packing which "stays up" to the journal instead of packing down.



Heavy Bad Order Card.

Inspection of Safety Appliance—In yards handling a small number of cars the repairs to special appliances may be delegated to the car inspectors. But in yards handling many cars, special men are assigned to do this work, to avoid sending cars to the repair track.

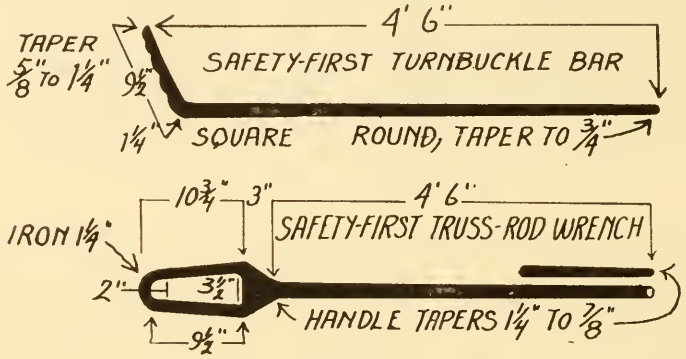
Two men usually work together, one on each side of a string of cars; or three men work together, one on either side and one on top.

Many tracks such as team tracks, freight-house tracks, storage tracks, etc., can be flagged for hours without delay to yard crews and many repairs made that would otherwise go to the repair tracks.

It is highly essential that a Carman exercise the greatest care in proper inspection and maintenance of what are known as Safety Appliances, not due to the fact that

it is a requirement of the law merely, but from the standpoint of safety. Safety appliances cover the following: Hand brakes and all connections thereto; hand holds, ladders, sill steps, brake steps, running boards, and air brake.

The requirements of the safety appliance laws were placed before all whose duties in any way made them responsible for their design and maintenance, with a view of reducing the causes which lead up to accidents as far as possible. Uncoupling levers and automatic couplers were required, thereby removing the necessity of going between cars to couple cars together; suitable



Two Handy Wrenches

ladders, hand holds, steps, brakes, with suitable attachments, suggested themselves to the Commission as a means of making the duties of railway employes safer, and after going into the matter of proper standards with the car owners, the Commission finally adopted what are known as the United States Safety Appliance standards.

Tools—At this terminal the following tools are required: Hammer, 10 in. monkey wrench, ½ and ⅜ in. wrench, 10 in. pipe wrench, screw driver, flat and round nose chisel, and 18 in. pipe wrench. In addition

to the above, Carmen should have free access to all other tools in the inspector's building.

Herewith are shown two tools which come in very handy at any car repair point. The first is a turnbuckle bar which allows a complete turning of the buckle by using the tool in different positions. The second is a handy truss rod wrench with a slightly tapered opening to fit different sized nuts. These no doubt are familiar tools around most yards but every tool room should be supplied with them.

Material Necessary—A line of material that is carried in the inspector's shanty will suffice for the special appliance men, a list of which was shown in preceding chapters.

Special appliance men, however, should have a small hand box to carry with them through the yard, which should contain the following: Cotter keys, coupler pin lifter clevises and pins, ½ and ⅜ in. lag screws, ⅜ in. and ½ in. bolts, nails, etc.

Heavier material, and material that is not used frequently, can be obtained from the car inspector's shanty when needed.

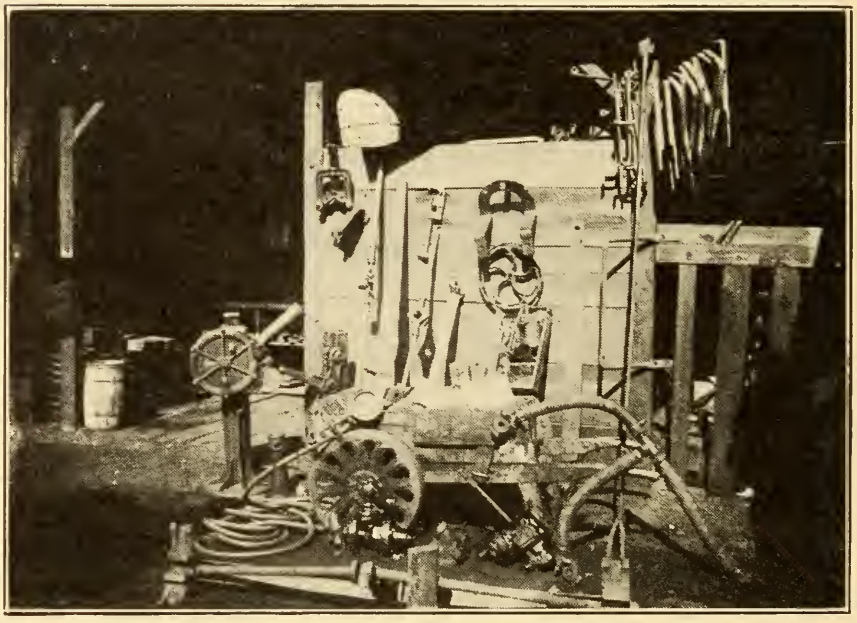
Repairs to be Made by Saftey Appliance Men—These men should repair brake wheels, ratchet wheels, loose nuts, renew cotter keys, brake shoes and keys, secure loose running boards, etc.

Sill Steps and Handholds—As a general rule the steps or hand holds only need the nuts tightened. If the handholds or sill steps are bent slightly, they can be straightened cold by using a bar, without removing them from the car. If the step or handholds are fastened by rivets, it will be necessary to remove the rivets and substitute bolts.

Brake Staff and Connections—The brake chains must be in good condition, secured at the staff with a ½ in. bolt and locking nut. In riveting the end of a bolt it is a good practice to hold a sledge or wrench against the opposite end of the bolt.

Ratchet wheels can be removed by removing the brake wheel and slipping the ratchet over end of the shaft.

Running Boards—Running boards should be se-



Shows test hose equipped with gage, also 3 way connection composed of air hose to test both ways from central point in yard. Also shows other repair equipment that will be used at this point in the train yard.

curely fastened by screws or bolts. All loose boards should be secured with screws, and protruding nails should be removed. After the cars have been inspected and repaired upon arrival, the train is switched and the cars that have been carded for the repair track and shop

are set out on a separate track, after which they are placed for repairs.

In some yards the outgoing trains are made up on "make up" tracks, these being used only for this purpose. In other yards the train is made up wherever the foreman of the engine decides, and it is up to the car inspctors to keep in touch with him and find out on what track the first outgoing train is to be made up. It will prevent delay to trains if, when the engine couples to the train, the hose are all coupled and the inspector ready to go over the train and make the terminal test.

A train should be made up, stretched, and the air hose coupled as far in advance of the leaving time of the train as possible. It is preferable to use air from the yard line and hold the pressure up to the maximum in the train line until the train line and connections are thoroughly gone over and examined for leaks. Unions that leak or show any signs of leaking must be tightened. If in tightening, the union comes off where the sleeve screws on, the pipe and union nut must be loosened and the sleeve tightened on the pipe. This usually necessitates the renewal of the gasket. Clamps or air pipes must be tightened, cotter keys in brake pins applied and spread, and safety guards secured and in place.

Air hose must be carefully examined for porousness, leaky gaskets in couplings, and loose clamps on air hose. Should a leak be found in the air hose or connections, the angle cock at each side of the leak should be closed and repairs made. Do not take chances; change the hose or gaskets and avoid trouble on the road.

In renewing a hose gasket, the groove in which it

fits should be carefully cleaned out before a new gasket is inserted; and after the repairs are made, the angle cocks should be opened very slowly to prevent brakes being thrown into emergency.

Leaks in release valves may sometimes be stopped by shaking the release rod. Leakage at the exhaust valve in the triple may be stopped by closing the cutout cock in the branch pipe, draining the air out of the auxiliary reservoir, and then opening the cutout cock quickly.

After the train line is fully charged the brakes should be applied, piston travel adjusted to not less than 6 nor more than 8 inches, and brakes released and examined to ascertain if all brakes release properly. This test should be made with the yard line and repairs made; and when the engine is coupled to the train it will only be necessary to charge the trainline and set and release

DEFECTIVE AIR BRAKE

THIS CAR CAN BE PLACED BETWEEN AIR BRAKE CARS

Car No.....*Initials*.....*Train No*.....*Date*.....191....

DEFECTS

Brakes to be cut out for the following

1. **Defective Triple**
2. **Release Valve**
3. **Cross Over Pipe**
4. **Brake will not Release**
5. **Car has Slid Flat Wheels**
6. **Brake Rigging**

Brakes should not be cut out for the following

7. **Cylinder Packing**
8. **Brake will not Apply**
9. **Retaining Valves**
10. **Brake Pipe Leaks**
11. **Brake Pipe Clamps**
12. **Piston Travel** **Too Long** / **Too Short**
13. **Angle Cocks**
14. **Brake Leaks Off**

15.....

Card Applied at.....

Conductor .....*or Inspector*.....

INSTRUCTIONS—To indicate the defect draw a line through the description.

Tack Card to Side of Car near release rod.

the brakes from the engine, the inspector of course going over the train to see that they do set and release and that the train is ready to depart.

Defective Air Brake Card—Cars having defective air brakes should be carded with a specially designed card, and the detachable portion mailed to the point where the repairs are to be made. Since trains are permitted to operate with less than 100 per cent of the air brakes in service, the air brake card, similar to that shown, should be used; anyone can see what is defective at a glance, and in the case of a broken train line, this car may be switched to the back of the train.

CHAPTER VI.

INTERMEDIATE TERMINAL REPAIRS.

Location—To facilitate the handling of cars to and from the repair tracks, these should be located near the train yard. In this way direct connection between yard and repair track forces are maintained, which is beneficial to both, as there are often slack times in the train yard, while on a repair track the work is never caught up. If located close together, the yard force can help out on the repair track occasionally.

There should be three "light" repair tracks and two "heavy" repair tracks. One of the three light tracks should be for steel cars and two for wooden cars, and one of the two heavy tracks should be for steel cars and one for wood. A system or arrangement that is properly worked out means a greater output of cars from the repair tracks each day.

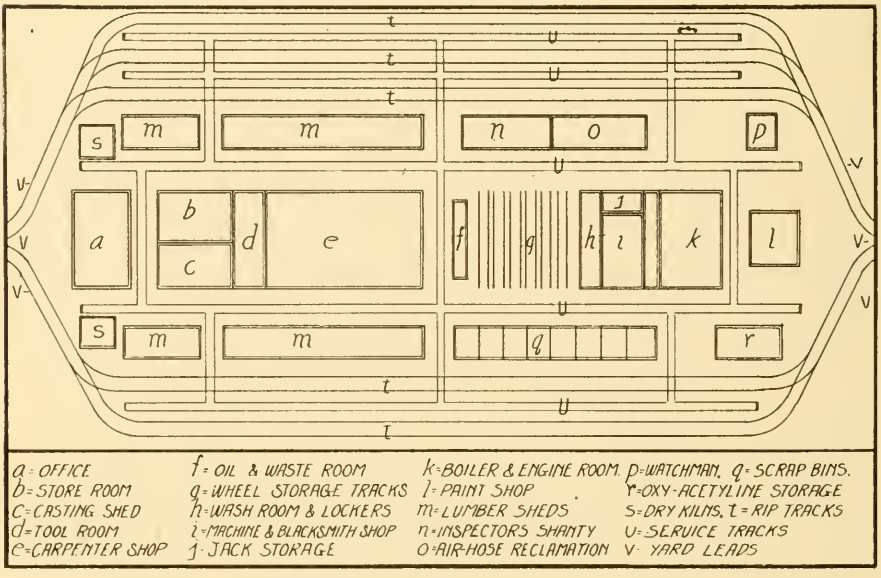
The three light tracks should have a capacity of 100 cars and the two heavy tracks a capacity of 20 cars, properly spaced.

The illustration shows the plan of the repair tracks with location of offices, shops, storerooms, etc., which compose the Car Department property.

In the arrangement of the repair and service tracks and the location of the various buildings, the aim has been to have the work shops and material placed as near the central point as convenient in order to facilitate the movement of material to the car in need, regardless of its location in the repair yard.

Service Tracks—The system of service tracks shown is for the rapid transportation of supplies and material from the stores to the individual car or from one point in the yard to another. They are narrow gauge and of light rail. The change from one track to another is made upon turntables.

Buildings—The buildings consist of the office,



This Layout of Repair Tracks and Location of Buildings Facilitates Movement of Material from a Central Plant to All Parts of the Yard.

storeroom and casting shed, carpenter shop and wood mill, machine and blacksmith shop, paint shop, lumber shed and boiler and engine room, etc.

Number of Men Employed—About 100 men would be employed at this point, including office help and supervisory forces. Details depend on the organization of the road.

Repairs Made—At this point all manner of repairs that are ordinarily made outside the shops may be made, with the exception of heavy repairs to steel cars. This class of work is generally done at the large car shops and under better conditions, with proper equipment.

Wooden cars may receive a general overhauling during summer months but to attempt to do this work in winter is a losing proposition. The men cannot stand the cold, blustering weather and the work is hindered by falling snow, rain and sleet. For this reason it is better policy to limit the extent of repairs to about 150 hours labor and confine the operations to partial underframe repairs, and possibly renewing ends or roofs.

Repairs to steel cars should be limited to straightening endsills, corner posts on open ends, repairing hopper doors and such of the safety appliances as become defective.

Light Repair Track Work—Some of the repairs which may be made to wooden cars on these tracks are as follows: Applying brake beams and connections, truck bolsters, arch bars, wheels, sand planks, couplers, end sills, draft timbers, sill splices, side doors and roof boards; renewing decayed, broken or missing parts of running board; applying draft bolts, center plate bolts and adjusting various kinds of lading in all kinds of cars. Repairs to steel or steel underframe and superstructure cars may include straightening hopper doors, repairing end sills, corner posts, braces, car ends (on gondola cars); and such truck repairs as are common to all types of cars. The work done on these tracks should be of such a nature that in case the truck has to be removed the balance of the track room will not be held up more than one day after repairs are started.

Heavy Repair Track Work—This work should consist mainly of cars requiring the renewal of long sills, lining, siding, roofs, end posts, side posts and braces. And during the warm months of the year, general rebuilding and application of standard betterments is in order. The aim should be to keep repairs down close to the limit of 150 hours per car and divide the work to suit conditions as found on the car.

The repairs to brake beams and brake rigging, arch bars, wheels, couplers, draft and center plate bolts have already been described and we pass on to the other repairs.

Renewing Long Draft Timbers—In renewing one or both timbers the coupler and attachments are dropped, and as the long timbers extend beyond the body bolster, it is necessary to set jacks and take the weight of the car to loosen the bottom leaf (if it is a two leaf bolster) and allow the timbers to be removed after the draft bolts have been driven out. If it is a system car and standard draft timbers are kept in stock, the lug castings are removed from the broken timber and bolted to the new one and the new timbers applied and bolted in place. The coupler is replaced after the car has been lowered and the bolster bolted in place. In repairs of this kind the application of metal drop arms is recommended.

Renewing End Sills—An end sill that is applied to the car outside the sheathing or siding is known as an "outside" end sill, and one that is covered by the siding as an "inside" end sill.

Modern practice in removing inside box-car end sills is to remove both corner irons, then with a nail set, drive the nails straight through the siding into the end sill, re-

move any appliances that may interfere with the removal of the sill, remove the truss-rod nuts, pry out the end sill and let it slide from under the siding. By careful handling in this manner the siding on the end of the box car may be saved. This work may be done on loaded cars if the load consists of bulk stuff easily shifted. If the car is loaded with bulk grain, sand, lime, coal or loose merchandise of any sort the lading must be transferred before repairing.

The outside end sill is applied more quickly as it is only necessary to loosen the truss rod nuts, remove the coupler, and such other appliances as interfere with the operation, and pry the sill from the truss rods, and then replace with a good one; after which the coupler and other appliances may be replaced.

In both cases, jacks should be set under the needle beams or cross tie timbers nearest the end being repaired, to hold the car from sagging and breaking the sills, if the car is loaded.

Renewing End Plates—Where only the end plate is to be renewed, the job can be done by removing the plate corner irons and a portion of the roof, slacking off the nuts on the tie rods, driving the nails through the siding (using a nail set) into the end plate and prying the sides apart until the end plate can be lifted out.

Adjusting Height of Couplers—The height of a coupler is measured from the center line of the coupler shank to top of rail; and on empty cars must not be less than 32½ nor more than 34½ ins. Empty cars should be adjusted to 34½ ins. The adjustment on loaded cars should not be less than 31½ nor more than 33½ in. The coupler can be raised by tightening up the carrier iron or by putting a shoe between the carrier

iron and the shank of the coupler; or by placing a shim between the spring and the truck bolster. The M. C. B. rules allow the use of metal shims between arch bar and oil box, if the former methods do not suffice. In putting shims in trucks, a good grain lumber should be used and the shims made as large as possible. Thin shims, used in several layers, work out and make a bad job.

Special attention should be given to the gauging of couplers when cars are on shop tracks, to insure that they have a contour meeting the requirements of M. C. B. rules.

Patching Coal Car Siding—Often a car will come in with bursted sides. Renewal can be made by cutting the boards long enough to extend between three posts. If the side stakes are metal, having two rows of bolts, the joint can be made so that the ends can be butted up against each other. With wooden stakes having a single row of bolts, the joint should be made on an angle so that a bolt may be placed through each splice of each board.

Truck Bolsters—A rigid wooden or metal bolster is removed by first disconnecting brake rods as necessary, raising the end of the car, moving the truck forward until a trestle can be placed, lowering the car until the trestles carry a portion of the weight, and then removing the truck. After putting a block in front of each wheel, both top arch bars may be removed, after which the bolster is removed by sliding it forward over the top of either pair of wheels.

The center plate, side bearings and column guides may now be removed from the old bolster and replaced on

the new one. If a metal bolster is used, the same method of removing and replacing must be followed; but if the side bearings, center plates and column guides are cast solid, a part of the operation is eliminated.

After replacing the truck, the clearance between side bearings must be measured and adjusted to not more than ¼ in., brake rods connected, cotter keys spread—(when bolt is used as a key bolt the locking nut must be tightened) and height of coupler measured.

Swing Beam Bolsters—Wood or metal swing-beam bolsters are removed by the same method as described with rigid bolsters, except that the arch bars are not removed. After the truck is out from under the car the bolster is removed by placing a bar under one end of the bolster and over arch bar or side of truck, and raising the bolster until a bar or board can be laid across under the truck sides, raising both ends above the level of the truck sides, then sliding the bolster over the wheel or side of the truck.

Body Bolsters—Metal is fast taking the place of wood in body bolsters, but wooden or metal, the method of repairs is similar. The brake rods must be disconnected, the car raised until the center plates clear, the truck moved forward until it clears the bolster. The car is then blocked between the truck and sills and enough weight left on the truck to "steady the car." All conditions being favorable, with a metal body bolster the nuts can now be removed from the bolts, the car raised and with the body bolster resting on the truck the truck can be run forward, the old bolster removed, a new one applied and the truck returned to its position. A set rule cannot be adhered to for each operation in repairing cars. New men, new meth-

ods, and new construction make constant changes necessary, and only general rules are possible, leaving the details to be met as found.

Needle Beams or Cross Timbers—Needle beams or cross ties are removed by disconnecting the truss rods at the turnbuckles or loosening the nuts or turnbuckles sufficiently to give the slack necessary to remove the queen posts. Floor washers must be used on bolts in needle beams, body bolsters, brake blocks, sub sills and draft timbers to prevent the heads of the bolts being drawn into the sills and to facilitate removal when making repairs.

Splicing Car Sills—The M. C. B. rules cover the design of the splice, the location of the splice on the sill and the number of adjacent sills that can be spliced. If the sill and location of the splice will permit splicing without removing the truck, it is not necessary to raise the car body. When necessary to remove the body bolster, proceed as follows: Set a jack under each side of car near body bolster, disconnect brake rods that interfere, raise the end of car until center plates clear, and set trestles under each side of car and lower it until the trestles hold a portion of the weight of the car.

In splicing the center sills where the end sill is renewed at same time, remove the coupler, deadwood and draft timbers, then with a nail set drive the nails through end siding into the end sills and pry the end sill out until the tenons on the sills will permit it to drop down. Now run the car truck out and remove the body bolster. After locating the point where splice is to be made, saw the sill through, pry it loose from the decking, drive the nails up through the decking, fit the

splice and bolt it in position. The end sill may now be applied.

In splicing sills on cars having outside end sills it is not necessary to remove the end sill to renew or make new splices to center sills. It is necessary, however, to loosen one end sill to apply full length longitudinal sills. Splices should be made so that they could be removed if necessary to renew them under load.

The variation in construction makes it impossible to always follow a set method. Different Carmen use different methods for accomplishing the same results; and as long as the repairs are made in a reasonable time and in a workmanlike manner it is good practice to permit the man to use his own methods.

Grain Leaks—Investigation shows that a great deal of grain leakage occurs between the car sheathing and side sills, due to the tendency of the sheathing to work away from the sills under load. Nails do not seem to stop this trouble.

One remedy has been the application of sheathing straps made of ¼ in. by 1½ in. flat iron to the sides of box cars. These straps are fastened by bolts through the side sills together with rods which extend through both side and intermediate sills.

Some grain losses occur from warped flooring due to the fact that nails are used. The only remedy for this is to bolt the flooring to the side sills, and it is recommended that the same kind of side straps be used here as is applied to the sheathing. These are to be applied just inside the post line and bolted to the sills.

Renewing Corner Posts—Corner posts with tenons that fit up into the end plate and sills make necessary the removal of about one foot of siding when renewing

the end post. The roof must be jacked up until the tenon will clear; then the post may be removed. Corner posts which form a part of the siding and are bolted at the top and the bottom are much easier to remove. Other types have a pocket casting at the top and bottom and do not require mortices in the sills and plates.

Renewing or Splicing Side Sills—Side sills may be renewed or spliced by first setting the nails in the siding, then loosening the down rods, removing the bolts, jacking the posts, etc. off the sill, after which the sill may be repaired or replaced.

Renewing Ridge Pole—To renew a ridge pole, first remove the roof of the car and both end fascias, then take out the ridge pole, take down ridge pole bolts and replace it. A car going to the shop for general repairs can be made safe to move by blocking between the roof and floor, and fastening the bracing and blocking firmly.

Steel Cars—Repairs to steel cars will be briefly touched on in a chapter that follows. Light repairs, such as straightening draft arms, end plates, etc. can be made at a medium sized terminal, and as Carmen become familiar with steel work it will be handled as easily as repairs to wooden cars are now handled. Various types of cars make various methods of doing the work necessary. Rivet-heating forges, track chisels, chisel bars, etc. should be maintained at all repair points.

There is additional opportunity for the Carman to resort to ingenious methods in steel car work to avoid tearing down so many parts of the car to straighten a sill, draft arms, etc.. A portable torch or a basket filled with charcoal, or a bricked up furnace can be used to heat the spot where the sill is bent. After it is heated

it may be drawn in place by means of rods or jacked in place by a jack.

Steel Draft Timbers—Side stakes, bracing end plates, etc. can be cut loose from the car, straightened and re-riveted in position. At outside points without the material or facilities, permanent repairs to steel cars cannot be made. A car can be emptied, a set of temporary draft timbers applied and the car moved to a point where repairs can be made.

Cars having weak draft sills or draft sills bent out of line can be temporarily repaired by jacking into position, putting false bracing on the inside to hold it in line, and the car may then be moved to a heavy repair point.

CHAPTER VII.

FREIGHT CAR SHOP REPAIRS.

In this chapter a general outline of the work done will be given, as methods of doing routine work have been covered in the foregoing chapters. The idea is to give a

The Car Shop and Repair Tracks.

description of methods employed in making the heavy repairs, and rebuilding and reinforcing of cars in general at the largest terminals and shops.

Two lasting impressions are gained upon visiting a large repair track and car shop. A greater part of the actual repair work is rebuilding and applying reinforcements, such as steel underframes or center sill channels,

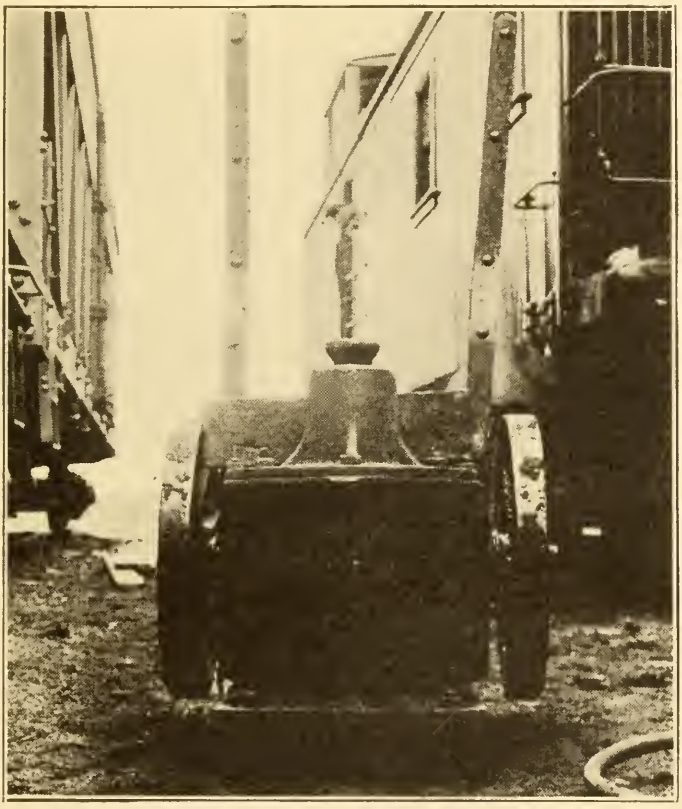
where such work would be greatly hindered by weather conditions. The first impression gained is the immensity of the car repair problem and the second is the sense of efficient organization of the forces making the repairs. The intricacy of the organization is more readily recognized when a car with a steel superstructure is undergoing repairs. The wood and steel car workers follow each other, each gang stripping and tearing down and repairing or rebuilding various parts as the process demands.

In this class of work each Carman follows one branch of the repairs on all cars, and becomes a specialist. He does not, however, become as familiar with the various other branches as he would were he required to work on all parts of the car.

Efficiency can be acquired only by doing things well, and this policy restricts the Carman in the large shop organization; for in laboring to become proficient in one branch, he often loses sight of the main points in other branches, and it is only by a continual study and a so-called sense of "keeping one eye on your own work and the other on the other fellow's" that the Carman is enabled to enlarge his vision and keep pace with the modern methods of repairs to equipment in all its branches.

The Repair Tracks—The number of repair tracks vary and it is the capacity rather than number of tracks which must be considered in the layout. It is safe to say that 300 or 400 cars are found on the shop tracks and in the shop at a terminal of the size we are considering. The output from these tracks will average about 100 cars per week, or about one-third of the track capacity.

This is a fair average estimate, when the fact is considered that there are some cars that require more than 180 hours to repair. Wrecked steel and steel underframe and superstructure cars may be placed in this class.



Air Jack for Lifting Cars.

Quite often it is necessary to cut these cars apart with the cutting torch, in order to straighten and splice bent and broken parts.

The Shop and Equipment—The shop is in most cases a well lighted brick or composite structure of sufficient size to accommodate about fifty cars, and is

equipped with a great many appliances which the smaller points do not have. All the cars are raised from the trucks by means of pneumatic jacks, and these are mounted on a small two-wheeled truck and can be moved about from one car to another easily. One gang does nothing else but raise and lower cars. Various heating torches, oxy-acetylene welding outfits, pneumatic presses and oil furnaces for heating and straightening of steel parts, comprise the principal tools used in the work of making the actual repairs.

The wood shop or mill, blacksmith shop, wheel shop and reclaiming shop are all parts of the main shop organ-

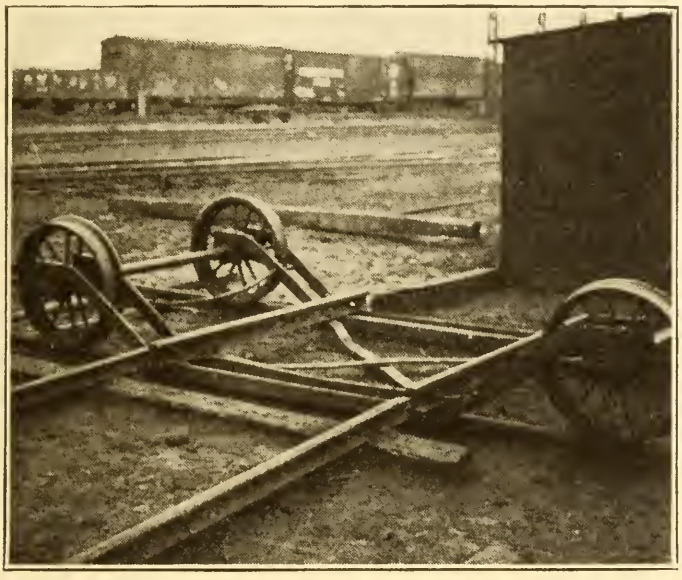
Service Track Turntable

ization, placed separately to avoid confusion, and to promote efficiency in the different operations.

Service tracks, either of the narrow gauge or broad gauge type located between the repair tracks are valuable additions for facilitating repairs in a large yard.

Whenever possible the standard gauge is recommended with turntables as are shown.

Some shops use a low-hung lorry having tracks placed across it. When this is used on a cross track it takes the place of turntables.



Lorry for Handling Service Carts

Stock and Method of Handling—Where the general store is located some distance away from the rip-track, considerable time is lost by Carmen or supply men going for material, especially when only small amounts of special material are drawn.

A rip track should have its own store built near the repair yard, and men should be placed in charge to keep the material in proper shape and insure correct distribution of charges. If possible, service tracks should run adjacent to the store, or, better still, into

the building where material may be loaded at one operation.

At some supposedly up to date car repair yards, material is still being loaded and unloaded to and from

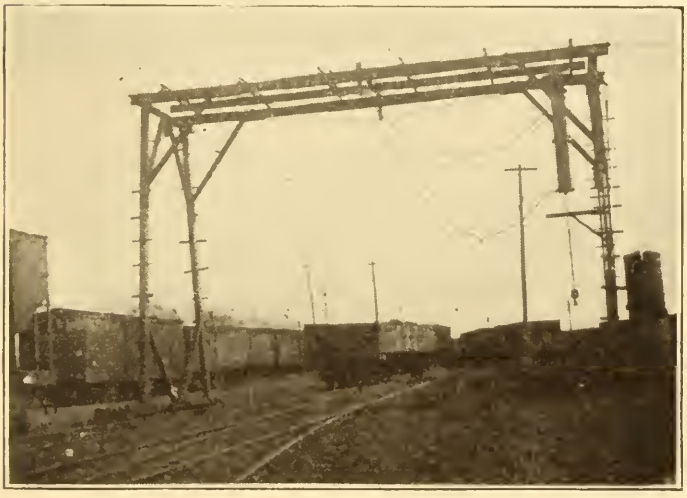
One End of a Rip Track Store

cars by means of manual labor. This is a slow, expensive method. Where compressed air is available air hoists should be used to do the work.

In the accompanying two views are shown different types of cranes for the operation. One is of the single post type which will turn in a complete circle, and allows considerable horizontal movement for the hoist to travel in.

The other consists of a structure extended over several tracks and supported on four legs. The crane last mentioned is a more expensive installation than the first but has a much higher capacity.

Single Post Air Hoist



Loading and Unloading Air Hoist

Reclaiming Material—Considerable thought should be given to each and every defective part being reclaimed. Rigid records only will produce figures which show whether reclaiming can be done at a saving or at a loss. Real savings in this line are usually impossible without a highly specialized organization working on large quantities of material.

Reclaiming Nuts

Bolts and nuts are things which can be reclaimed and they find their way to the scrap pile sooner than any other material because the nuts drop off. A bolt cutter and nut tapper will save much of this material. Shears should also be installed for cutting off bolts the right length, and hammers operated by belt, steam or air may be used to straighten bent bolts.

Scaffolds for the Carman—A trestle or scaffold should be provided in the yard for supporting planks

for Carmen to stand on when they are performing operations which cannot be handled from the ground.

Such scaffolds should be built strong, but as light as possible, and should be located at points in the yard where they are easily reached when needed.

Reclaiming Bolts

The provision of home made devices of this sort is a great aid to the Carman in performing his work.

Scaffolding or trestles, however, should not be carelessly or imperfectly made, nor should they be carelessly placed, as accidents are likely to result from such carelessness.

The photograph shows a trestle at the end of a car,—top platform not shown. At the left hand side there is shown a plank scaffolding which rests on trestles and

which is used by the Carman for work on the side of the car.

Note the substantial construction of the trestle at the end of the car, and the fact that it sets level and solidly so that there is no tipping when the Carman is standing on top of it.

Scaffolds for Repair Work

The Repairs—In the general overhauling of a wooden box car carded for heavy repairs, new longitudinal sills will usually be required, perhaps not all new; also it will usually need new end sills, draft timbers, deadwood, end posts, corner posts, sheeting, lining, siding, end plates, carlines, new roof, side and end braces, decking, repairs or renewal of doors and complete overhauling of trucks.

The car is first raised from its trucks by the jacking gang, and placed on horses. Then follows the stripping gang, which proceeds to tear the car down. Couplers and attachments are removed and draft timbers and

Double Lorry Track at the End of the Car Repair Tracks.

bolsters taken down, after which the lining, siding, fascia, and roof are stripped from the car body. This leaves the superstructure bare for further inspection and decision as to the number of posts and braces to be renewed.

If any number of longitudinal sills (less than the complete underframe of eight sills), are to be renewed, without tearing down the superstructure, repairs should be made with the use of metal draft arms.

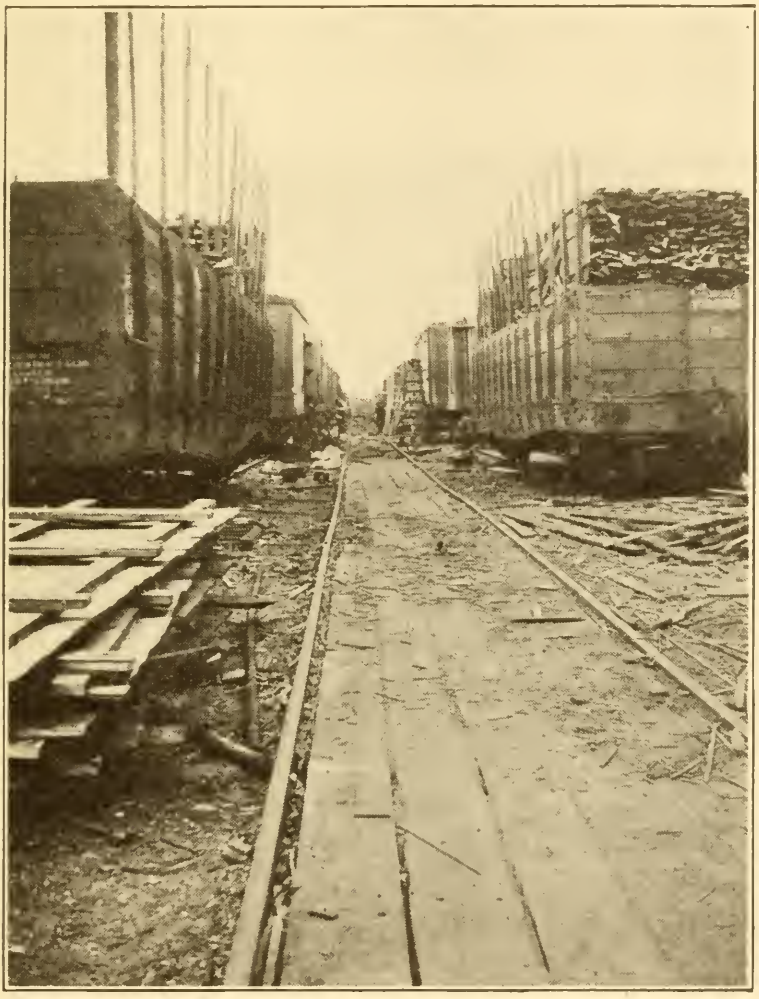
The end sills are left in place and assuming that two center sills and three intermediate sills are to be renewed, they are cut at the body bolster and dropped down at this point to disengage the tenons from the end sills, after which they may be removed from the car. By leaving the end sills attached to the other sills, a portion of the weight from the superstructure is distributed to each sill, and the remaining sills are braced laterally and at the same time held in position. New sills are cut and framed, including boring in the mill room; and are brought to the car to be replaced as soon as the strippers have finished their work. A "clean up" gang of laborers follows the strippers, removing the scrap lumber and timbers to the wood mill and boiler room, for reclamation of such parts as can be utilized and for use as fuel

The carpenters now take the car and the work of reconstruction starts. The longitudinal sills are put in place and the cross ties are bolted on. The body bolster is next replaced and there is now sufficient firmness to the sills to permit the end sills to be removed and new ones substituted if necessary. Side posts and braces are renewed, also end posts and end plates, and braces, sheathing and siding applied.

Draft timbers and couplers follow in turn, and decking is laid after the new roof has been applied. The inside lining is then put on and the balance of the repairs to doors, door track, etc., together with the application of the safety appliances, is carried to completion quite rapidly. In some shops, the carpenters overhaul the

trucks and in others a gang goes from one car to another repairing only that portion of the car.

The air brake gang replaces the cylinder, reservoir,



A Large Repair Track Near Chicago.

train line pipes and clamps, and the painting gang soon transforms the outward appearance after which it is allowed to dry 12 hours before stenciling.

Bulged Gondolas—It is a common sight to see wooden gondola cars, under load, with sides bulging. There are several causes for excessive bulging. In many cases, the construction is such that the torsional strength of the side sills is all that keeps the sides from spreading. If the underframe sags under the load, the distortion has a tendency to force the posts out. During recent years the increased difficulty of obtaining siding to extend the full length of the car has led to the use of short pieces, which further weakens the side.

Of the methods used to overcome spreading of the car sides, the most common is the use of tie rods fastened to the tops of opposite posts. While this is an effective means of overcoming the trouble it should only be used as a temporary expedient, as the rods make the loading and unloading of long material very difficult. It is doubtful whether the bulging of sides can be entirely overcome on cars with weak underframes. Probably the most effective reinforcing for the sides, on the majority of wooden cars, is secured by adding diagonal tie straps to make the side act as a truss, and by placing gusset sheets transversely in the center of the car, to give lateral stiffness.

Reinforcing Car Ends and Underframes—While no reliable statistics on the subject are available, it is conceded by railroad operating and mechanical officials that the weakest part of box car bodies is at the ends, and that such weakness in construction has been the cause of enormous claims for loss and damage.

The outside sheathing becomes loose, particularly at the end sills after a few years service, and the thin lining is soon broken by shifting loads; over thirty per cent of the total loss of grain in transit, is due to these defective

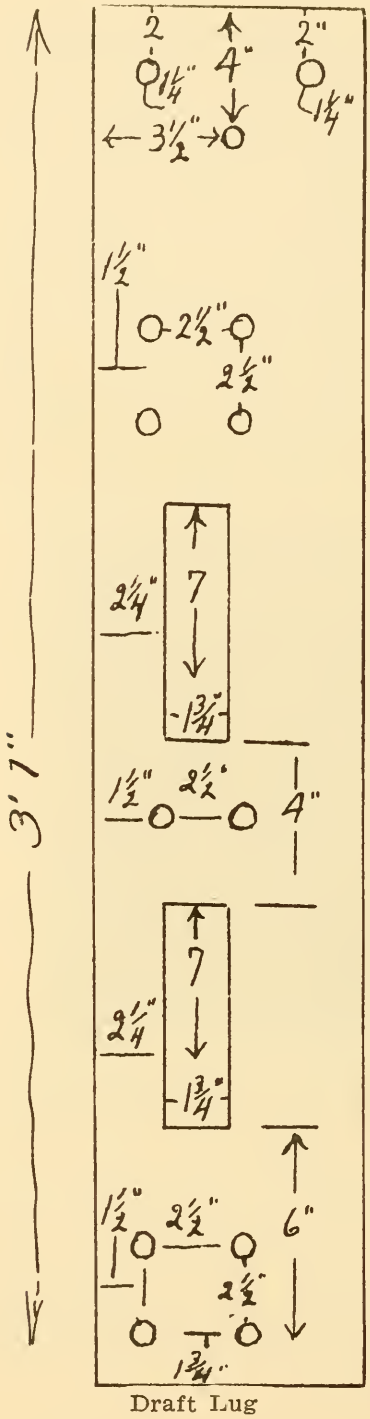
ends. Such inadequate strength also entails the expenditure of large amounts every year by all railroads for repairs. In many cases one end will be reconstructed several times during the life time of the car, because the original design and construction is being continued.

Old box car ends should be reinforced by the addition of outside metal end posts, or by metal reinforcements for the wooden end posts. These should be firmly attached top and bottom, braced if necessary. Then, if the end sheathing does not have to be renewed, the application of a tight and thicker inside end lining

Handling Wheels and Couplers About the Shop and Repair Track is Laborious Work at the Best. Such Tools as These Help to Make it Easier.

will give the car end the required strength and tightness at a minimum expense.

On some types of reinforcement it is not necessary to remove the old broken end posts. If sheathing is good,



Draft Lug

jack the posts back to position, and apply the reinforcements and the inside lining. This, of course, refers to ends not completely shoved out or pushed in.

Some such reinforcement is the only means for lengthening the life of the end of the car. Other parts of the car have an indirect effect upon the life of the end.

Special Draft Rigging Repair—A sketch is shown of a lug used on repairs to Hercules draft rigging. The dimensions in this sketch apply to a lug as used for a steel underframe of a Hart Convertible Ballast Car. The back of the lug butts against the angle iron at the body bolster. The length can be adjusted to suit various styles of draft arms, and it is claimed that draft riggings, so reinforced, stand up better than the original rigging.

Steel Underframes and Center Channels—For revenue service the wooden underframe car is now admit-

ted to be too weak in construction to withstand the buffing shocks to which it is subjected in heavy trains of cars of higher capacity and greater weight.

Service Tracks Provide Efficient Means for Handling Material in the Shop and on Repair Tracks. A System of Switches and Crossovers is in Use at this Point.

There are, however, a great many of these cars of

sufficient capacity to warrant the application of reinforcements. Such reinforcements include steel draft arms or center channels and a partial underframe including metal body bolsters.

The second paragraph of section (h) and section (i) of M. C. B. Rule 3, are self explanatory for these measures and are quoted below as follows:

Section (h) "After October 1, 1918, when cars equipped with short draft arms, receive general repairs, long metal draft arms extending beyond the body bolster, steel draft members extending full length of car, steel center sills or steel underframes, must be applied."

Section (i) "After October 1, 1920, no car with trucks of less than 60,000 lbs. capacity will be accepted in interchange unless equipped with wooden or metal draft arms extending beyond the body bolster, or metal draft arms integral with body bolster, or metal draft arms extending to metal body bolster and securely riveted to same."

As these repairs are made when the car is given general overhauling, there is little need of a detailed description of the methods of application.

Instead of applying the two wooden center sills and the separate bolsters, combined steel center sills and bolsters may be applied, the ends either being flanged and bolted to the center sills or extended to the end of car, terminating in the striking plate or head block. In case they are thus extended, an angle is bolted or riveted to the side, to which the end sill is secured by bolts.

In applying these center channels, it has been proved that they should be cover-plated to avoid bending in absorbing buffing shocks. Not only are the channels

often bent sufficiently to require removal for repairs, but the entire wooden underframe is sometimes broken and must be renewed.

It has been said that "The Car Department cannot make money for the railroad company, but it can and should, by proper methods, *Save* Money." There is much truth in that statement and every Carman should feel that his work is a saving to the company employing him.

CHAPTER VIII.

STEEL CAR REPAIRS.

A Separate Craft—Repairing or building steel cars is a trade in itself. The tools and metals used border on that of boiler making and shipbuilding, but the work is not classed under either head and is considered a craft separate and distinct. A first-class steel car repairer is one who is familiar with the general construction of steel cars, and understands the handling of the metals under all conditions. He is also familiar with all kinds of pneumatic tools, and heating facilities which are employed in making the repairs.

Classification of Steel Car Repairs—In repairs to steel cars the work may be classified under three headings, viz.: 1st—Light Repairs at Small Repair Tracks, 2nd—Heavy Repairs at Intermediate Repair Points and Shops, 3rd—Rebuild Work—where the major portion of the car is renewed or repaired, either on account of damage, worn out condition, weak construction, or a combination of these causes.

Light Repairs Defined—The following are some of the items which come under the heading of Light Repairs:—

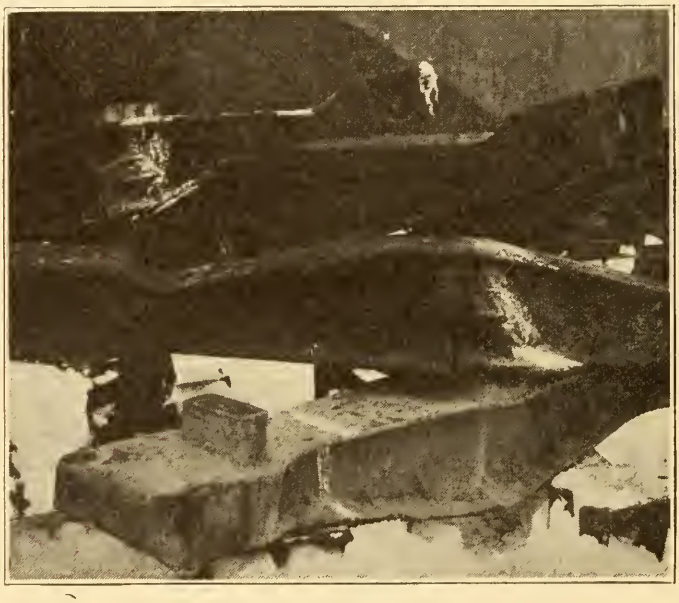
1. Renewing side bearings and center plates, repairing safety appliances, straightening solid and reinforced ends on box and lowside gondola cars; and straightening corner and end posts, and corner and end braces on hopper cars.

For this class of work the only special equipment

necessary is a blow torch or heater, for heating parts of the car which can be straightened without removing. These heaters are operated by compressed air and burn fuel oil.

Heavy Repairs Defined—Heavy repairs include bent sills, or body sprung out of shape, bent or buckled plates, sheets in sides or ends rusted out, bent or broken end, corner and side braces, etc.

This class of work is nearly always confined to large repair yards and shops, as a large stock of material must be carried in addition to the tools and appliances to work with.



Autogenous Welding of Bolsters

Autogenous welding has made it possible to save some material which was formerly sent to the scrap pile. Knuckles, couplers, bolsters, steel trucks and

many things made of metal may be welded and reenforced by this process. It also serves a valuable purpose in steel or wrought iron cutting. It is especially adaptable for use in steel car repairs where various parts must be cut apart and other parts, with certain dimensions, applied in their place. In work of this kind, the amount of labor and time saved by autogenous welding proves astonishing in some cases. But the amount which may be lost by ill-advised reclaiming is

Pneumatic Press for Steel Work

also astonishing. Careful judgment should therefore be exercised.

Steel repair yards should be provided with large punch and shear machines with sufficient gap for the largest steel plates used. Forms and presses must be installed for bending and straightening cold material or

parts heated in the furnace. Home made pneumatically operated presses, built over face plates, can be used for straightening channel irons and all steel structural parts commonly used on a car.

Classification—Car repairs made by the steel car men is divided into "Hot" and "Cold" straightening (where only straightening is done). Thermit, electric and acetylene welding are used on various jobs requiring heating, such as cracked and broken parts, particularly truck sides of the Bettendorf cast steel type, and cast steel body and truck bolsters.

Classification—Cars repaired by the steel car force include:

1. Steel center channels including body bolsters and end sills.

2. Steel underframe, including bolsters, end sills, side sills and diagonal braces.

3. Steel underframe complete with reinforced end superstructure.

4. Steel underframe, with steel superstructure including side braces, side and door posts and reinforced carlines.

5. The all steel car including general service, ballast and tank.

The general run of repairs to these cars is similar to those made to wooden cars. These include change of wheels, couplers, brake beams and rigging, center plates, side bearings, draft and truck springs, hand holds, operating levers, castings, sill steps, running board, side doors, etc., for it must be remembered that the steel underframe or superstructure does not wear

out as quickly as wooden ones and unless damaged by fire, derailment or wreck, very few repairs are made to the steel parts of the underframe or superstructure.

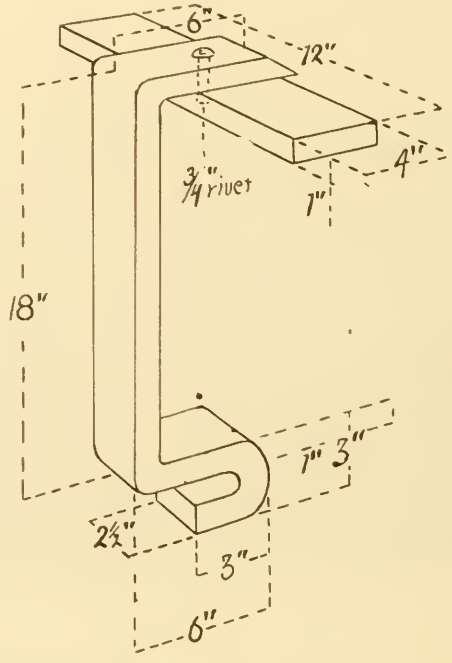
A large percentage of the steel work done today is either reinforcing, by applying steel underframe and cast steel draft arms in lieu of the wooden sills on

This Heating Torch is Used to Heat Parts of Steel Cars Preparatory to Straightening. Fuel Oil is Used.

wooden cars; or repairing or renewing parts of steel cars damaged by cornering, pushing in, or derailments, or decayed account of rust.

The Old Man—Many home made devices are used in steel car repairs. The "old man" shown helps solve one of the Carman's problems when drilling holes in the wings of the dump door hanger castings on National Dump Cars. After the old castings are cut off and the two rivets through the flange of the center sills

are removed, the new castings are bolted up so that the wings fit securely against the flange of the center sills. The jaw on the lower part of the "old man" will now be forced on the castings and sill flange between the hanger eyes. This will hold the device securely and the



"Old Man" for Holding Air Motor to Drill Holes in Wings of Dump Door Hanger Castings

motor may be placed in position to drill through old holes in the sill plate and flange, and through the wings of the new castings.

Rivet Guns—Guns for cutting or driving out bolts or rivets can be used to a great advantage on steel car repair work, especially in places where a good blow cannot be struck with a sledge. The rivet cutting gun shown also has a long extension cutter which makes it

possible to reach rivets in the sides of cars without scaffolding.

Cincinnati Rivet Cutting Gun

Tank Cars—Tank cars come under two General Classifications as follows: (1) With separated underframe center sills; and (2) without separated underframe center sills. In the last named the tank shell is thickened up to take the buffing stresses.

It is of supreme importance to know that all rivets and seams are tight as the danger to life and limb

from tank car disasters and failures have been unpleasantly frequent in the past few years.

Tank fittings such as safety valves, discharge valves, and methods for operating discharge valves and steam heating systems, are all of great importance, and, at the present time, are receiving careful study with an eye toward revisions of the A. R. A. tank car requirements where necessary. These are all very important subjects, and while existing standards are good, they are not deemed good enough to let alone.

In gauging tank cars three different systems are followed:

1. That procedure followed by the Western Weighing and Inspection Bureau located at Chicago, wherein their representatives actually measure the internal dimensions of the tanks and compute therefrom the capacity of each individual tank.

2. Gauging of the tanks by means of accurately built and tested master tanks which are of different sizes. These are pumped full of water, the water then transferred to the completed tank and thus the capacity accurately determined. This method is followed by the Union Tank Car Company.

3. Gauging by means of an accurately determined water meter.

The latter method has not always been satisfactory for the reason that water meters have not been manufactured as yet, having an accuracy above 1 per cent, which amounts to considerable in a large tank.

Retest by the A. R. A. tank car rules is governed in detail by the A. R. A. or old M. C. B. tank car regula-

tions, and is accurately followed.

Tank-car repairs are similar in character to other steel freight car repairs but with this important exception,—that in tank work the repairs must be more carefully made, and seams, joints and rivets must all be caulked. In general, closer, careful inspection and better workmanship is demanded.*

To describe in detail the methods used for repairing steel cars and to give each type of car the proper consideration in one chapter, is impossible.

The subject of repairs to and maintenance of steel cars, is more than big enough to warrant a book on this subject alone.

*Those especially interested in Tank Cars might read with profit a book entitled "All About Tank Cars," which can be obtained by writing the Railway Educatioal Press, Chicago.

CHAPTER IX.

AIR BRAKE REPAIRS.

The air brake work on freight cars is generally divided into three classes: (1) inspection, (2) outside repair work, (3) inside repair work.

The air brakes on a car consist of the apparatus proper and the brake rigging. Included under the first heading are the triple valve, auxiliary reservoir, brake-cylinder, release valve, retainer valve, angle cock, cut-out cock, brake pipe, cross-over pipe, strainer, pipe fittings and clamps.

Under the second heading are the brake beams, brake shoes, and keys, brake hangers and pins, brake levers (live and dead) cylinder levers, intermediate levers, top and bottom rods, push rods and connecting rods.

Outside Work—The outside force as a rule handles the pipe and the brake rigging work. They also remove and apply the various parts of the air brake apparatus, and make the tests before removal and after applying.

Inside Work—The inside force generally repairs and tests the retainers, release valves, angle and cut-out cocks, and triple valves. In fact, they make the repairs on the parts which have been removed and brought in for attention.

The Triple Valve—Without a doubt, the most complicated air brake part which the inside repair man comes in contact wtih is the triple valve, so called from

its three functions of (1) applying the brakes, (2) releasing the brakes and (3) charging the auxiliary reservoirs.

The condition of a triple valve is ascertained from tests made on an M. C. B. triple valve test rack. Service sensitiveness, friction release, service port capacity tests, packing ring tests, graduating, slide valve, check valve, emergency valve, and gasket tests are demanded, with extra tests for the retarding devices which the modern triples are equipped with.

Space will not permit the M. C. B. code of tests to be given in this book but some timely hints for the air man are given herewith.

All triple cleaning should be done in the air room. A repaired triple can take its place. All parts should be thoroughly cleaned with gasoline and then blown off with compressed air. The ports should receive special attention as the jarring of a triple in its trip from the air room shakes the accumulations of dirt loose, and in many cases a cleaned triple, due to the dirt, resembles one which has been in service for months.

All rubber gaskets and seats should be kept free from gasoline or kerosene in the process of cleaning air brake parts.

The packing ring in the triple piston is of more importance than any other part of the triple. Its requirements demand that it be made as air tight as possible, without excessive friction against its bushing in any position the piston may assume.

If the ring is tight in the groove it should be loosened by means of gasoline without being removed. Removing a ring distorts it. If the old ring is to be used again

it should be turned to the position it first occupied in the groove. If the ring is too tight for the groove, a lapping plate with a blocked pin should be used and the ring brought down to size on a facing plate. Float emery and kerosene should be employed.

Old rings may be removed by means of a tool made from a hack-saw blade which has been ground to a taper. If the groove is found defective a new piston should be used. Rings should fit the bushing fairly snug, and should be lapped to a joint with the use of a light oil. If rings are fitted too tightly the scarf ends of the ring will distort the ring grooves.

If the ring or gage shows the bushing out of round, it should be reamed, rolled or ground to even size before being fitted for packing rings. Care must be exercised in the use of reamers or rollers as they have been known to produce bad bushings.

Feed grooves should be cleaned with pointed wooden sticks, and gaskets and valves of rubber or leather should be wiped off and not scraped. In wiping the various air brake parts, cloth should be used instead of waste.

Slide Valve Repairs—In facing down the slide valve or flat graduating valve, the work should be done on a lead face plate by means of flour emery used dry. Slide valve seats, if badly worn, should be filed with square triple files having ward sides. It is better practice to grind a valve entirely in preference to scraping. Ground glass or carborundum in medium and fine grades should be used. An oil grind with some grade of light oil will finish the work.

Triple valve pistons and emergency valves should be

tested on centers. The graduating stem should work freely in the guide nut, and the graduating stem spring and retarded release spring must conform to standard dimensions and be free from corrosion. Before applying the various parts to the triple, all cap screws, bolts and other threaded portions should be coated lightly with oil and graphite for facilitating future removals.

Care should be used in removing the emergency valve seat and unless the emergency valve rubber seat is in first class condition, it should be renewed.

Slide valve springs should have just enough tension to hold the valve in engagement with its seat when not subjected to air pressure. Excessive tension of the spring places an unnecessary load on the slide valve and increases the resistance to movement, and therefore, impairs the sensitiveness of the valve.

Lubrication—The seats and faces of the slide valves and graduating valves should be lubricated with triple-valve graphite, rubbing it in thoroughly by means of a piece of chamois skin glued to the end of a stick shaved to resemble a paddle. After the pores of the brass have been filled, and surfaces have been polished with a chamois, all free graphite should be removed. If any free graphite remains it is likely to roll up, particularly where moisture is encountered and produce the opposite from the desired effect.

Standard gaskets should always be used, as home-made gaskets do not serve the purpose anywhere near as well.

Check valves should be carefully ground in.

The triple valve packing ring and its bushing should be lubricated with either a light oil or suitable grease. The bush should be lubricated after insertion of the piston, and parts should be lubricated sparingly.

No lubrication should be applied to the emergency piston, emergency valve or check valve, and no triple should be allowed to go in service after being cleaned, until it has stood the test on an M. C. B. tester.

Retaining Valves—The retaining valve is connected to the triple exhaust port, and is used to retain air in the cylinders after the triple has been released and is charging up its auxiliary. The retainer valve and its pipe should be tested each time the brake cylinder and triple valve are cleaned or tested. Tests can be made by fully applying brakes and then releasing with the retainer handles turned up. Three minutes after the triple has moved to release position, it should be noted that the brake shoes are held tight against the wheels, and if considerable air exhausts when the retaining valve is again turned down, the valve and its attendant piping may be considered all right.

The restricted exhaust port in retaining valves should be cleaned each time the triple valve is cleaned. In case the weighted valve or the cock leaks, they may be ground in with grinding compound and the cock lubricated with tallow mixed with a small amount of beeswax.

Every freight car should be equipped with a retainer valve, which should always stand in a vertical position. The location should be such that water cannot gather nor freeze in the vent port. The ideal location is near the brake staff, within easy reach, with at least 1 inch clearance over the cap for removal. On drop end gondola cars they should be located near the top of the right side board, "B" end of the car, and within easy reach from the end sill.

On oil tank cars the retaining valve should be located

on the same side as the hand-brake staff, and on the side of the car directly over the triple valve.

On oil tank cars having outside sills, the valve should be supported by a bracket attached to the sill, and within convenient reach of the running board. On cars not having outside sills, the valves should be attached at a convenient point on the side of the tank by a bracket securely riveted to the tank.

Regardless of retainer valve location, bolts instead of rivets must be used to hold the retainer in place. This is done for the purpose of easy removal.

Brake Cylinders—Cleaning and Lubricating—In removing the piston from a brake cylinder, the piston should be secured firmly to the non-pressure head in order that the tension of the spring may not be lost. It is then possible to remove the head, piston and spring at one time, after the cylinder bolts and nuts have been separated. All dirt deposits should then be removed with a putty knife or similar tool, and rust spots in the cylinder should be scraped out by means of a half round file, ground to a sharp cutting edge. The cylinder should be cleaned with kerosene but care must be taken to see that no kerosene comes in contact with the brake-cylinder leathers as mineral oil destroys the filler which is used to make the leather air-tight.

The leakage groove at the back end of the cylinder should be cleaned out, and in cleaning out the auxiliary tube the triple should be disconnected from its auxiliary.

The expanding ring, when applied in the packing leather, should be a true circle and fit the entire circumference, with an opening at the ends from 3/16 to ¼ inch; when removed from the cylinder the ring open-

ing should be 1½ to 1 9/16 inches, but of course, with this opening the ring will not be a true circle. Rings should be closely examined and should not be used if they have the wrong dimensions. Old rings should be repaired and gaged.

Leathers should be turned flat to reveal cracks and weak spots. Packing leathers worn more on one side than the other should be turned so as to bring the thin side at the top of the cylinder. If the wear is extreme, new leathers should be used. Pistons should be turned each time cylinders are cleaned, and in applying new leathers be sure and place the flesh side of the leathers on the piston in such a manner as to bring it against the walls of the cylinder.

In lubricating the cylinders a suitable compound should be used lightly upon the cylinder walls and upon the outside surface of the leather. Lubricant must not be placed on the inside of the packing leather.

A thin coating of lubricant must be applied to the entire interior cylinder wall with a brush.

In entering a piston, care must be used or the leather will be injured. Blunt flat bands of iron serve the purpose nicely. After entering the piston part way, describe an 8-inch circle with the piston sleeve. In case the expanding ring is out of place this cannot be done.

Stencil marks should be scraped off or repainted. The place of cleaning, day, month and year must be stencilled with white paint, preferably on both sides of the cylinder or auxiliary reservoir.

M. C. B. Recommendations—The M. C. B. Association in their circular No. 20, dated November 25, 1918, says in part:

"Inasmuch as inspection shows that the brakes on a great many cars are not now being cleaned, even in 12 months, it is recommended that wherever possible, they be cleaned at the expiration of the nine month period.

"Third, that all roads not equipped with the standard triple valve test rack and the standard air brake hose coupling gage, procure them as soon as possible.

"Fourth, that the number of brakes cleaned yearly by each road should equal or exceed the number of cars owned.

"Fifth, that special attention be given to maintaining brake pipes, brake cylinder, reservoir, retaining valve and pipe secured to the car.

"Sixth, that angle cocks and cutout cocks should have operative handle with proper clearance."

The nuts holding the cylinder and auxiliary to their respective plates, and the latter to the car, should be securely tightened. This is very important. A majority of brake pipe leaks occur at the triple valve union, because the auxiliary reservoir and cylinder have become loose on the car.

Testing Brake Cylinders—An air gauge should be used in testing a brake cylinder for leakage. Connections should be made at the triple exhaust, before the retainer pipe is connected up.

With the latest type of retainers, the gage should be screwed into the exhaust port of the retainer.

After the auxiliary has been fully charged, sufficient reductions of brake-pipe pressure are made on the outside shop tester to produce 50-lb. brake-cylinder pressure. The triple is then released. With the gage attached to the exhaust no brake-cylinder air can escape.

Brake-cylinder leakage should not exceed five pounds per minute. By following this method the exact amount of leakage is determined because there can be no loss through the triple.

Where the triple and cylinder has been cleaned and tested the brake pipe and strainer should be thoroughly blown out; the branch pipe, and the triple valve strainer should also receive cleaning attention.

Piston Travel—Running piston travel on cars should be 8 in. Due to the various movements of parts in motion, it has been found that running travel is greater than standing travel. Therefore, in taking up slack on standing cars the travel should not be less than 6 nor greater than 7 in.

Rip Track Inspection—All cars on the rip track for repairs should be tested, regardless of dates stenciled on the auxiliaries or cylinders. Cars should be coupled to the yard testing plant, and brake pipe leakage reduced to 3 lbs. per minute, and the triple valve tested to determine whether it will properly apply and release. At the same time, the retainers and piping should be tested and piston travel adjusted. A regular tester should be used for this purpose.

In inspecting a repaired car, attention should be given to pipe clamps. Missing ones should be applied and loose ones tightened. Hose and angle cocks should be turned to proper angle and position.

Pipe joints, air hose, release valves, angle and stop cocks should be tested by means of soap suds under 80 lb. air pressure.

Look out for missing or defective brake shoes, brake beams or foundation brake gear, and see that the levers,

and rods are of the proper dimensions and have the proper angle. Brake levers should stand at approximately right angles with their rods, when brakes are applied with correct piston travel.

The hand brakes should be examined to see if they are in a satisfactory condition.

CHAPTER X.

AIR BRAKE RECOMMENDATIONS

Most of the common air brake troubles are due to oversights which in themselves seem small, but which in time, prove costly.

Brake Cylinders and Reservoirs—The brake cylinder and reservoir should be located in the most accessible place to facilitate inspection and repairs; and where steel reservoirs are used they should be attached by means of wrought iron straps, as finger or end clamps allow the drum to become loose and cause pipe leaks.

The brake cylinders on freight cars should be attached to steel or wrought iron plates, of ample strength to prevent deflection under brake applications. Where wood is used it has been found that the cylinders cannot be kept tight.

In bolting the reservoirs and cylinders to the car all bolts should have locking nuts or cotters. Bolt heads should be set in socket washers. Where possible, it is better practice to use the combined type of cylinder and auxiliary reservoir in place of the detached type, to prevent the leakage from extra piping.

Release Valve and Rod—Where possible, the release valve should be located on top of the freight auxiliary, with a rod of ample strength (not less than ⅜ round iron) extending to the outside of the car, with a substantial support at outer end of rod.

Bleed cocks, on auxiliary and supplementary reser-

voirs on cars having deep center sills, should be provided with a rod extended through the center sill, to the side of the car opposite the reservoir. This allows an easy release from both sides of the car.

Automatic Slack Adjusters—Slack adjusters function so automatically that they receive, as a rule, insufficient attention. They should always be cleaned, lubricated and tested each time the brake cylinder is cleaned. Its cylinder should take the same lubricant which is used in the brake cylinder when the adjusters, packing leather, and expander are examined. Dry graphite should be used in the ratchet nut for the screw. Type "J" will take 10 cu. ins.; type "K," 14 cu. ins. Graphite used in greater quantities will cause caking.

Slack adjusters are tested with a brake cylinder piston travel of 10 ins. and initial pressure of 50 lbs.; allowing not more than 5 lbs. leakage per minute.

Pipes—In piping, sharp bends and elbows should be avoided as they cause friction in the passage of air. Pipes should be hammered and blown out on both new and old work before being connected up; and in making joints a mixture of graphite and oil should be used. It is better to use a superior grade of pipe and pipe fittings for all air brake and signal pipe work.

Brake Pipe—On passenger equipment 1¼ in. extra heavy pipe should be used for brake pipes, and on freight equipment cars, 1¼ in. standard weight pipe should be used.

Pipes should not sag or contain pockets, and substantial pipe clamps should be used in sufficient numbers to keep pipes from shifting or vibrating. In clamping any pipe it is well to remember that the pipes

should be held at the center of vibration. Leaks occur rapidly at joints when a pipe is securely clamped at its ends and is allowed to vibrate at its center.

On all cars, a nipple 10 ins. long should be used behind the angle cock to facilitate future repairs. On coal carrying and refrigerator cars, 1¼ in. galvanized pipe should be used.

Branch pipes should be so piped as to permit no strain on the triple valve.

The brake pipe on the ends of cars should comply with M. C. B. standard. This is very important as any deviation will cause a long or short connection between cars when coupled up.

Centrifugal Dirt Collectors should be used and they should be placed between the cut-out cock and triple, as near to the latter as convenient.

Retaining Valve Pipes—One elbow should be applied to the retaining valve pipe, it being located at the end sill of the car where the pipe turns upward. (M. C. B.)

The pipe should be carried along the side of the intermediate sill when practicable, from the triple valve to end of car, and be supported by clamps not to exceed 6 feet apart, with the first clamp 6 ft. from the triple valve. Retaining valve pipe should run horizontally from the triple, then upward and extend to end of car by means of two right-angle bends, with union in horizontal pipe connected to triple by a pipe nipple 5 ins. or less in length. The object of this installation is to provide flexibility in case the reservoir and cylinder shift position during a brake application. Galvanized pipe should be used on coal carrying and refrigerator cars.

The vertical retaining valve pipe on end of car, passing through hand-brake step, should be entirely free from bends, so as to permit removal when necessary. The step should be slotted at least 2½ ins. so that the pipe may be shifted in case the retainer requires removal.

Triple Valve Exhaust Pipe—All triple valves not connected with a retaining valve should have an exhaust pipe about 6 ins. long, screwed into exhaust port and bent downward.

Braking Power—The light weight of a car, in connection with an established brake pipe pressure (or the resulting brake cylinder pressure, with brakes fully applied) are used in determining the proper ratio of brake force necessary.

The recommended brake pipe pressure to be used in determining braking ratio for service application should be 110 lbs. for passenger cars and 70 lbs. for freight cars.

The following table covers Type of Equipment, Type of Control Apparatus, Brake Pipe, and Cylinder Pressure:

Type of Equipment	Type of Control Apparatus	Brake pipe pressure	Brake cyl. pressure	Braking ratio Corresponding to cyl. pressure percent
Passenger Cars	Quick Action Triple of all Types.	110	60	90
Passenger Cars	P. C. Passenger Control	110	86	90
Passenger Cars	U. C. Universal Control	110	60	90
Freight Cars	Quick Action Triple Valves—All Types	70	50	60
Freight Cars	Empty and Load Brake Equipment	70	50	60 40

Leverage—The total leverage on all passenger and freight equipment cars must not exceed a proportion of 9 to 1 and truck levers on four wheel trucks must not exceed 4 to 1.

For both freight and passenger equipment the hand and power brake should be harmonized; in other words, they should work in the same direction so the power brake can take care of the hand brake slack.

With new shoes and tires, the brake rods should be of such length that, with all slack out, the piston travel will be from 6 to 7 ins. Many times the slot in the struts of the brake beam does not allow full movement of the levers, and special inspections should be made of this.

Many designs of brake rigging do not fully compensate for shoe wear and tire turning. Such cars will require brake rod changes to compensate for this faulty design when worn shoes and turned wheels occur.

The use of inside hung brakes is unanimously conceded as best practice. The rigging is more compact, and the beam suspension from the truck instead of the car body maintains the rigging in its proper position as related to the truck, which is impossible on car body suspension.

Truck suspension insures the maintaining of proper shoe height from the rail, regardless of the loaded or light weight of the car. This is important as the lowering of brake shoes as the car is loaded, causes excessive piston travel. Low hung shoes, also, produce low braking power and create excessive strains on brake hangers. It is preferable to have hangers not less than 10 ins. in length and they should hang at right angles

to the imaginary line drawn from the center of the wheel to the center of the shoe. Brake beams should not be less than 13 ins. from the rail to center of shoe at face.

Figuring Braking Power—Braking power can be ascertained by finding the push rod force. Freight cars are braked at 60 per cent of their light weight, on a basis of 50 lbs. in the brake cylinder. To find the area of a brake cylinder, multiply the radius of the cylinder bore by itself and then multiply the result by 3 1/7. If the last result is then multiplied by 50 lbs., the final result will represent the pound pressure on the push rod.

In figuring leverage, the point on the lever where the unknown force is applied is called the weight. The second point is where the known force is applied and is called the power. The third point is called the fulcrum.

Regardless of where these points occur, the power arm is always the distance between the power and the fulcrum, and the weight arm is always the distance between the weight and the fulcrum.

The power multiplied by the power arm and the result divided by the weight arm gives the weight as an answer.

The power multiplied by the power arm and the result divided by the weight gives the weight arm as an answer.

Recommendations—Automatic slack adjusters should be used on all passenger cars, in order that the vehicle may always have proper running piston travel.

High speed brakes should be applied to all passenger equipment cars.

Foundation brake gear on all modern passenger equipment cars should be designed so as to withstand 105 lbs. brake cylinder pressure. Foundation brake gear on freight equipment cars should be suitable to withstand a brake cylinder pressure of 85 lbs., except where the Empty and Load Brake is applied, when 60 lbs. cylinder pressure in both cylinders should be used as a basis in determining the strength of the rigging.

The length and location of brake lever guides should be such as to provide for full take-up of slack by the automatic slack adjusters, with 11 in. piston travel, without permitting levers to strike. Where brake levers extend through steel underframes, the slots in frames should be sufficiently long to permit of free movement of lever with shoes worn out and with 12 ins. piston travel.

Brake beams should be provided with proper support to insure best efficiency and service from both the brake beam and brake shoes.

When cars are in for general repairs, the foundation brake rigging should be thoroughly inspected and all excessive lost motion eliminated. All pins should be removed for inspection, pin holes trued up, and new pins applied wherever necessary.

M. C. B. Brake Beam Requirements—(1) Standard length of brake beams from center to center of heads to be 60 ins.

(2) All brake beams for heavy capacity freight cars and modern passenger equipment cars to endure maximum load at center without more than 1/16 in. deflection.

(3) Height of brake beams measured from top of

rail to center of face of new shoes to be 13 ins. for inside hung beams.

(4) Angle of brake beam lever to be 40 deg. from vertical.

(5) Beam No. 2 must be used on cars of more than 35,000 lbs. light weight and it may be used on cars of 35,000 lbs. light weight or less.

(6) Pinholes in brake beam struts to be drilled or reamed out to properly fit pins.

(7) The brake beam hanger bracket must be attached to some rigid portion of the truck.

(8) Brake beam hangers to be of ample length to allow for shoe and tire wear without causing a radical change in the angle of suspension.

(9) Angle of brake hangers to subtend 90 deg. with a line drawn through the center of wheel and center of brake shoe when the brake is applied. This is to apply with shoes half worn.

(10) Where brake beam release springs are necessary, they should be so designed that each will not exert a force upon the brake beam on which it bears, of more than 25 lbs.

Hose—Standard M. C. B. hose should be used for the brake pipe on both passenger and freight cars. Sample hose from each series should be tested as prescribed in the M. C. B. recommendations. In applying fittings to the hose, care must be taken to see that the ends are smooth and free from sharp edges. Rubber cement and not oil should be used in applying. Couplings should be gaged and those over the limit must not be used. Gaskets should measure to M. C. B. requirements.

Cars on repair tracks should have hose tested for leakage by the use of soapsuds, when weather conditions will permit, and if found porous, or leaky around

the fittings, should be removed. In applying the hose the threaded portion of the air hose nipple should be coated with a mixture of graphite and oil.

Most hose fail due to the elements finding their way to the ducking from openings in the outer and inner lining of rubber. An uncoupled hose swings sufficiently to wear out at the nipple end. Air hose should be provided with an approved, nipple-end protector. Many cases of leakage can be avoided by turning the angle cock to the correct angle and by repairing couplers which are over limit on the gage.

Hand Brake Power—(1) Hand brake power for passenger equipment cars to be based on a pull of 1,500 lbs. at hand brake staff chain when a 24 in. lever is used.

(2) Sufficient hand brake chain and space on staff should be provided to prevent chain from lapping double or fouling; this with sufficient slack in brake rigging to produce 12-in. piston travel.

(3) Hand brake power for passenger equipment cars to be not less than 40 per cent of the light weight of cars or greater than 80 per cent.

(4) Hand brake power for freight equipment cars to be calculated with pull of 1,500 lbs. on hand brake staff chain.

(5) Hand brake power for freight equipment cars to be equal to 50 per cent of light weight of car.

(6) Where a compression spring is used with hand brake levers, it should be of ample length to permit maximum movement of levers with 12-in. piston travel, without fouling or spring being compressed solid.

These recommendations are based largely upon the requirements of the Air Brake Associations and the Master Car Builders' Associations.

CHAPTER XI.

TESTING FREIGHT TRAIN BRAKES

Freight trains should receive the same tests as passenger trains before leaving a Terminal. The co-operation of two departments is absolutely necessary. The Mechanical Department must supply the men, the right kind of men, and enough men to handle the work quickly and well. The Transportation Department must allow time for these tests. Most road delays due to faulty equipment are caused by lack of Terminal inspection.

Compressed Air at Yards—Many freight yards are equipped with compressed air for testing trains and such work is facilitated by such installations. Nevertheless, it is generally acknowledged that the best method from a practical standpoint consists in using an inbound test in order to save time in switching out bad orders. An outbound test should also be used as a check.

Incoming Test—Enginemen and trainmen of freight trains on arrival at terminal will leave the brakes applied by a 20 lb. service reduction made from 70 lbs. Where the engineman has made an automatic application for stopping he will, as soon as stopped, add to it by one further, continuous reduction, sufficient to make a total of 20 lbs. On its completion he will give one short whistle blast as advice to brakemen that he may cut off, and to inspectors that inspection may begin.

When the train must be left on two or more tracks, or crossings must be cut, those concerned will follow the foregoing plan before cutting off each part.

On brakes being applied, as indicated by whistle signal, inspectors will at once and rapidly examine for piston travel, brakes failing to apply, any that have leaked off, and brake-pipe leaks. At this time make no repairs; merely indicate the defects with chalk.

After completing inspection, repair the defects that should be cared for in the yard. For other defects bad-order cars for repair tracks unless impracticable, as with perishable or time freight. The air brake and the general inspection should not be combined.

Piston Travel—Adjust incorrect piston travel (4 ins. or less or over 8 ins.) close to 7 or 8 ins., but before marking for apparent short travel, be sure, by trying brake beam, that the brake has not partially leaked off.

When making the incoming brake test it is necessary for the inspector to go over the train quite rapidly to inspect all the cars before the brakes leak off. Most men are unable to judge the distance the piston travels without going under the car, and, for that reason, rarely mark a car for brake adjustment unless it has a very long travel.

In order to overcome this trouble the measuring device described in the following may be used. It consists of a scale 12 ins. long mounted on a handle 4 ft. long so as to resemble a "T". Both parts are made of seasoned pine material and the handle should be made ¾ ins. round.

The scale is painted black and stenciled with white

figures one inch apart with proper markings. The figures should start from figure "6" in the center and go to figure "12" in both directions so that either end of the scale may be used. Scale should be 5/8 ins. thick and 1¼ ins. wide.

The handle is made 1¼ ins. wide at the end where the scale is jointed to the handle. By holding the scale against the piston rod the travel can be checked rapidly without getting under the car.

Consider cars over twelve months since brakes were cleaned as having defective brakes. Loads that cannot be held for brake repairs earlier will, where the destination is a terminal, be marked on arrival, "B. O. when empty" with date, and will be delivered to repair tracks as soon as practicable after unloading.

The following form is a very good one to check up the amount of work done at the different repair points and as the date of previous stenciling is included they can at once note any indication of poor workmanship which would result in cars from any particular repair point having to be recleaned before a reasonable service is secured.

NAME OF ROAD

Report of Air Brakes Cleaned.....Repaired
and Lubricated.....at.....Station
Month.....Year.....Car .....Date
Previous Stenciling.....Initial.....No. or Name
..... Class.....Date.....
Shop Remarks .....

Records—There should be two record books used by the air brake cleaner; one is turned in every night,

with a record of all work done that day, and the other book is issued for the next day's work.

The advantage of having the stenciling for air brake cleaning applied so that it can be seen on both sides of a car, is apparent.

Brake Pipe Tests—Brake-pipe leakage is one of the most liberal contributors to train shock and break-in-twos. It wastes air, takes away from the engineman the ability to control the amount of brake applications, contributes to brakes sticking, causes overheating of the air compressors and even prevents the maintenance of standard brake-pipe pressure. The maximum brake-pipe leakage allowable should not exceed 7 lbs. per minute as determined by standard test. This test should invariably be given before out-bound trains are allowed to proceed.

Out Bound Test—After the engine is coupled to train and air brake system completely charged to 70 lbs. a brake-pipe reduction of 10 lbs. should be made and the brake-valve handle then placed in lap position. A leakage greater than 7 lbs. per minute is excessive and should be taken care of. Evidence of leakage is found by noting the air gauge in the cab of locomotive or the caboose gauge. Train should be stretched during this test.

Brake-pipe leakage is produced in numerous ways but the most common causes for it are poorly clamped piping that will permit shifting in switch movements or shocks which occur along the road. Allowing train and yard men to pull hose apart instead of separating them by hand creates many leaks in time, as this produces spread coupling jaws, destroys gaskets and creates porous hose. Excessive slack tends to stretch hose,

causing them to open. Auxiliary reservoirs, loosely bolted, tend to create leaks at the triple union nut.

The other factors which assist in producing leakage are brake pipes applied out of proper height and distance from the face of the coupler, nipple ends broken off, and new threads cut on old nipples and angle cocks not given the proper angle toward center of the track, all of which do their "bit" toward producing shocks and break-in-twos.

Brake Rigging Inspection—In the work of inspection, special attention should be given to certain parts of the brake rigging. Brake beams, brake-beam connections, and brake hangers should be carefully inspected to see that they are in good condition with brake-connection pins in place, and cotter or split keys properly applied and opened.

Brake levers and lower brake-connecting rods to be inspected to see that they are in good condition and brake beams and beam connections examined for defects.

Brake hangers should be inspected at the brake head to see that they are not worn till unsafe. This should also apply to hanger at truck connection, to see that the hook or eye are not worn to unsafe limit.

Testing Hand-Brakes—Hand brakes should be tested to see that they are in operative condition and the brake chains not too long to prevent fouling when brakes are applied. Brake chain links should not be less than ⅜ in. in diameter at any point.

Brake wheels, brake-ratchet wheel and brake-ratchet pawl should be inspected to see that they are properly retained and careful inspection should be made to see that they are properly maintained.

Bolts and pins used in connection with hand brakes should be in place and properly secured.

Triple Valve Leaks—Triple-valve defects are caused by leaking slide valves, check valve case gaskets, or rubber-seated valves, main piston packing rings, defective auxiliary reservoir tubes and defective graduating springs. A blow from the triple valve exhaust indicates valve leak or a rubber-seated valve leak. If the blows stops with brakes applied, the trouble is in the triple valve slide valve. The test is made by cutting out the cut-out cock to the triple valve. If the slide valve is known to be all right a triple valve gasket is leaking or there is a defective auxiliary reservoir tube. A slide valve may cause a blow in any position the triple valve assumes, but a defective tube or body gasket will only produce a blow in release position of the triple valve.

A leaking piston packing ring may keep a brake from applying when a light reduction has been made on a long train, and invariably this triple valve will have difficulty in releasing, causing stuck brakes. A dirty triple or a defective graduating spring will cause undesired quick action. A triple acting this way is known as a "dynamiter". Many times the blow at the exhaust port of a triple valve may be stopped by jarring the triple valve with a hammer.

Stretching the Trains—A stretched train exposes many leaks passed unnoticed in a bunched train. Many points use a yard air plant for testing trains and it is generally admitted that such an installation saves considerable time and labor; but it must be remembered that brake pipe leakage represents the greater part of

air-brake defects, and with a yard plant there is a tendency to test trains as they are found, which means as a rule a bunched train. It must be understood that a test for a full train or its sections must be made when the train is stretched, regardless of whether the test is made by locomotive or yard plant.

At many points where time is not available, extra gangs should make the repairs as found by the inspectors. There is a tendency on many roads to have an inspector cover all parts of a car on his task of inspection. This is objectionable for two reasons. Air leakage demands quick attention if the defect is to be located. Furthermore, the importance of the air brake demands the full attention of an inspector.

If a freight train receives the same attention as is given a passenger train innumerable delays now prevalent in this particular service will be eliminated.

CHAPTER XII.

DERAILMENTS AND DERRICK CARS

Derrick cars are placed at various points for picking up wrecks. It is a rule at the principal points, to keep the boiler under steam and ready for instant use. A regularly organized gang should accompany the derrick.

The cause of each derailment should be determined if possible, with the view of preventing a reoccurrence due to a similar cause, but it is very often a difficult matter to place the blame between the operating, maintenance, and mechanical departments. It is the duty of the representative of the mechanical department, authorized to render the report, to look the territory over carefully to see if defective car equipment is responsible.

Many different causes enter into derailments, and the mechanical representative should know what indications to look for in his investigation.

Derailments are caused mainly by mechanical failures or imperfections in cars, locomotives and track. Often such failures are a combination of defects between two of the above factors, as for instance, a car having wheels with worn flanges or tread worn hollow may climb the rail at a point in a curve where the track is out of line, surface or gauge. The flanges being worn decrease the gauge of the wheels and increase the liability of the wheel to leave the rails where the gauge is wide.

Low joints in track may cause a fracture of an arch bar in cold weather, which in the majority of cases results in a broken truck and often a derailment.

More derailments have been caused by failures of brake beams and connections improperly supported than by any other part of the car. Broken brake hangers, and bolts, missing cotter keys, shoes and brake shoe keys, and broken and worn cut brake beam heads contribute to the causes of derailments.

Defective wheels are also responsible for many serious wrecks. This fact may be coupled with operating conditions as resulting in brake-burnt and slidflat wheels. A car may leave a terminal under normal conditions and before it has traveled very far, perhaps only 50 miles, the air brake may become defective or inoperative; or other conditions may arise which will cause the wheels to heat and break.

One common cause of derailments is so-called "spread track". The lateral movement of both cars and locomotives is normally about 1¾ inches. This lateral movement at high speeds causes a continued and sufficient pressure against the rails to force them out of gauge.

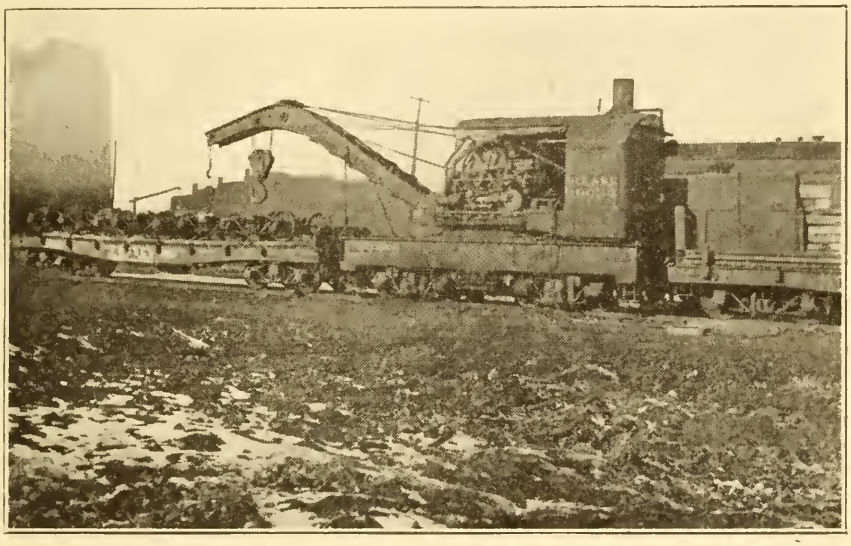
Straight track is maintained easier than curves and it is a noticeable fact that more derailments occur on curves than on straight track.

Loose and low joints causing incessant pounding in the early part of the spring before the frost is entirely out of the ground, tends to loosen spikes a few feet each way from each joint and in such cases a rail may "turn over".

The locomotive is harder on the track than the cars. It has a long wheel base, which tends to force the rails out on curves. The tractive effort also, exerted in a curve, tends to force the rails apart. The heavy wheel loads of the locomotive on the track, if the track

is not well supported, tend to strain and gradually weaken the rail,—"part new and part old defect"—as it would be shown in the Casualty report.

In handling wrecks or derailments, the object in view, if the main lines are blocked, is to clear one main line as soon as possible. The train dispatcher will advise which one should be cleared first if one is as easy to clear as another. Methods used vary with the size



The Strong Arm of the Car Department, Better Known as the "Big Hook".

of derailment, cars or engines involved, and lading of cars, together with facilities for working and the location of the derailment. Here again the dispatcher's knowledge of the location and conditions will be of value to the wrecking foreman and it is good policy to get in touch with him before leaving the terminal. Conditions that exist and where work can be started to advantage, will then be known before the outfit leaves the terminal.

The trainmaster often accompanies the wrecking outfit, and in such cases the wrecking foreman may rely on him to keep in touch with dispatcher and notify him when extra trains are due.

The photograph shows a 100 ton wrecking derrick which is used in handling cars and locomotives which have been derailed.

The flat cars at the left contain auxiliary trucks to be applied to wrecked cars; and the one at the right is equipped with a water tank and is used for storing a supply of blocking and chains to be used in handling cars. The combination sleeping and dining car is seen in the background.

A tool car for jacks, cables, rail clamps, tackle blocks, torches, lanterns, bolts, brasses, track spikes, track bolts, and a various assortment of tools, is also necessary in every well organized wrecking outfit.

The wrecking crane or "big hook" generally comes under the direct supervision of the car foreman. When not out on the road it serves a valuable purpose about the rip track in handling heavy parts such as timbers, trucks, car wheels and sills.

CHAPTER XIII.

HOT BOXES.

The idea prevails among many that the care of the car journal is simply a process of stuffing the journal box full of oil-soaked waste. But men experienced in this branch of lubrication realize that it is a subject of vital importance. More economical methods are being evolved daily, as is proven by the fact that although the equipment is heavier and the cost of materials has increased, the lubrication costs have been reduced from year to year, simply because better methods are used, eliminating the waste caused by improper oiling.

Oil on the ground settles dust but does not prevent hot boxes. It is possible to prevent hot boxes on cars, and avoid consequent delays and possible accidents by a thorough understanding of lubrication.

It is impossible to compute, with any degree of accuracy, the total cost of one hot box to a railroad company; but when one considers the delay to the train, the loss of revenue if the car has to be set out, the cost of sending men out with material to make repairs, the loss of material through damage or destruction of journal, brass or packing, the damage to the body of the car, the occasional necessity for replacing the wheels, and even the entire destruction of the particular car—all of these make the hot-box expense a huge one. There is also the danger of the car being left adjacent to buildings or explosives, and causing additional damage.

Due to the fact that this interesting subject has been covered from so many different angles, there has been great diversity of opinion on just what represents the ultimate cure. Unfortunately most articles treating on this subject have dealt with but one phase, and coming

Two Hot Boxes Are Shown on the Second and Third Cars. A Very Familiar Scene to Most Carmen.

from a seemingly reliable source, they have drawn a number of converts to different methods of checking this trouble. Hence various roads follow various methods to combat these hot box epidemics.

Which is right? No doubt all are to a greater or

less degree. Few attack the problem with a knowledge of all the contributing causes.

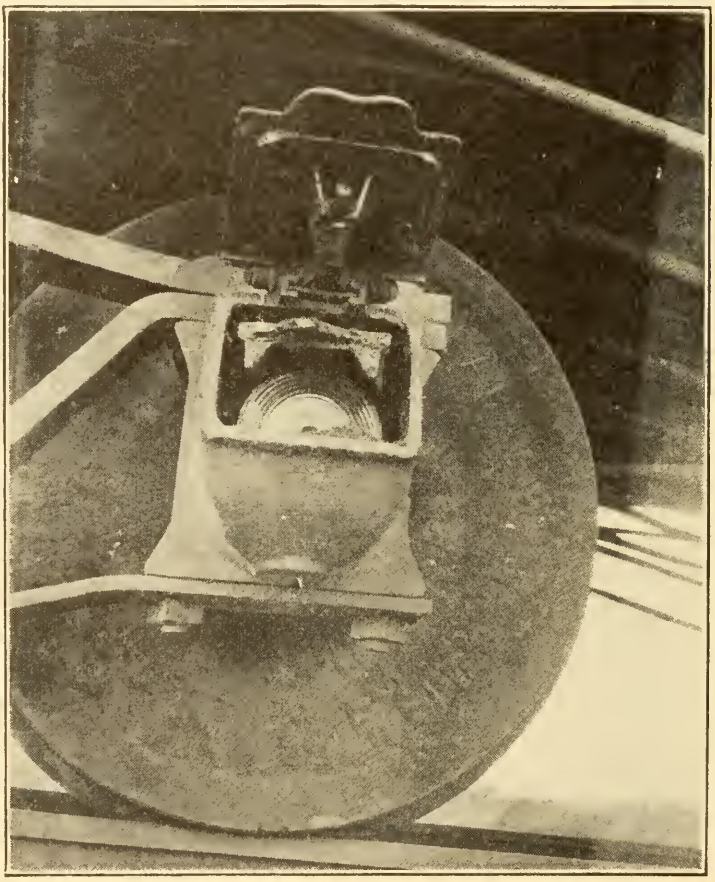
Hot boxes originate from two major causes; excessive pressure and lack of wick contact. With the car oil generally in use, a pressure over 800 pounds per square inch on a journal will force oil out and allow a contact of the brass and journal. Weights on journals are so figured that about one-fourth of this weight is generally placed on every square inch of the bearing surface of the journal. Therefore under proper running conditions an overloaded car would not run hot as cars are never loaded four times greater than their capacity. What then creates this excessive pressure sufficient to create hot boxes? It is caused by unequal distribution of weight usually due to imperfect car brass wedges.

The top surface of the M. C. B. wedge has a 78 in. radius. This imposes the weight allotted for that journal on the center of the wedge to be distributed over the brass evenly.

With the top of a wedge worn flat, any irregularity of the brass will cause excessive pressure at either one end of the brass or the other, and instead of there being a pressure not greater than 300 pounds to the square inch, the pressure runs sufficiently high to destroy the oil separator between the brass and the journal. Loaded cars will feel this effect sooner than light cars, but let it be understood that with a car brass wedge distributing an even weight per square inch over the bearing surface of the journal, an ordinary overload will not create a hot box. It is plain, therefore, that car brass wedges should be gaged before being applied, and imperfect ones sent to the reclamation plant.

Excessive Friction—Excessive friction is caused by

defective lubrication or excessive bearing pressure. Defective lubrication may be the result of using an inferior lubricant, an insufficient amount of lubricant or because not enough oil reaches the journal. There will



The Tips of the Wedge Are Broken and the Wedge has Worked Partially Out of the Box. This Causes Excessive Bearing Pressure at the Front of the Journal. The Result is a Hot Box.

be insufficient lubrication if the packing is not up against the journal or if the waste has insufficient capillary attraction.

Capillary attraction is the power which conducts or delivers the oil from the bottom of the box to the journal. Wool waste has less capillary attraction than cotton. Packing should have capillary attraction, should be absorbent so that it will carry a large quantity of oil, and should require replenishing but seldom. It should be resilient so that a small quantity can be used, and so that it can be depended upon to bear with light, persistent pressure upon the journal.

An inferior bearing metal contains hard spots, which alone bear when the soft metal is worn, thus letting the hard spots carry all the load. This condition exists where brasses are relined at the local shops, at which places babbitt is collected from various machines in the shop and is likely to be mixed with steel shavings, etc. In cases where this kind of babbitt is used, it is good practice to take a light cut over the bearing face with a boring bar grinder on a specially designed machine which smoothes the face of the brass.

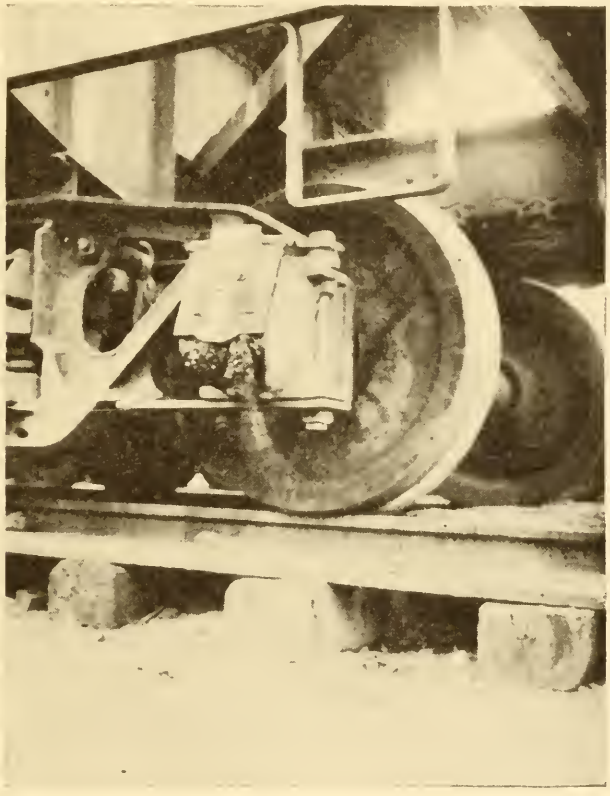
Brass and lining should be true to designed dimensions so as to fit the wedge and box perfectly, and must have sufficient strength to support the load without buckling; and material should be used which the oil will adhere to easily. The metal must be hard enough to hold its shape under the load and temperature to which the service subjects it. It should be soft enough to soon shape itself to the greatest number of irregularities in the journal, thus increasing the bearing area and reducing the pressure per square inch. It should be soft enough so that it will be injured by grit before the journal is (for it is much easier to change a brass than a journal); but it must not be so soft that it would be injured by very soft substances which would

grind up without damage. It should not be seriously affected by the usual temperature changes. It should not, when melted, have a tendency to cling to the journal. It should be a good conductor so as to quickly carry away the heat that is generated in service, and not keep it confined at the actual bearing surface.

Insufficient bearing surface may result because of the journal having a bearing on the sides and no bearing on the crown; thus relieving the crown of the load it should carry and causing a pinching of the journal. Or the bearing may be too loose on the sides, causing a concentration of the load on a small part of the crown that the sides should help to carry. Excessive bearing concentration results if the journal is too small or if the bearing metal is raised off the journal by the pressure of foreign abrasive or cutting particles, or if the bearings are out of alinement, as in the case of truck sides being out of square with the axles. When part of the bearing is relieved from carrying its proportion of the load, part of the journal in contact is overloaded. This uneven contact is noticeable on worn bearing brasses which are removed.

Lack of Wick Contact—Lack of wick contact is the most common source of hot boxes. The average oil box on our cars contains a gallon of oil, and an examination of a train shows wheel plates covered with oil that has run out the opening at the back end of the box, which is considerably lower than the opening at the front. All the oil in creation, however, will not keep a box from running hot if the wick or dope is not in contact with the journal. Many things cause lack of wick contact; *wrong kind of packing*, dope with short ends, fibre without resiliency, dirty dope and

improper packing. Dope should have long threads and be permanently resilient. Dope should be rolled loosely by hand with the long threads wrapped over the



The Illustration Shows One of the Common Causes of Hot Boxes. Loose Strands of Waste Left Hanging Out of the End of the Oil Box will Act as a Syphon and Draw the Oil out of a Box Wicking and Cause a Hot Box Due to Lack of Lubrication. This Shows How Necessary it is that no Strands of Packing be Left Hanging Out to Allow Oil to Drip Away.

rest similar to a pillow. Boxes should not be packed too high or too tight. The use of an adjustable dust guard is strongly recommended to prevent dust and

snow entering the box, and in addition a back plug should be used and box should not be packed in front of the collar. The use of packing with permanent resiliency or spring to make constant wick contact will show the biggest improvements.

Capillary Attraction—Insufficient capillary power may result from the packing being charred, or covered with sand and grit, or by the oil having been washed out and packing soaked by water or melting snow.

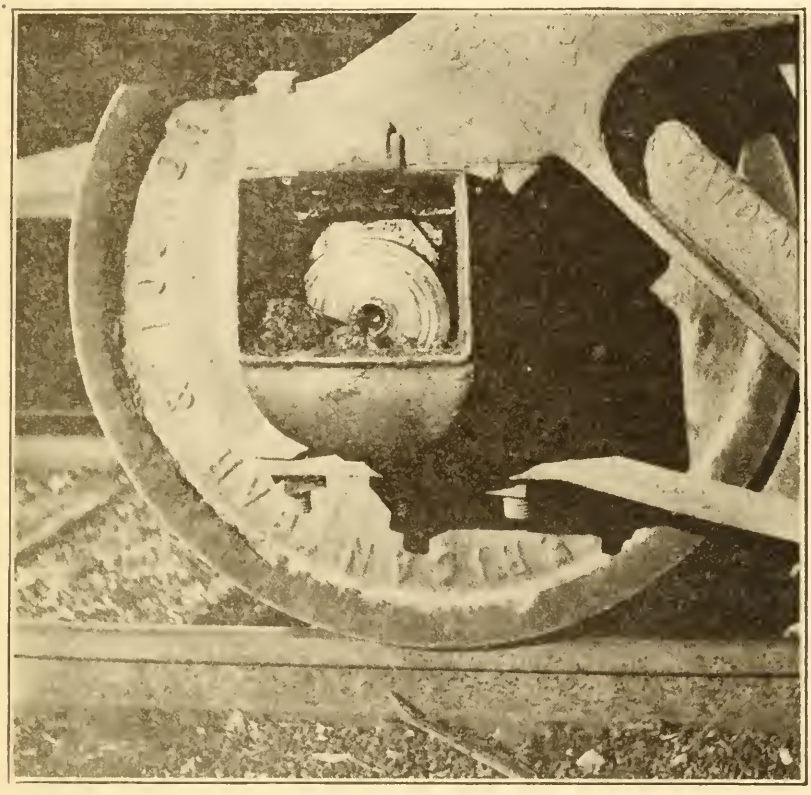
"Dry waste" is caused by waste remaining in the box too long without attention, boxes standing in water, strands hanging out the end of the box, crack in box, or waste improperly prepared. "Dirty waste" is caused by improperly fitting dust guard, oil box cover lost or not fitting close to the oil box, and carelessness of the packer. Water causes ordinary waste to lose its resiliency.

A test on saturation may be made quickly by grasping a piece of waste in one hand and squeezing it tight; if a small amount of oil shows up on the back of the hand, between the fingers, the waste contains sufficient oil. The fibers may be tested by picking up a piece of saturated waste and pulling it apart; if the fibers come apart without breaking after it has been separated 10 to 12 inches, they are too short.

All packing contains a certain percentage of short stock which is by no means valueless; in fact, if all the stock were long the waste would be extremely hard to separate into proper portions for packing, as well as being almost double in price.

Maintaining Box Covers—At this point it might be well to note some of the preventive measures which may be taken to reduce the likelihood of hot boxes. Dirt

entering the journal box causes the waste to lose a great deal of its resiliency, and consequently destroys the wick contact. A packing which does not depend alone on the resiliency of the waste, will improve this condition. The importance of maintaining oil box covers is not generally recognized today. The argument has been

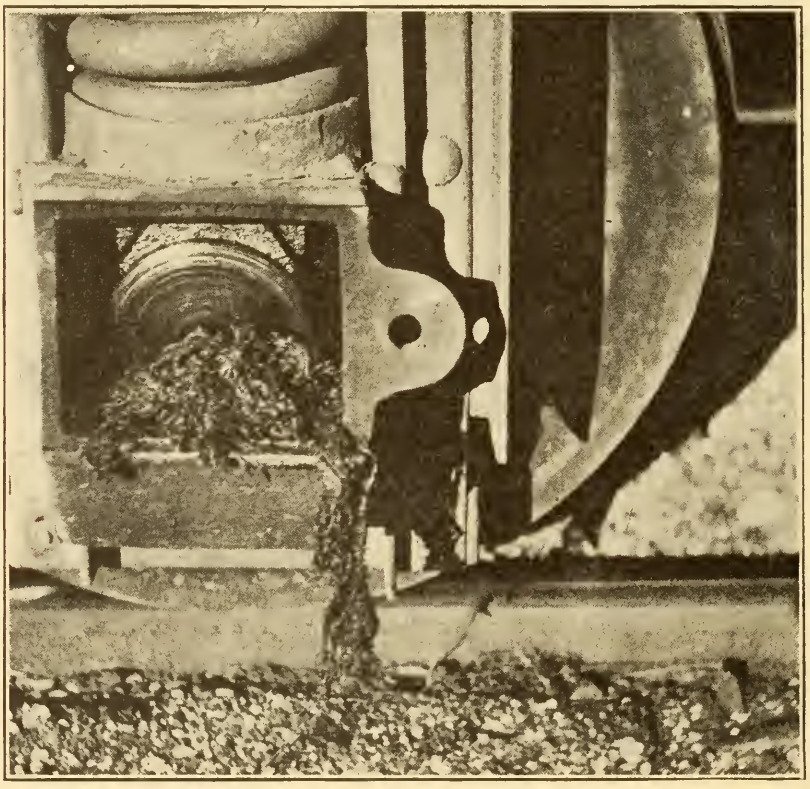


Journal Boxes Are Equipped with Lids and Should be Maintained. Dust and Sand in the Box Destroy the Wick Contact.

made that a box with a missing cover seldom or never runs hot. There may be some truth in this, but if we are to keep foreign substances from the oil and waste

in the journal boxes the box cover should be maintained. A tight fitting lid keeps the oil in and the dirt out.

Cars that are in coal, ore, sand, dirt, or ballast service should be especially watched as the dust from the load gets into the box and acts as an abrasive. It also mixes with the oil in the dope and the mixture draws the wicking away from the journal.



A Familiar Sight in Many Train Yards. Such Conditions Should be Corrected at Each Terminal.

The illustrations show the condition of packing in two boxes without covers. The absence of covers is a leading reason for "robbed" journal boxes.

Preparing Waste for Packing—The oil should be of sufficient body to keep surfaces of the brass and journal free from actual contact under four times the normal load, with the highest temperatures. It should flow easily in ordinarily cold weather and not be thick and sticky even when subjected to extreme cold; for that would tend to keep the journal from revolving. To meet these requirements in service, a winter oil and a summer oil are furnished.

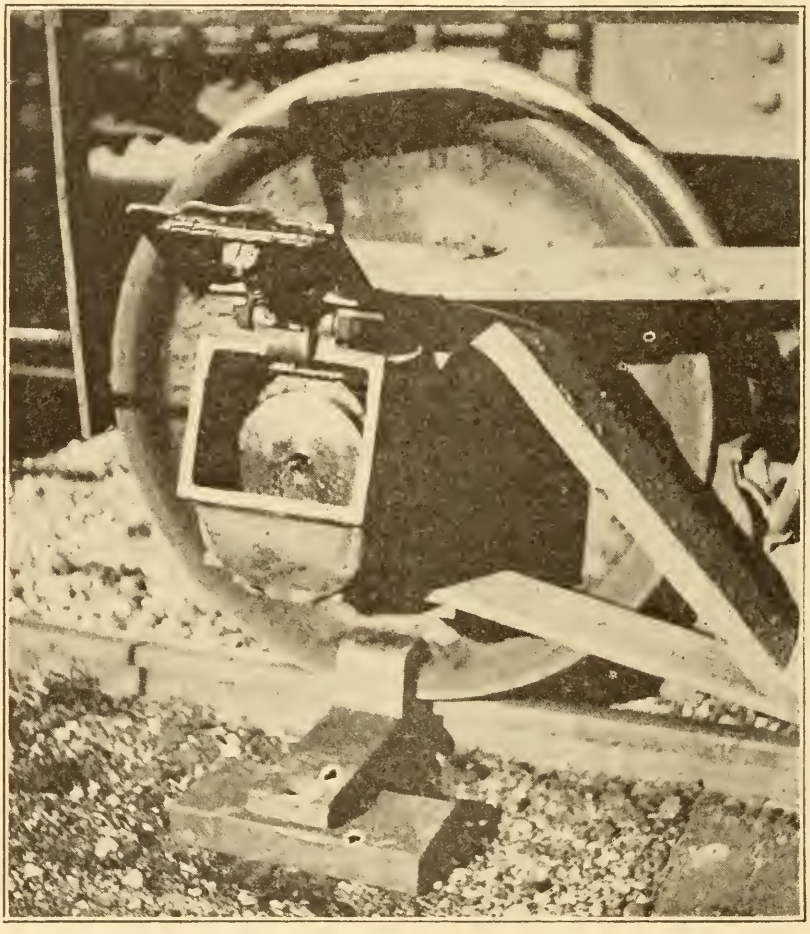
A metal soaking vat should be made about 2 ft. wide, 2 ft. deep, and 5 ft. long on the inside, with a good, tight-fitting lid. A sliding tray should be provided about 2 ft. long, with mesh netting on the bottom. This tray should be placed on angle irons which are secured to the sides of the vat, about 10 in. from the bottom. Oil-soaked waste can be deposited on this tray until the excess oil is drained out of it. A hasp and staple should be fastened on the lid so that the vat can be closed and locked. In the bottom of the vat, a 1-in. pipe coil should be placed for the purpose of heating the oil to the required temperature.

In preparing new packing, the waste should be pulled apart and placed in the bottom of the tank, and completely submerged in oil for at least 24 hours; after which it should be placed on the screen tray and allowed to dry 12 hours, with the vat held at a temperature of 70 degrees. The oil remaining in the waste should equal four pints of oil to one pound of waste.

Experience has taught that the use of free oil by the Carman is not practical because the packing in a box settles, becomes glazed over the top, forming a direct gutter for passage of oil from the front of the box to

the dust guard, out of the end of the box to the wheel and to the ground.

Worn Brass Or Cut Journals—Renewals of worn brasses or cut journals should be handled at the nearest

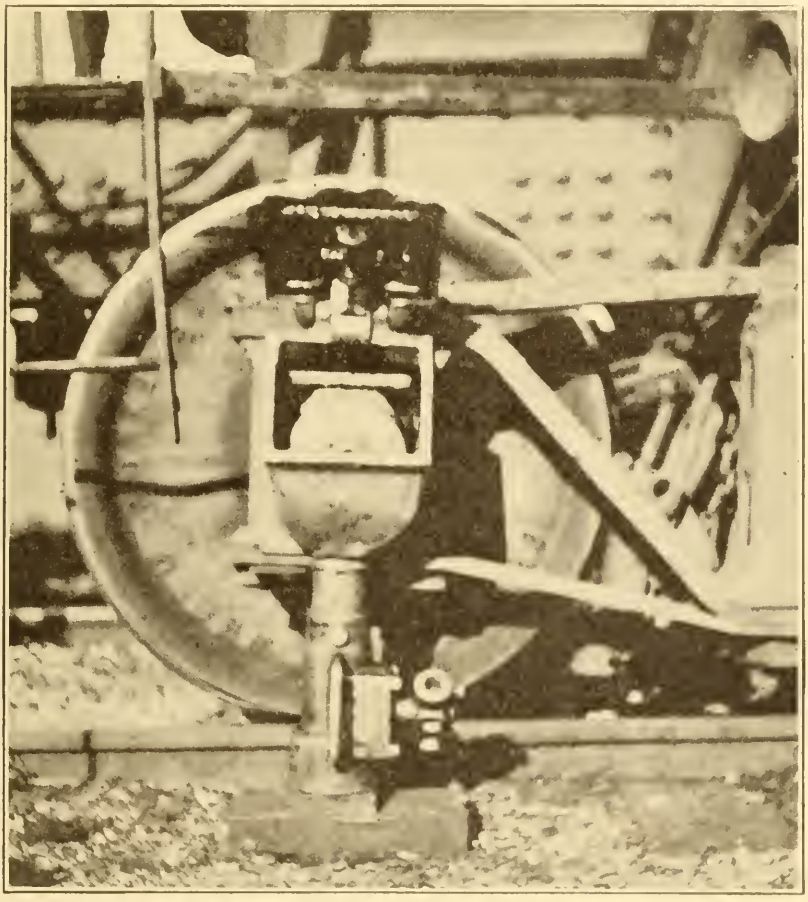


A Simple and Effective "Wheel Holder" for Holding the Wheel Down to the Rail When Changing Brass. Try it. They Can be Made from an Old Truck Lever.

point where a Carman or Carmen are employed, in order that the movement of the car may be facilitated. The trainmen will give a hot box temporary relief, put on

a water cooler and try to make the point where the Carmen are located.

A brass worn thin is likely to break and cause a journal to heat; and while there is no set thickness at which



Using the Wheel Holder on a Tank Car Demonstrates Its Usefulness. Note the Ample Clearance on the Wedge. Jack Raised 2½ in.

these brasses should be renewed, common practice among Carmen is to remove the brass when it wears within ¼ in. of the top of the collar on the journal.

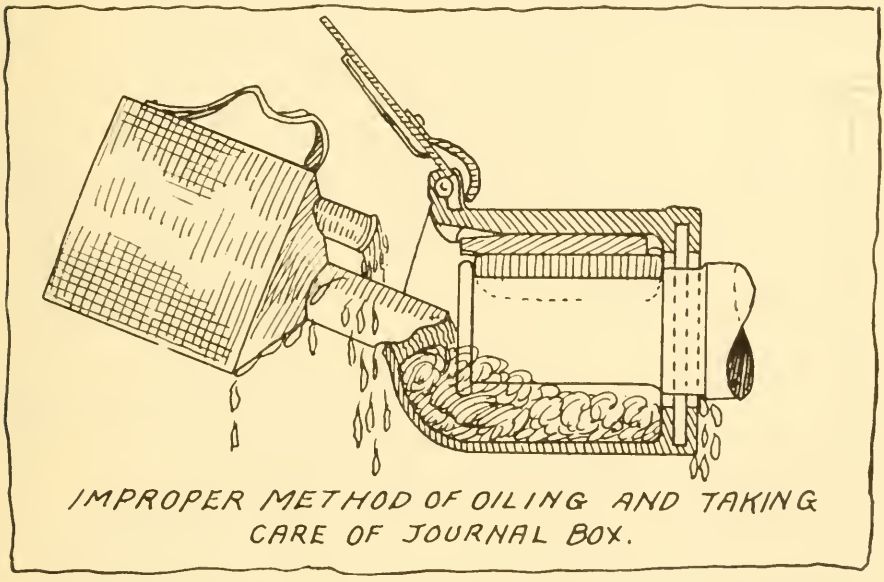
Packing Journal Boxes—The first operation in packing a journal box is twisting up a piece of packing of sufficient length to reach around the journal, from the center of one side to the center of the opposite side, by means of the packing iron. This plug should be placed in the back of the journal box, to help to exclude dirt and avoid the waste of oil. Small bunches of packing should now be placed first on one side and then on the other, filling the box up to the center line of the journal, (no higher because the threads from the waste may be drawn in between the brass and the journal) continuing with this operation to a point just inside of the inside edge of the collar. Here the packing should stop abruptly.

When the packing is well up against the journal from the fillet at the back to inside of the collar on the end, up to the center line of the journal, all is done that can be done as far as arranging the packing is concerned. The rest of the packing should serve to hold the oil ready to be carried up to the journal, as well as to maintain the wick contact by holding the packing in position. After the box is packed no loose strands should be permitted to hang out of the box, and the face of the box and lid should be carefully cleaned before the lid is closed.

All boxes on all cars should be carefully looked after at important terminals and in practice it has been demonstrated that the use of a packing iron has done more to eliminate hot boxes than simply flooding the boxes with oil. Even at regular packing stations it is not always necessary that all packing should be removed from the boxes; sufficient packing however

should be removed from under the journal to satisfy the inspector of its condition and that it contains sufficient lubrication. If the packing is in good condition, replace with the packing iron, beginning by firmly placing it in the rear of box, adding any amount of good packing necessary.

Journal bearings, wedges, etc., should be carefully inspected for breakage, or thin brass. There are tricks in all trades and the art of inspecting journals and



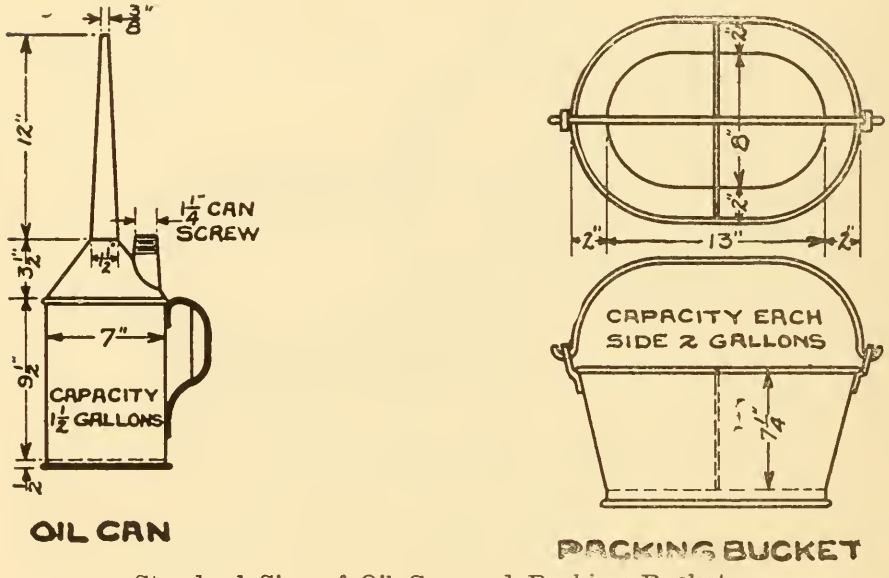
Journal Boxes in this Condition Should Have the Packing Replaced at the Back of the Box Before Oil is Supplied.

bearings is no exception to this rule; proficient inspectors can readily tell the condition of journal by use of the packing hook, and by noting signs of heat on oil box, wedge, brass, journal or wheel plates.

Oiling Journal Boxes—At oiling stations the inspector raises the lid, locates the packing at back of box underneath with his packing iron, adds packing if

necessary, and applies a small amount of free oil. Oil should not be added until the condition of the packing is ascertained by the method described; an excessive use of oil, as evidenced by the accumulation on the wheels and outside of boxes, should be avoided. Oil should not be poured on waste that is glazed on top, because this only gives temporary relief.

Time of Packing Boxes—As a rule all system cars are repacked every six months unless for other causes more frequent packing is necessary, and the date is sten-

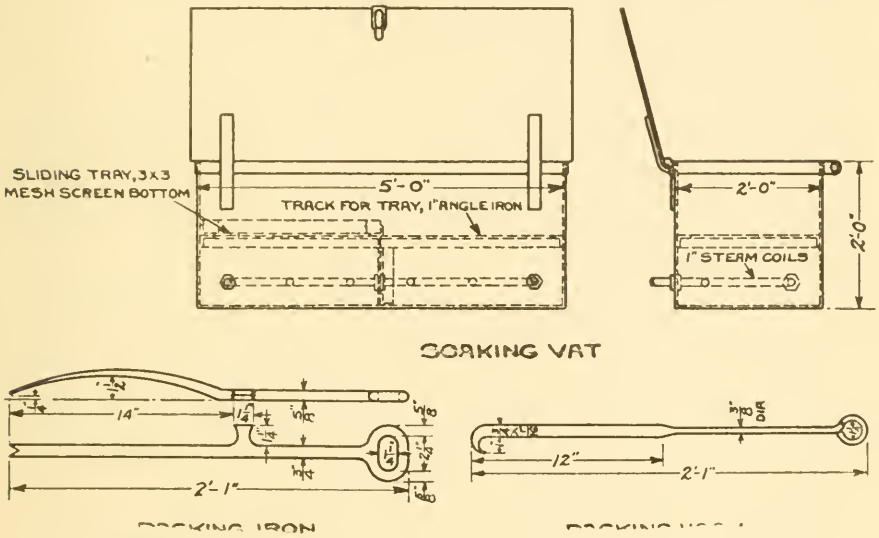


Standard Size of Oil Can and Packing Bucket.

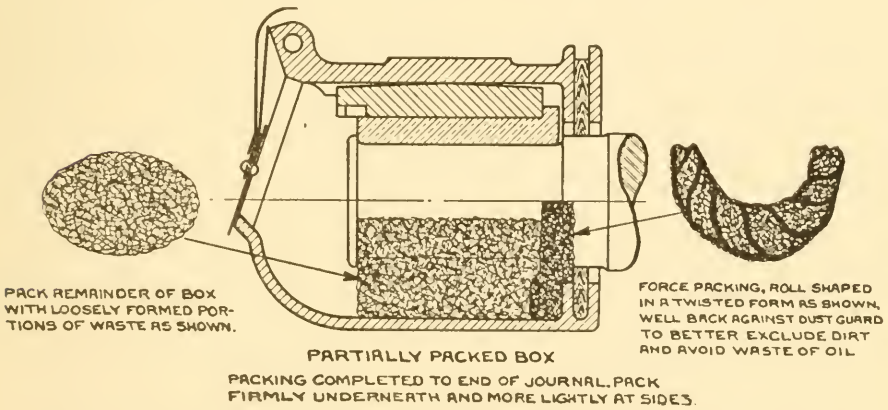
ciled on the outside of the top arch bar. The average miles per day made by a freight car is small and if the box has been properly packed to prevent the lubricating oil from running out, the box should run a long time with very little attention.

Tools for Packing Journal Boxes—In packing a box a two-compartment bucket should be used, one side used

for new packing, the other for old packing. The tools needed are an oil can with a straight spout, a hook for removing the packing, and a packing iron to place the



Waste Soaking Vat and Tools for Packing a Box.



The Box Shown has been Properly Packed. The Front "Plug" is Being Eliminated by a Great Number of Roads, as it Allows Better and Quicker Inspection of the Journal Box and Packing.

packing; this iron to have a hook on it for opening the oil box lid.

The Best Practice Abused—Abundant instances occur where a car oiler is furnished prepared packing and does not have or take time to remove old packing and repack the box properly. He removes a small amount of old packing from the front of the box and adds a small amount of new. This simply misleads the inspector, because in raising the lid the box has the appearance of having been freshly repacked, and if the use of free oil is not prevented he will pour oil in the box without stirring the packing.

A book might be written on hot boxes. It is a burning issue, figuratively and literally. No road is exempt. Those having the greatest success combating the evil are those willing to make an initial expenditure for equipment and maintenance in accordance with the importance of the car bearing.

CHAPTER XIV.

PRACTICAL UNITED STATES SAFETY APPLIANCES

The study of United States Safety Appliances covering cars and locomotives, as taken from the charts and specifications by the Interstate Commerce Commission, may seem to the Carman to contain a useless number of dimensions and working figures. If taken in a practical sense, however, a clearer understanding may be gained. It is the intention of the author to cover the subject in such a way that every Carman may understand it without study. The standard figures for dimensions are adhered to in all cases.

Survey of the Appliances—"Hand brakes shall be of any efficient design and shall work in harmony with the power brake." No car is equipped with two sets of brakes, therefore the hand brake must work in harmony with the air brake.

"The brake shaft should be not less than 1¼ inches in diameter." An inch and a quarter was found to be the smallest practical dimension which would give sufficient power to set the brake and allow for safety. On account of the uncertainty of true welding, the M. C. B. Association ruled against welding of the safety appliance parts.

A 15-inch brake wheel of wrought iron, malleable iron or steel was found to be of such size that sufficient leverage could be obtained by the average man to set the brake.

The location of the brake wheel is such that it will

not interfere with the efficiency of either the running boards, or end ladder.

A clearance of 4 inches around the brake wheel allows a man effective operation of the brake with safety and efficiency.

One-half inch bolts and rivets used almost exclusively in Safety Appliances, will withstand the maximum strain expected in ordinary wear and tear of service and allow a margin for safety.

The stirrup form of brake shaft rest or step, being "U" shaped has the highest degree of efficiency, while setting the brake and guards against the brake chain becoming tangled.

The square fit at the top of the brake mast reduces the likelihood of the wheel becoming loose. The taper fit of two inches in twelve, is one commonly used in mechanical work. It keeps the wheel from sliding down on the brake mast.

Running boards are given a width that will allow a man to walk on them without the necessity of stepping off on the roof if he becomes momentarily unbalanced. The latitudinal one is wider as it is placed near the end of the car, where one may become more affected by the height, and also to cover extreme widths allowed for variations in the location of side ladders.

Ladder treads are spaced at 19 inches because that is the height of the average man's foot from the floor when his knee forms a right angle. A ladder tread 16" long gives sufficient room to conveniently place both feet on it without interference or extra precaution.

The ladders are spaced 8 inches from end or side of car to inside of ladder, because that is the maximum distance to conveniently reach from one to the other.

The end and side ladder rounds coinciding produce safety, because you can depend upon where to step when passing from one to the other.

A two-inch clearance to hand holds is given, because the length from the second joint of the middle finger of a man's hand is approximately one and one-half to one and three quarters inches. The other quarter inch is allowed as a margin of safety and allows a depth great enough to secure a good hold

Foot guards are applied to keep the feet from slipping off the rounds of the ladders, especially at lower end and side ladder locations.

The end clearance of 12 inches allows a minimum clearance of 24 inches for a man to work in, or in climbing an end ladder between two cars should he be forced to go between them.

Roof hand holds are spaced between 8 inches and 15 inches, because the average man's forearm with fist doubled up is 15 inches in length. Eight inches is the more convenient distance for a safe application of the grab iron or hand hold.

The location of side and upper end hand holds is placed at "not less than 24 inches, nor more than 30 makes it at the average height of a man's head and is inches above the center line of coupler," because that convenient for him to reach without losing his bearing. The lower end hand holds are located so as to be easily accessible should a man be forced to use them while between cars. The additional end hand hold used with outside end sill, is located at such a height as to be conveniently used in passing between two coupled cars.

Sill steps are placed between 22 and 24 inches above

the top of the rail, as the average man can step from that location to the ground or vice versa without overbalancing and losing his bearing, even while cars are in motion.

Below are given the safety requirements for the various appliances, with explanations of various details.

Hand Brakes—Each car shall be equipped with an efficient hand brake, which must work in harmony with the air brake on the car. No special design is required, but it must provide the same degree of safety as demanded by these rules.

Brake Shaft—Brake shafts must be made of wrought iron or steel not less than 1¼ ins. diameter without a weld and provided with a drum and trunnion. This drum must not be less than 1½ ins. diameter and the trunnion not less than ¾ ins. diameter. The drum and trunnion are located at the lower end of the brake shaft. The trunnion must extend through and below the brake mast rest and be held in position by means of a suitable ring or cotter.

The upper end of the shaft is squared not less than ⅞ ins. across for insertion of the brake wheel. The squared portion is tapered about 2 in 12 ins. A threaded portion of the shaft extends above the wheel for the provision of a ¾ in. nut for holding wheel in place. This nut must be riveted over or held in place by means of a lock nut or cotter key.

Brake Chain—Brake chains must be made of iron or steel of stock not less than ⅜-in. diameter and the rod link must not be less than 7/16-in. diameter. It must be secured to the brake shaft drum by means of a hexagon or square head bolt, not less than ½-in. in size, the head of which must be securely riveted over.

Brake Shaft Rest—The brake shaft rest must be of such design that will not permit the chain to drop under the brake shaft. The "U" shape is preferable.

Brake Step Board—If a brake shaft board is used it should be 28 ins. in length, and its outside edge must not be less than 8 ins. from the face of the car and not less than 4 ins. from a vertical plane parallel with the end of car. Two metal braces must be used to support it and these shall not have a section less than ⅜x1½ ins.

Brake Ratchet Wheel—The ratchet wheel shall not be less than 5¼ ins. in diameter and have not less than 14 teeth. It must be secured to the brake shaft by a key or square fit. If a square fit is used it must not be less than 1 5/16 ins. square. Means must be provided to prevent the ratchet wheel from raising on the shaft.

Brake Shaft Support—There should be an extra brake shaft support applied if the distance between the brake wheel and ratchet wheel exceeds 36 ins.

Brake Pawl—The brake pawl shall be pivoted upon a bolt or rivet not less than ⅝-in. diameter, or upon a trunnion. If a trunnion is used, it must be fastened by not less than a ½-in. bolt or rivet. The brake pawl or shaft must be connected by a rigid metal connection.

Brake Wheel—The brake wheel shall be made of malleable iron, wrought iron or steel and may be flat or dished. Its diameter must not be less than 15 ins. It shall be fastened to the brake shaft by a square, taper fit hole, about 2 in 12 ins. There must be not less than 4 ins. clearance around the rim of the brake wheel and it must not be less than 4 inches from a vertical plane drawn through the inside face of knuckle when closed, with coupler horn against the buffer block and parallel with end of car.

Location of Brake Shaft on Different Types of Cars—On box and other house cars, brake shafts must be on end of car and to the left of and not less than 17 ins. nor more than 22 ins. from center.

On drop end low side gondolas, drop end high side gondolas, all tank cars and caboose cars without platforms; brake shafts must be on end of car, left of center.

On flat cars brake shaft must be on end of car, to the left of the center, or on side of car not more than 36 ins. from right hand end.

On caboose cars with end platforms, brake staffs must be on platforms to the left of center.

Operating or Uncoupling Levers—There is no standard design of operating levers, the single or double design may be used without weld. There must be one at each end of the car. If a single lever is used it must be at the left side of end of car.

Levers of the single design must not be more than 12 ins. from the side of the car, and those of other types, not more than 6 ins. from the side of the car. The center lift arms must not be less than 7 ins. in length. The center eye at the end of lift arm must not extend beyond the center of the eye of knuckle lock more than 3½ ins. when the horn of coupler is against the buffer block or end sill (see plate "B".)

The handles of the operating levers must extend sufficiently beyond the end sill to give a minimum clearance of 2 ins. around the handle, the minimum drop must be 12 ins. and the maximum 15 ins. The rocking or push-down type requires not less than 18 ins. from top of rail when the lock is in release position. A suitable stop

is provided to prevent the inside arm from flying up in case of breakage.

All uncoupling levers for the different classes of cars are the same with the exception of those for tank cars without end sills. On these cars the minimum length must be 42 ins. measured from center line of end of car to handle of lever. These should not be more than 30 ins. above the center line of coupler.

Sill Steps—There must be four sill steps on each car, to be made of wrought iron or steel without weld, with a minimum cross sectional area of ½x1½ ins. or equivalent, minimum clear depth of not less than 8 ins. and tread not less than 8 ins. If steps exceed 21 ins. in depth an additional tread must be provided.

Steps are to be fastened to the car by not less than ½-in. bolts with nuts to the outside (where possible) and riveted over, or not less than ½-in. rivets. The steps must be located one near the end on each side of the car not more than 18 ins. from end of car to center of tread of still step. The outside edge of tread must not be more than 4 ins. inside of face of side of car, and tread must be not more than 24 ins. from top of rail.

These specifications apply to all classes of cars with the exception of tank cars without side sills, and tank cars with short end sills and end platforms. On these cars one step must be located near each end on each side under side hand holds. Tank cars without end sills come under another ruling as follows: These cars must have one step near each end on each side, flush with outside edge of running board, as near end of car as is practicable.

If these steps exceed 18 ins. in depth they must have

an additional tread and be laterally braced. If tanks on tank cars without end sills have high running boards making ladders necessary, still steps must meet ladder requirements.

Caboose cars without platforms and having side doors must have two steps, one on each side of car, minimum length 5 ft. minimum width 6 ins., minimum height of back stop, 3 ins., maximum height from top of rail to top of thread, 24 ins. They must be supported by two iron brackets having a minimum cross sectional area ⅞x3 ins. or equivalent each of which must be securely fastened to car by not less than ¾-in. bolts.

Caboose Platform Steps—Safe and suitable box steps must be provided at each corner of caboose. Lower tread of step must not be more than 24 ins. above top of rail.

Ladders—Ladders must be made of iron, steel or wood. When iron or steel are used the diameter of threads must be not less than ⅝-in. and wooden treads must be not less than 1½x2 ins. of hard wood. Ladder treads also act as hand holds, and should be secured by not less than ½-in. bolts with nuts outside (where possible), bolts riveted over, with ½-in. rivets. ⅜-in. bolts may be used on wooden ladders in applying treads where same are gained into stiles. The proper clear length of treads is not less than 14 ins. on the ends of cars, nor less than 16 ins. on sides.

Tank cars without side sills and tank cars with short side sills must have ladder treads not less than 10 ins. and clearance on all ladder treads must be not less than 2 ins. The bottom tread must be equipped on inside end with foot guards not less than 2 ins. high when ladders are used which are not equipped with stiles, or with stiles extending less than 2 ins. from face of car.

Treads of ladders must be spaced 19 ins. apart, but a variation of 2 ins. is allowed from top tread of sill step to the bottom tread of side ladders, and 21 ins. is allowed from top tread of sill step to the bottom tread of side ladders.

Not less than 12 nor more than 18 ins. from the eaves is allowed for the top tread of ladders on box or other house cars, and the top tread of ladders on gondola cars must not be more than 4 ins. from the top of car. End ladders are spaced the same as the treads of side ladders but a variation of 2 ins. is allowed to comply with the car's construction.

When the construction of the car will not permit the application of tread of end ladder to coincide with tread of side ladder, the bottom tread of end ladder must coincide with second tread from bottom of side ladder.

On box and other house cars, hopper cars, and high side gondolas with fixed ends ladders must be located not more than 8 ins. from right hand end of face of car, or not more than 8 ins. from left hand side of end of car. On drop end high side gondolas, side ladders must be located the same as on box or other house cars (no end ladders being required).

On tank cars without side sills and tank cars with short side sills and end platforms, two ladders are required when such cars have continuous running boards, if so located as to make ladders necessary.

When only two ladders are necessary, one ladder should be located at the right hand end of each car. On cars with side running boards there must be a ladder at the end of each running board. On caboose cars with platforms, a ladder is required at each end but the dimensions are not specified. With caboose cars without

platforms, four ladders are required the same as on box and other house cars. Caboose cars without platforms, having side doors, must have ladders placed not more than 8 ins. from door.

Fixed-end low-side gondolas, drop-end low-side gondolas, flat cars, tank cars with side platforms and tank cars without end sills do not require ladders. (If these tank cars have high running boards, making ladders necessary, sill steps must meet ladder requirements.)

Conference Ruling on Automobile Cars with Swinging End Doors—These cars may come under the head of cars of special construction, and the end ladders must be placed as nearly as possible to designated location.

Ladders, Spacing of Treads—The spacing of top ladder treads must be taken from eave of roof at side of car, whether latitudinal running board is used or not.

Ladders and hand holds need not be applied to swinging side doors of ballast and gondola cars. Ladders must be placed on such cars as prescribed for high-side gondolas and hopper cars, with sill step under ladder or as near under ladder as car construction will permit. Ends and sides of cars must be equipped with hand holds, in the same manner as flat cars.

End Hand Holds (Horizontal)—Hand holds must not be made of material smaller than 5/8-in. diameter, of wrought iron or steel without weld. Their proper clear length is 16 ins. except that where 16-in. hand holds are impossible 14-in. ones may be used. The clearance for these hand holds is 2 ins. There must be eight or more such hand holds on certain classes of cars (4 each end) and four on other classes (2 each end). Those cars

requiring eight horizontal end hand holds are: Box and other house cars, hopper cars, high-side gondolas with fixed ends, and low-side hopper cars.

Upper hand holds must be located not less than 24 ins. nor more than 30 ins. above center line of coupler, where car permits, except when ladder tread acts as a hand hold. These hand holds must be placed not more than 8 inches from the side of the car. The other four hand holds are located as follows: On face of end sills not more than 16 ins. from side of car, projecting either outward or downward.

Drop-end, high-side and low-side gondolas, flat cars, tank cars with side platform and caboose cars with platforms, require but four horizontal end hand holds. Tank cars without end sills also require but four horizontal end hand holds. They must be located on the running board, one near each side on each end of the car, or on end of tank not more than 30 ins. above center line of coupler, not more than 2 ins. from edge of running boards, and projecting outward and downward. On caboose cars with platforms they must be located in a horizontal position, one near each side on each end of car on face of platform and sill, clearance of outer end of hand hold to be not more than 16 ins. from end of platform end sill. Cars having platform end sills of 6 ins. or more in width, measured from end post or siding and extending full width of car, must have additional horizontal hand holds provided. They should be 24 ins. long and should be located near the center of the car, not less than 30 ins, nor more than 60 ins. above platform end sill. On caboose cars without end platforms they must be the same as specified for box and other house cars.

Tank cars with side platforms, tank cars without side sills, and tank cars with short side sills and end platforms, require tank head hand holds. Two are required if safety railing does not run around the end of tank. When used they must be located on each head of tank, not less than 30 ins. nor more than 60 ins. above platform on running board, and they must be securely fastened not less than 6 ins. from outer diameter of the tank.

End Hand Holds (Vertical)—Cars having platform end sills must be provided with vertical end hand holds. Two must be used, not less than ⅝-ins. in diameter with tread not less than 18 ins. without weld—and must have 2 ins. clearance.

These hand holds must be located opposite ladders not more than 8 ins. from the side of car, and not less than 24 ins. or more than 30 ins. above the center line of coupler; measured from bottom end of hand hold. They must be secured by bolts not less than ½-in. in diameter with nuts outside (if possible), bolts riveted over, or ½-in. rivets.

Conference Ruling—The law makes no distinction between passenger and freight cars; end hand holds must, therefore, be placed on the ends of passenger cars and cabooses.

Side Hand Holds (Horizontal)—Side hand holds must be not less than ⅝ in. diameter, of wrought iron or steel without weld.l Four are required. The tread must be not less than 16 ins. long with a clearance of not less than 2 ins. They must be located not more than 8 ins. from the end of the car and not more than 30 ins. nor less than 24 ins. above the center line of coupler where car will permit. Some fixed-end and drop-end

low-side gondolas, and low-side hopper cars are so constructed as not to permit location of side hand holds as specified. Under such circumstances the hand holds must be securely fastened with not less than ½-in. bolts with nuts outside (if possible) bolts riveted over or with not less than ½-in. rivets. Ladder treads act as hand holds.

The location of horizontal side hand holds is not the same on all classes of cars.

Flat cars, tank cars with side platform, tank cars without side sills, and tank cars with short side sills and end platforms, have horizontal hand holds not more than 12 ins. from end of car; one near each end on face of each side sill. The four hand holds on tank cars without end sills, are located one near each side on each end of car on running board over sill step. They should be placed not more than 2 ins. back from outside edge of running board, projecting outward and downward. When these hand holds are more than 18 ins. from end of car, an additional hand hold must be placed near each end on each side, not more than 30-ins. above center line of coupler. The outer end of hand hold should be not more than 12 ins. from end of the car.

On caboose cars with platforms, side hand holds should be located as follows: One near each end on each side of car from a point not less than 30 ins. above platform to a point not more than 8 ins. from bottom of car. Top end of hand hold must not be more than 8 ins. from outside face of end sheathing. Their minimum clear length should be 36 ins. and minimum clearance 2 ins. On caboose cars without platforms there should be one near each end on each side of car, not less than 24 nor more than 30 ins. above center line of

coupler. Clearance of outer end of hand hold must not be more than 8 ins. from end of car.

Side Hand Holds (Vertical)—These hand holds are used on all tank cars if equipped with safety railings. There are four of them, one over each sill step, secured to tank or tank band.

Conference Ruling—Ladders and hand holds need not be applied to swinging side doors of gondolas and ballast cars. A side vertical hand hold must be placed on corner post of such cars, as nearly as possible over sill step.

Vertical side hand holds on ballast cars must be applied to the outside face of the corner post, i. e., the faces which are parallel to the sides of the car.

Side Door Hand Holds—Caboose cars without platforms require these hand holds. They consist of two curved and two straight ones. The curved hand hold is located from a point at side of each door opposite ladder, not less than 36 ins. above bottom of car, curving away from door downward to a point not more than 6 ins. above bottom of car. They must be not less than 5/8-ins. diameter of wrought iron or steel, with a minimum clearance of 2 ins., and must be secured the same as other hand holds.

Platform Hand Holds—Caboose cars with platforms require four of these hand holds. One right angle hand hold should be located on each side of each end extending horizontally from door post to corner of car at approximate height of platform rail, then downward to within 12 ins. of bottom of car. They must be made of wrought iron or steel with a diameter of not less than 5/8-ins. and have 2 in. clearance. Hand holds shall be securely fastened with bolts, screws or rivets.

Roof Hand Hold—There must be a roof hand hold over each ladder. They must be made of wrought iron or steel with a diameter not less than 5/8-ins. The tread must measure not less than 16 ins. with a minimum clearance of 2 ins. They must be held in the usual way as specified with other holds. These holds must be located as follows: One parallel to tread of each ladder not less than 8 ins. nor more than 15 ins. from edge of roof.

On refrigerator cars where ice hatches are in the way the location may be nearer the edge of the roof. On caboose cars where stiles of ladder extend 12 ins. or more above roof, no other roof hand holds are required.

One right angle hand hold may take the place of two adjacent specified roof hand holds, provided the dimensions and locations coincide. (M. C. B. Rules require them to be without weld). Right angle hand holds must have an extra leg securely fastened to car at point of angle.

Cupola Hand Holds—Cupola hand holds should number one or more and should be located as follows: One continuous hand hold extending around top of cupola not more than 3 ins. from edge of cupola roof, or four right angle hand holds, one at each corner not less than 16 inches in clear length from point of angle, may take the place of the one continuous hand hold specified in locations coincide.

Running Boards—Running boards must be made of wood, running full length of car in center of roof, and securely fastened. On caboose cars with cupola, longitudinal running boards must extend from cupola to ends of roof. The length and width of running boards may be made up of a number of pieces securely fastened to

saddle blocks with bolts or screws, but not to be cut off or hinged at any one point.

With outside metal roofs, two latitudional extensions must be made from longitudional running boards to ladder location. The width of these boards must be not less than 18 ins. and latitudional extensions not less than 24 ins. wide.

Tank cars without side sills, tank cars with short side sills and end platforms, and tank cars without end sills are excepted. The proper width of running boards on the above cars is 10 ins. on side and 6 ins. on end. Refrigerator cars, on account of ice hatches, do not require latitudinal extensions.

End clearances of running boards are specified as follows: The ends must be not less than 6 ins. nor more than 10 ins. from a vertical plane parallel with end of car. Tank cars without side sills, tank cars with short side sills and end platforms, and tank cars without end sills are exceptions. The end clearance for these cars must be not less than 6 ins. The measurement is taken from a line passing through the inside face of knuckle when closed, with coupler horn against buffer block, end sill or back stop.

If the running boards extend more than four inches from edge of roof, they must be supported by substantial metal braces. Usually there are two braces, one on each corner of the extension, fastened to the car and to the running board with not less than ½-in. bolts.

Tank cars without side sills, tank cars with short side sills and end platforms, and tank cars without end sills, must be equipped with running boards. One continuous running board around sides and ends, or two boards running full length of tank, one on each side must be

used. With tank cars having end platforms extending to bolsters, the running boards must extend from center to center of bolsters, one on each side.

When running boards are applied below the center of tank, the outside edge of such running boards must extend not less than 7 inches below bulge of tank, and they must be securely fastened to tank or tank bands.

Safety Railings—One safety railing continuous around sides and ends of tank, or two running full length of tank must be used. On tank cars with side platforms, not less than ¾-in. iron must be used. On tank cars without side sills, and tank cars with short side sills and end platforms, and tank cars without end sills, not less than ⅞-in. wrought iron or steel must be used, with a clearance of 2½ ins. Railings must be not less than 30 ins. nor more than 60 ins. above running board. They must be securely fastened to tank, tank bands or posts, and secured against end shifting.

End Ladder Clearance—No part of the car above end sills, within 30 ins. from the side of the car, may extend (or stick out) to within 12 ins. of a vertical plane parallel with end of car. The measurement is taken from a line passing through the inside face of knuckle when closed, with coupler horn against buffer block or end sill. No other part of end of car, or fixtures on same above end sills other than exceptions noted, may extend beyond the outer face of buffer block.

Buffer block, brake shaft, brake step, brake wheel, running boards or uncoupling lever and air hose, are not to be regarded as fixtures as that word is used in that part of the order relating to "End Ladder Clearance."

High-side gondolas and high-side hopper cars are those with sides which extended more than 36 ins. above

the floor of the car and low side hoppers and gondolas are those with sides which extend 36 ins. or less above the floor of the car.

CHAPTER XV

SAFETY FIRST

There has been so much said regarding the Safety First movement and so many instructions have been given the Carman, that further mention of this subject while important, may seem almost out of place in this book.

However, there is one feature which should not be overlooked and that is that Safety First talk will fail to get results if, year in and year out, unimproved and unreliable appliances and tools are given the carman for his work. This refers especially to appliances which are used daily and which are being bought constantly.

Right here the Carman can help the situation by first studying and then recommending those appliances and tools which mean Safety First in the carman's work.

Take the question of car jacks. Safety First falls on deaf ears if the Carman has new jacks furnished him continually which do not operate safely.

Safety First talk won't accomplish much if combined with Safety Last actions. But it is up to the Carman to register his protest when anything is furnished him which is not safe, because he is the man using it and he knows. The Carman must remember that the management cannot always be fully informed on the safety or effectiveness of everything which they buy. They should be glad to have any information on the kind of service given by appliances and tools. The Carman can help by recommending that which gives safe service, and by re-

porting instances of appliances which are a menance to safety.

It is not the Carman's duty to specify the strength of materials, sizes, etc., that should be used in various appliances; but he can report when certain appliances do not seem to be strong enough.

By co-operation with the proper officials and by making his objections to unsafe tools and appliances, the Carman can help a great deal in making conditions safer for the Carman and thus preventing injuries.

Car repairing and inspecting have always been classed among the hazardous occupations in railroading, yet many Carmen have been fortunate in not having any serious accidents.

A great number have been injured, however, and sometimes through their own carelessness or that of others; so that in addition to recommending and persisting in the demand for safe tools, etc., the Carman should acquire the habit of using safe methods instead of unsafe ones.

Preventable accidents can be classified as follows:

1. Those due to the use of unsafe tools.
2. Those due to the improper use of tools.
3. Those due to not wearing goggles when doing work that is hazardous to the eyes.
4. Those due to not using guards on machinery.
5. Those due to the improper handling of materials.

One kind of accident that stands out strongly enough to be mentioned in the list of preventable accidents, is the improper handling or piling of material. A pretty safe rule to follow in a case of this kind is to try and keep everything in such shape that you can walk around

the place in the dark without being in danger of getting hurt. It is true that it is not always possible to handle your material in so careful a manner, but if this idea is kept uppermost and lived up to as far as possible, there will be few accidents on this account in daylight.

One thing to guard against, after everything has been done in the way of making the machinery and tools safe, is to keep a watch and check on the unsafe or careless man, for there will always be some of this type and those who are reckless of their own and others safety.

In driving an automobile they say the only safe way is to be prepared for the other man, whether he be a pedestrian, a team driver or an automobilist, to do the wrong thing. In other words, figure that the other man is not to be depended upon and then you will probably be safe. Make your moves for your own safety, in-so-far as possible, in no way dependent upon the work or action of the other man.

In raising heavy materials or appliances this is not always possible. There are some cases where several men must do the lifting together, and where misunderstanding or the failure of one man might mean an accident. In a case of this kind, it is better to waste a little time giving full instructions and being sure that every man understands; because trying to save minutes may mean losing limbs.

The Carman must protect himself in every possible way from the carelessness or accidents of his fellow employes and against the movements of trains. This means always using the blue flag or the blue light as the case may be, and being sure that they are placed in such a position that they will be seen and there will be no excuse for their being overrun.

The safe Carman will always use horses or trestles of adequate strength under the cars after they are jacked up, even though he may have that type of car jack which he knows to be absolutely safe. It might be that the foundation under the jack would give way or the car be accidentally moved far enough to tip off the jack.

Nails are important enough to require mention. There were over 10,000 persons injured in the United States in a year by nails protuding from planks which were left carelessly about. Take time to turn down all the nails you see sticking up.

This chapter is not intended to cover the Safety First movement in detail but only to mention a few things, and possibly to bring a few ideas, which had not been touched upon or emphasized before; chiefly among which is the necessity for the consideration of Safety First in all appliances and tools which are being purchased constantly, as well as the education of the Carman to the Safety First attitude.

CHAPTER XVI.

FIRST AID TO THE INJURED.

Its Origin—The origin of first aid dates back to primitive surgery and the early study of medicine. The human instinct always asserts itself by attempting to relieve pain and suffering. As medical science and surgery developed, it becomes a known fact among doctors and surgeons that by the prompt application of medical skill, many serious deformities and in some cases the life of the injured person can be saved.

Its Meaning—First aid means giving immediate medical attendance to the injured, such as will temporarily relieve the suffering until proper and complete dressing can be made by a competent physician or surgeon.

Its Recognition—Railroad work has always been regarded as a hazardous occupation and many persons have been injured. Large railroad yards are often isolated and in such cases medical attendance is seriously delayed. Delays are costly to railroad companies no matter where or in what department; and many cases of serious injury have resulted in prolonged convalescence or death due to the weakened condition of the injured because of delayed medical attendance. Railroad companies through the efforts of their physicians and surgeons, recognized the fact that if hemorrhages could be stopped, broken legs splinted and bound temporarily, and the shock reduced by those in immediate attendance, a greater portion of those injured would entirely

recover. Plainly speaking, it meant money to the company.

Organization—With this end in view, the chief surgeons and physicians were appointed as instructors to teach classes at the various repair tracks, shops and round houses. The classes are usually composed of two men from each department and include office forces. These classes meet once or twice a month and on the company's time and property. A clean, well lighted and ventilated room is set aside for the classes and is equipped as a dressing station, including suitable stretchers, crutches, canes, bandages, splints, absorbent cotton, adhesive tape, proper and sanitary washing facilities and a supply of liniment, medicated soap, carbolated oil and alcohol.

A little book such as can be carried in the pocket conveniently, containing description and analysis of the bone structure of the body, charts showing the principal blood courses and their initial pressure points of contact by which bleeding may be stopped, illustrations and comments upon the method of treatment for various injuries is given each one of the class. A certain portion is chosen for each week or two weeks' study.

Classes—The time, usually one hour, is divided between a discussion of the subject, explanation of medical terms by the physician or leader in charge and demonstration of the different methods of treatment for injuries, using one member of the class as a subject.

The others apply bandages, splints and dressing for the injury. In this way, the work is made practical, and close watch is kept by the teacher and members of the class to see that all points are covered in detail. The careful handling to and from the stretcher is practiced, making the work doubly interesting.

CHAPTER XVII.

PASSENGER CAR EMERGENCY REPAIRS.

Upon the passenger car depends the safe and rapid transportation of human life and property. The inspection, cleaning, repairs and general handling of such equipment in service at terminals, is a part of the Carman's work, and upon his good judgment and familiarity with the modern passenger car, depend the continued safe service of such equipment.

Carmen employed in the freight yards or on repair tracks are called upon, in an emergency, to relieve those who handle passenger trains. For this reason, mention is made of the passenger car without attempting to go into details on the subject. Terminal inspection and repairs are necessarily more thorough and complete than running inspection and emergency repairs. The limited time of station stops or change of engines at the intermediate points, allows for only a rapid inspection for running defects about as follows: Safety appliances, diaphragms, air and steam hose, draft gear, wheels, truck frames and hangers, brake beams and connections, broken brake hangers, missing brake shoes, dynamo belts, loose and broken frame bolts and hot journals.

The safety appliances include couplers, operating levers, hand holds, coach platform steps and sill steps on cars without end platforms.

Air and steam hose are inspected for leaks and defective parts, care being taken to see that angle cocks

and steam valves are wide open between all cars and the engine. Both the train line and signal line must be closed at the rear end. If steam heat is being used, the rear steam valve on the last car must be left slightly open to allow condensation to escape.

The draft gear is inspected for broken bolts, springs, followers, pockets and loose and missing lug straps.

Wheels are inspected for defective flanges, flat spots, loose on axle, broken retaining ring bolts and broken tires. At the same time all journal boxes are inspected by placing the hand on the box, preferably on the side near the top, to ascertain whether or not there is more than ordinary friction heat present.

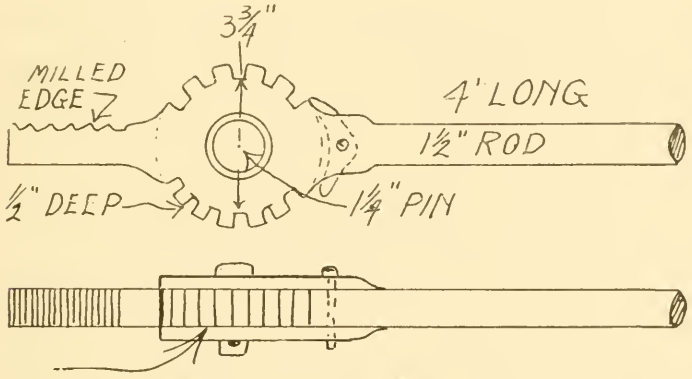
The truck frames are inspected as the inspector walks along. He should look carefully for broken truck hangers and hanger pins, broken brake hangers and pins, and also for defective brake beams. Safety hangers cannot be readily seen from the outside on some trucks, and the inspector must look carefully to ascertain whether or not they are in place. (This refers to the inside pair of wheels on a three wheel truck.)

Passenger car truss rods frequently require attention and there are so many other appliances under the passenger car that there is little room to work in to turn the buckles. The ratchet type of truss rod wrench shown herewith obviates the removal of gas tanks, battery boxes and other equipment usually found necessary before the buckle can be turned. With this wrench, the turnbuckle can be turned completely around with only a 6-inch space to turn the wrench.

The butt end for the buckle has a milled or roughened surface and the ratchet may be set at different angles as

the buckle is turned around. The handle is about four feet in length.

Dynamo belts may break and be lost while the car is in motion. These must be renewed at points where such replacement will not seriously delay the train, and



This Section of Wrench Can Be Made Interchangeable for All Size Truss Rods.

where men and material are on hand to make repairs. This is generally at a terminal where a change of engines is made.

Loose or broken truck frame bolts should be tightened or renewed, where such defects endanger the safety of the car. Very few such defects are found in the latest types of passenger trucks as the frames are cast in a solid piece. Pedestal bolts will be found to be the most liable to these defects, on account of the vibration of the trucks.

Dynamo body suspension frame bolts and nuts should be watched carefully and immediate attention given if found loose.

One railroad has a device for emergency repairs which has proved very useful at passenger terminals. It is

known as a station supply truck and is fitted with material for quick repairs. Previous to the use of this truck a repairman had to go to the tool shed for the necessary material. Now the truck is rolled up beside the car and the tools are within easy reach.

The truck is 5 ft. 2 ins. long, 3 ft. 8 ins. high and 14 ins. wide, with three horizontal doors on each side extending the full length of the truck. The arrangement was made as narrow and compact as possible so that it might readily pass between cars. The interior is partitioned for holding standard supplies. The body is mounted on two wheels about 30 ins. in diameter and they are so located as to nearly balance the truck. At the end with the rigid handle there is a support to stand the truck in a horizontal position when at rest. Supplies are as follows:

2 Journal-box jacks.
2 Journal-box jack boards.
2 Journal-box jack levers (pinch bars).
2 Packing hooks.
2 Packing irons.
1 Pail prepared packing.
1 Empty packing pail.
6 Brake-shoe keys.
2 Brake connecting pins 1¼ ins.
2 Brake connecting pins 1⅜ ins.
1 Knuckle pin, cotter and washer.
1 Bearing wedge 5½x10 ins.
1 Bearing wedge 5 x9 ins.
1 Bearing wedge 4¼x8 ins.
12 Standard nuts each: ⅞ ins., ¾ ins., ⅝ ins.
3 Brake shoes.
Springs Cotters (various sizes).
1 Brass 5½x10 ins.
1 Brass 5 x9 ins.
1 Brass 4¼x8 ins.
2 Brake connecting pins, 1⅛ ins.
12 Locking nuts each, ⅞ ins., ¾ ins., ⅝ ins.
1 Steam and air hose wrench.
1 12 in. pipe wrench.

2 1¼ in. train pipe nipples and couplings.
3 Each, ¾ in. and 1 in. train-pipe nipples and couplings.
3 Combination air and signal hose couplings.
1 Small roll ⅛ in. wire.
6 Air brake defect cards.
1 Signal hose.
3 Air hose.
3 Steam hose.
1 ¼ in. angle cock.
6 Steam-hose gaskets.
6 Air-hose gaskets.
1 Cold chisel.
1 Hammer.
1 Bracket for blue flag marker.
1 Bracket for blue lantern.
1 Screw driver.
1 Gallon can of car oil.
6 Wooden oil box lids (different sizes).
6 Pieces of second-hand carpet (for box covers).
4 Bolts, ½ in. by 6 ins., 3-in. thread with nut and washer and locking nut.
12 Tee-head pedestal tie-strap bolts with nuts and washers.
1 Coupler tail pin complete.
1 Ohio knuckle lock complete.
1 Uncoupling lever clevis complete.
1 Brake chain clevis complete.
1 Monkey wrench.
2 White pine reservoir drain plugs.

Heating Systems.

The following information in the form of questions and answers regarding the inspection and care of steam heat apparatus should prove valuable.

Q. How many systems of car heating are in general use today?

A. Two, the pressure and the vapor system.

Q. With which of these systems are blow-off or drip valves used?

A. With the pressure system. No blow-off or drip valves are used with the vapor system.

Q. Are cars equipped with more than one set of radiating pipes?

A. Yes. Some cars have two or more sets, with auxiliary admission valves controlling the steam to each set.

Q. What precaution should be taken when uncoupling steam hose?

A. See that no pressure remains in train line.

Q. How should a train be prepared before turning on steam for heating?

A. Connect all couplings between cars (if they are frozen thaw them out by blowing steam from one car to another), open all train pipe valves, allowing steam to blow through the main train pipes, until all water is out and only dry steam escapes from rear couplings; then partially close the end train pipe valve.

Q. If steam will not pass through train line, what should be looked for?

A. End train pipe valves and hose should be examined to see that train pipe valve or inner lining of steam hose is not torn or defective.

Q. If it is found that the hose is frozen when making up a train, how should one proceed to thaw it out?

A. By blowing steam from one car to another, leaving the hose coupling slightly open to let water out as ice melts. If frozen solid, change the hose.

Q. To what temperature should coaches be heated?

A. Between 65 and 70 degrees.

Q. For what purpose are special leakage valves placed in cross-over pipes under passenger cars, and what should be their position when steam is cut out from car?

A. They are to take care of condensation and when

steam is cut out from car they should be wide open.

Q. How can time be saved in getting steam through a long train?

A. By breaking the hose two or three cars from the engine, allowing the steam to pass through coupling, breaking the hose three or four cars farther back and so on, until steam comes through the rear end.

Q. Which end of a cold train would you begin to heat first?

A. The rear end.

Q. If there is sufficient steam pressure in the train and cars are not heated properly, what is usually the difficulty and what should be done?

A. This would indicate defective drips and they should be thoroughly examined, and if frozen, thawed out by using steam on the drip.

Q. What usually causes a steam pipe to freeze up?

A. *Condensation in the pipe which does not have the proper chance to escape to the atmosphere,* due to pipe being out of adjustment or to a leaky admission valve.

Q. When placing cold cars at the head of a train, what must be done before coupling to the main part of train?

A. Steam should be allowed to pass through cars before being coupled to the rear of the train.

Q. What should be done with steam hose when not coupled?

A. The hose should be hooked up in the chains provided for that purpose.

Q. When steam is blowing constantly at a drip, what does it indicate?

A. This would indicate that the automatically

operated valve fails to seat properly, which may be due to improper adjustment of the part, or to the expansive fluid contained in the diaphragm having leaked out.

Q. What should be the position of steam pipe blow-off valve when steam is being used?

A. With the direct system it should have just sufficient opening for water to pass out and with the automatic type they should be closed entirely.

Q. Is it possible to turn up the adjusting screws too far and prevent proper operation of drips?

A. It is.

Q. What should be the position of steam valves when cars are set out or left at terminals?

A. *They should be left wide open.*

Q. When cars are left for any length of time without steam, what should be done with hose couplings?

A. The couplings must be separated, thus allowing the water to drain off and prevent freezing.

There are two general rules of car heating. The first rule is, *"Keep a little steam escaping at the rear of the train."* The second rule is, *"Never cut off steam from the train line without first opening the rear train pipe valve and blowing out the train line."*

CHAPTER XVIII.

THE DRAFT GEAR

The subject of draft gear has always been a live one. Yet it is only after considerable study that the enormous importance of the draft gear is realized.

The value of good draft gear in protecting the car and its contents cannot be overestimated. Many failures of parts of the car remote from the draft gear, may be caused by inadequate protection afforded by the draft gear.

A draft gear is put on a car to absorb the shocks which occur in service, and the first thing for the carman to grasp in his consideration of the draft gear, is that it is made primarily to absorb butting shocks and not pulling shocks.

Any draft gear at present being offered for use on freight cars will absorb the maximum pulling shock produced by the largest locomotive and do it easily, unless the draft gear has been previously weakened by a buffing shock. At most, the shock encountered when starting a train cannot be any greater than the force sufficient to start the train, while in a buffing shock, the train or cars may be moving at any rate of speed up to a point where the entire car would be destroyed regardless of the draft gear used.

The shock which a draft gear must absorb is measured by weight and speed. This kind of force or energy is measured in foot pounds.

The foot pound capacity of a draft gear can be determined quite accurately in a laboratory. Some railroad men have said that they do not believe in laboratory tests. Such men contend that the only real tests are service tests.

It is true that service tests are final. But it is possible to obtain in laboratory tests much quicker results —results which it would require years of service to obtain. And if the testing laboratory and the apparatus used is correctly designed, you can see and measure the destruction as it takes place and thus get at the truth very quickly.

In this way, many corrections in design can be worked out at a small cost and in a few days; and in some cases even in a few hours. While if left entirely to the service to develop it, these corrections would take years, and cost many thousands of dollars, besides placing on cars an appliance which has not been perfected and which is bound to cause trouble

The main thing in the laboratory tests is to approximate as nearly as possible the conditions which obtain in service. And in a test of this kind there is no question but what any draft gear that shows up poorly will assuredly show up poorly when subjected to service conditions.

In a study of this problem, the following facts stand out quite clearly:

First: The cost of maintenance of freight cars due to natural causes, that is, wear, is very small; it probably does not exceed twenty per cent of the total.

Second: The unnatural cost, (80 per cent) which includes all repairs not due to natural cause, can be traced to shocks and is waste because it can be eliminated.

Anything that can be eliminated is waste. This unnatural cost will be three and often four times the natural cost.

Investigations show that all damage to cars from pulling can be traced to previous damage by collisions or bumping cars together. The tensile or pulling requirements on a car are not difficult to meet or comply with. But the buffing requirement is very different, as the heavier you build the cars and the faster they are going, the harder they bump.

How shall we reduce shocks? There are just two ways. First, don't bump cars so hard; and second, build a draft gear that will convert the hardest blow or bump into a push.

We may believe that we cannot slow down our speed in handling. We are a hurrying, rushing, pushing and wasteful people but we must either continue to allow a large waste in car maintenance or we must reduce the speed at which we handle the cars, or we must install the best possible draft gears.

To explain clearly the capacity of a draft gear and draft sills, it is necessary to use two terms, one of which can be called pounds *pressure* and which means the actual load in pounds that the structure will carry. This feature does not concern the draft gear and is misleading when it is used to indicate the draft gear capacity.

The other term which must be used is *foot pounds* which is the proper term to use in stating the draft gear capacity. A foot pound of energy is the result of a one pound weight falling one foot.

A car moving at a certain speed on the rail will deliver the same foot pounds of energy as a falling body of

equal weight traveling at the same speed. We show herewith tables giving the speed in feet per second and equivalent miles per hour of a body falling a distance of from one to ninety-six inches.

In this table the first column is the height of drop of a falling body in inches. The second column shows the speed in feet per second that a falling object will have at the end of the drop in inches. The third column shows what would be an equivalent speed in miles per hour. For instance, at the end of a drop of one inch, a falling body would be moving at the rate of 2 31/100 feet per second, or 1 58/100 miles per hour, and so on down through the table. Thus if you have a car running at a certain speed in miles per hour and it is brought to a stop, you refer to the table under the third column, miles per hour at which the car was going, and then under column one the corresponding figure will give the height of drop in inches of a falling body that would be equivalent to that many miles per hour. If this figure in the first column, changed to feet, is multiplied by the weight of the car in pounds the result will be foot pounds of energy which have to be absorbed when the car is brought to a stop.

For example, assume that the car weighs 155,000 pounds on rails and at the time it collides with the stationary object it is running 5 46/100 miles per hour. Looking under the third column in the table, we find the speed of 5 46/100 miles per hour in the third column and running across to the first column, we find that this is equivalent to a height of drop of 12 inches or one foot. Then to find out the amount of energy which was absorbed when the car was stopped, we multiply its

weight 155,000 pounds by one foot which is the equivalent height of drop and find that we have 155,000 foot pounds to be absorbed.

Now if this car should collide with another that was stationary on the track, equipped with draft gear having 1¾ inch travel and with a capacity of 4,500 foot pounds, while the moving car had a gear of 2½ inch travel with a capacity of 12,000 foot pounds, there would be a total draft gear capacity of 16,500 foot pounds in a combined travel of 4¼ inches.

The absorbing capacity of two underframes with center sills as hereafter described, up to the point of overstraining them, is approximately 40,000 foot pounds each, or 80,000 pounds for the two cars.

The ability of the standing car to move at the time of impact would be equal to this total absorbing capacity, making a maximum total of 96,500 foot pounds (16,500 plus 80,000) of non-destructive energy. This subtracted from the total energy of 155,000 foot pounds would leave 58,500 foot pounds for the cars to take care of and would result without question in damage to the couplers, sills, or other parts of the car. The extra energy would have to be absorbed by the destruction of the weakest part of the car instead of by the draft gear absorbing it.

Here is a case that, with the present limitations of draft gear travel, could not be controlled. Hence we must turn to the education of the trainmen, explaining and insisting that, to avoid damage to equipment, cars must be switched with greater care and lower speed. If it is impossible to do this, then you will have to say to the draft gear manufacturer, "we are forced to use a gear

which will control a shock of 155,000 foot pounds. How much gear travel will you need to do this?"

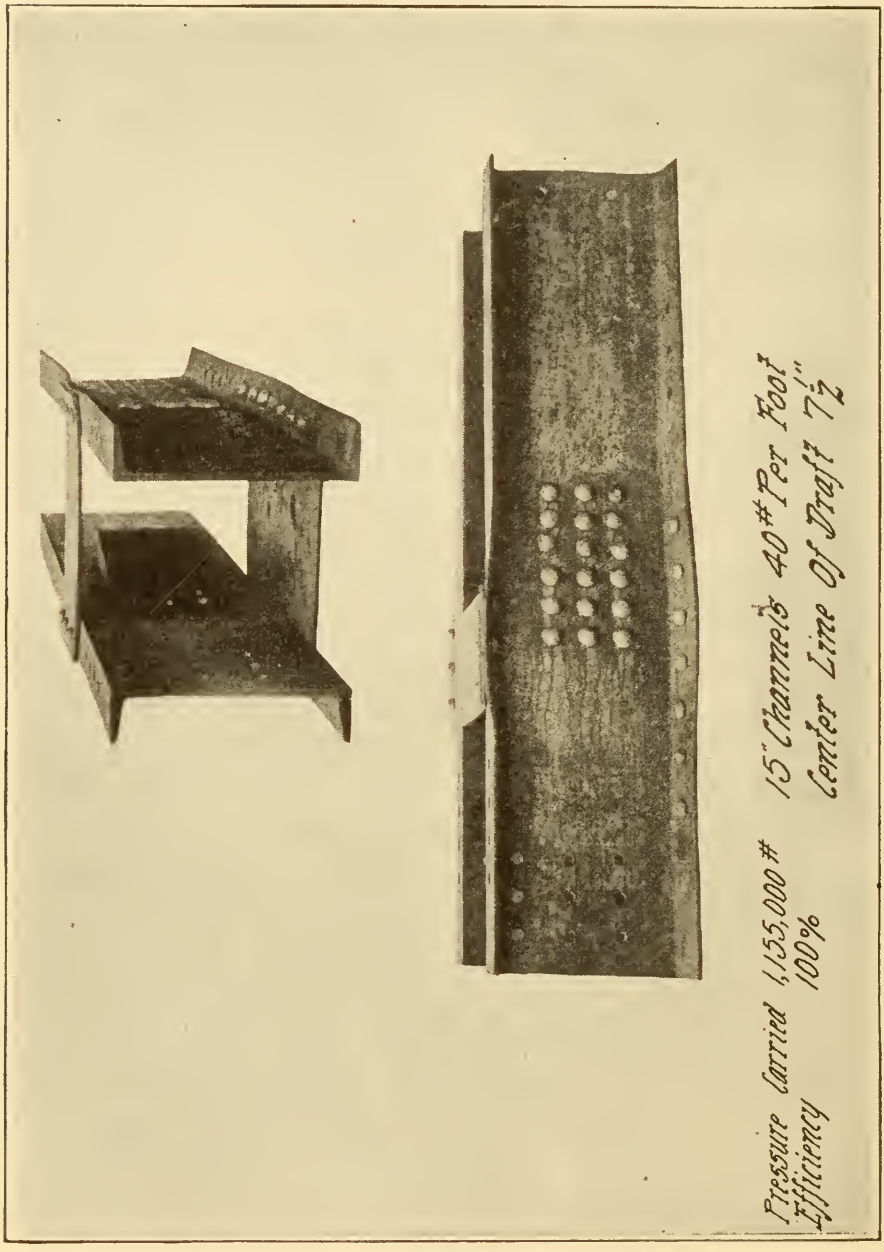


Fig. 1.

In other words, foot pounds of energy result in pound-pressure resistance. When you reach this limit, pound pressure on the car and every car has its limit of damage occurs.

Regarding the pushing strength of cars, we would refer to Fig. 1 showing a pair of sills tested for buffing strength. These sills are two 15-inch by 40-pound channels with a $\frac{5}{16}$-inch cover plate, $\frac{5}{16}$-inch tie plate and draft lugs all securely assembled according to the best practice in car building. In this test, the sills developed a maximum strength of 1,155,000 pounds pressure. This was their limit and under this load they would continue to bend.

Just think what it would mean if with one end held stationary we attempted to put enough locomotives pushing against it on the other end to generate this pressure. Take locomotives of 100,000 pounds tractive effort or draw bar pull, and 11½ (12) locomotives would be necessary to find the maximum capacity of the sills.

There can be no doubt that the strength of these sills is ample for all pushing purposes. But in the switching of cars, it only requires a speed of 3.8 miles per hour of a car weighing 155,000 pounds and equipped with no draft gear to produce destruction of this sill arrangement. Taking the same cars equipped with two 8 by 8 inch spring draft gears having a combined travel of 3½ inches, a switching speed of only 4.4 miles per hour would produce this destructive pressure.

In the table given showing foot pounds of energy, this information is given for three classes of cars, 60,000 pound capacity, 80,000 pound capacity and 100,000 pound capacity cars.

Fig. 1 shows a picture taken on a test of what was considered to be of modern steel car construction. This was tested to destruction in the laboratory. As noted

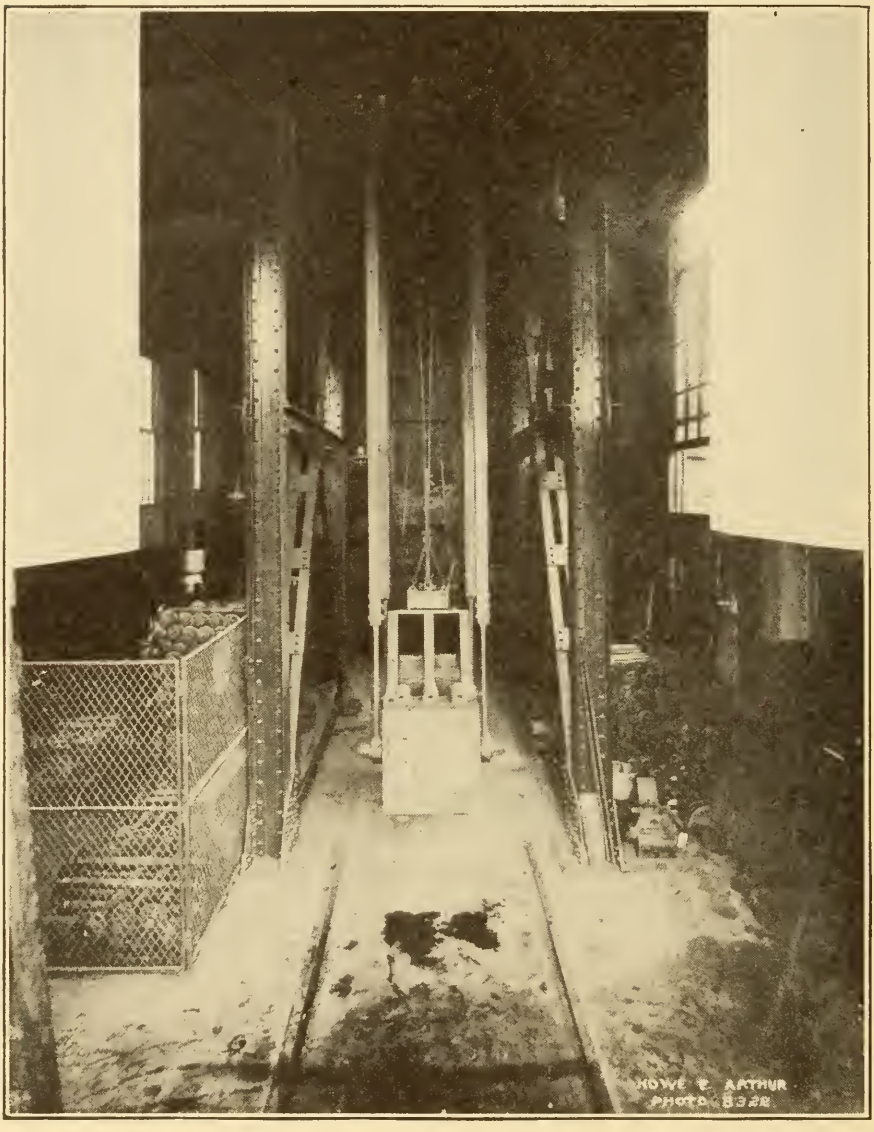


Fig. 2—The 30,000 Pound Pendulum Hammer in a Draft Gear Testing Laboratory.

in the illustration, this structure carried a load of 1,155,000 pounds at point of destruction. Fig. 2 shows

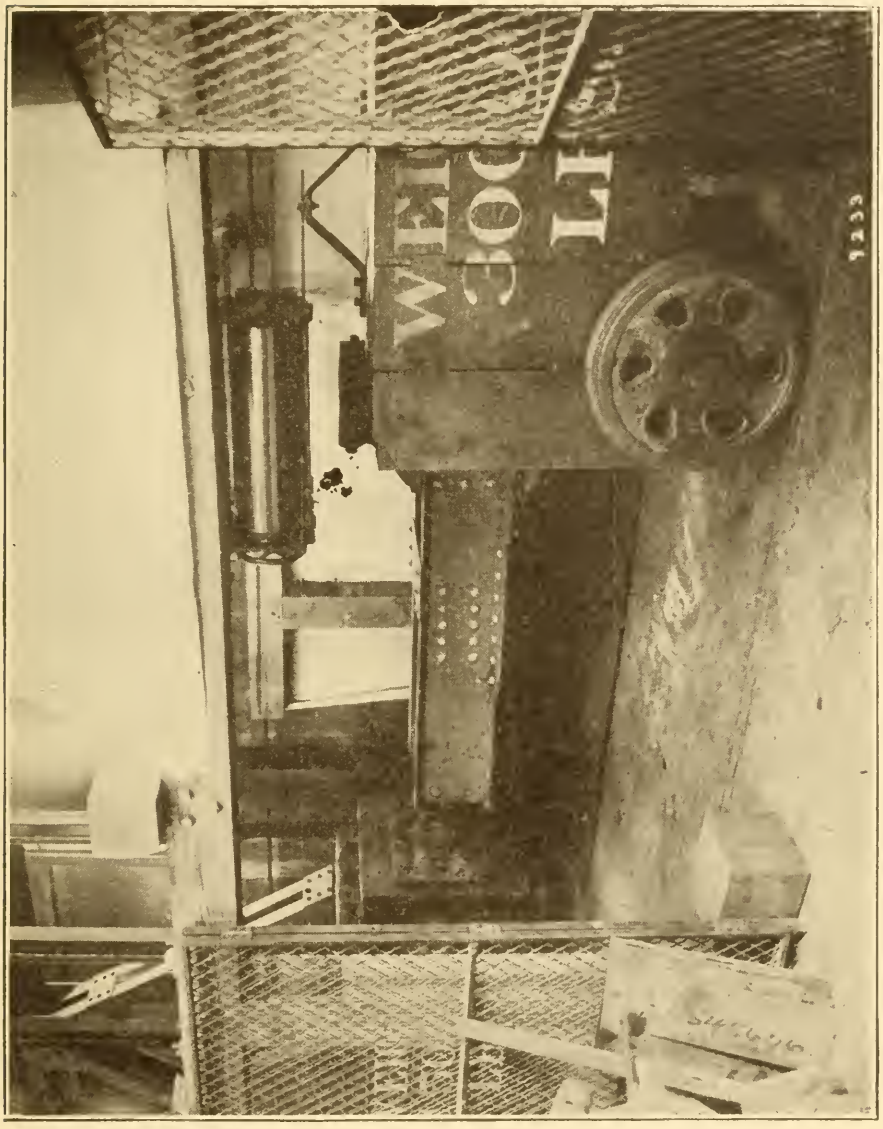


Fig. 3—Showing the 30,000 Pound Movable Car with Draft Sills Attached.

the 30,000 pound pendulum hammer. Fig. 3 shows the 30,000 pound movable car to which the sills and draft gear are attached for tests; and Fig. 4 shows

another view of the car with sills attached and the recording instrument which shows pounds pressure on the sills at each blow of the hammer.

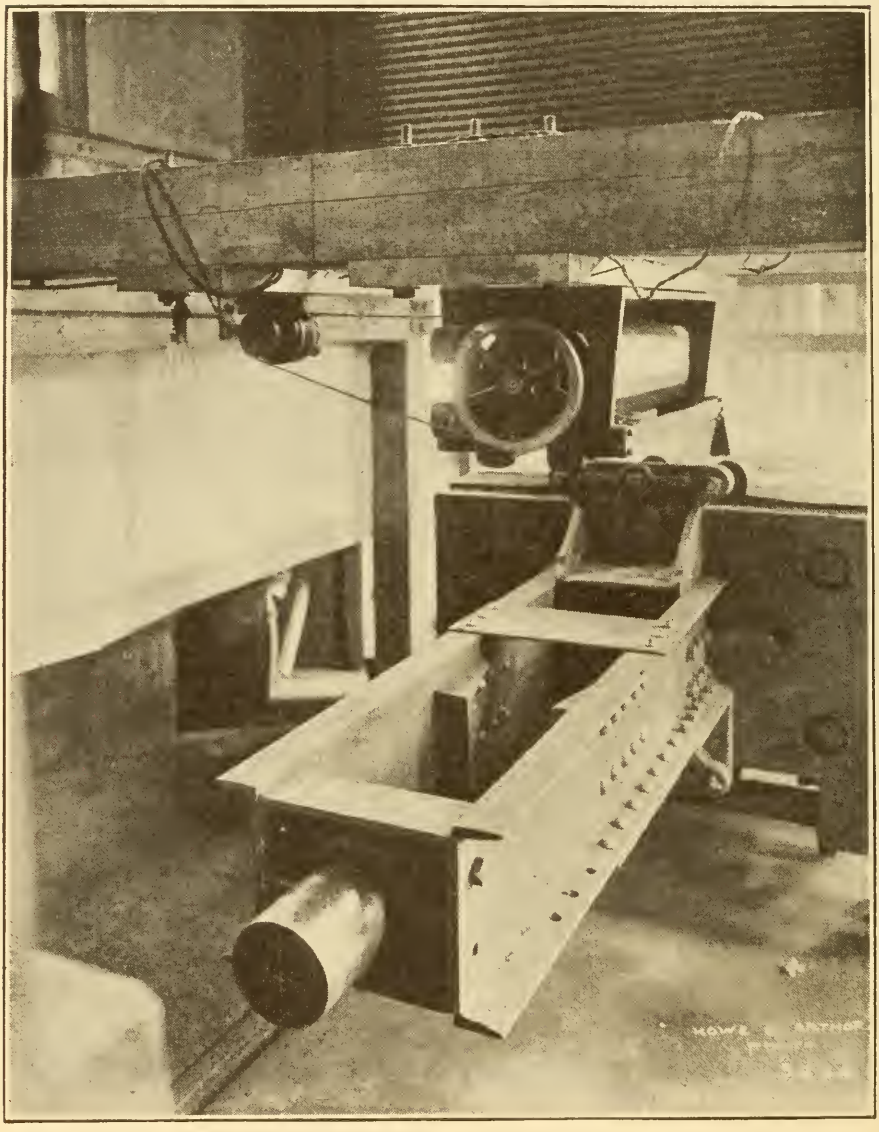


Fig. 4—View of Car with Sills Attached and Also the Recording Instrument.

Height of Drop in Inches	Speed	
	F. P. S.	M. P. H.
1	2.31	1.58
2	3.27	2.23
3	4.01	2.73
4	4.63	3.16
5	5.18	3.53
6	5.67	3.87
7	6.13	4.18
8	6.55	4.46
9	6.95	4.73
10	7.32	4.99
11	7.68	5.23
12	8.02	5.46
13	8.35	5.69
14	8.66	5.90
15	8.97	6.11
16	9.26	6.32
17	9.55	6.51
18	9.82	6.70
19	10.12	6.90
20	10.35	7.06
21	10.61	7.23
22	10.86	7.40
23	11.10	7.57
24	11.34	7.73
25	11.58	7.89
26	11.81	8.05
27	12.03	8.20
28	12.25	8.36
29	12.49	8.50
30	12.68	8.64
31	12.89	8.79
32	13.10	8.93
33	13.30	9.07
34	13.50	9.20
35	13.70	9.34
36	13.89	9.47
37	14.08	9.60
38	14.27	9.73
39	14.46	9.86
40	14.64	9.98
41	14.82	10.10
42	15.00	10.22
43	15.18	10.34
44	15.36	10.46
45	15.53	10.58
46	15.70	10.70
47	15.87	10.82
48	16.04	10.94

Height of Drop in Inches	Speed	
	F. P. S.	M. P. H.
49	16.20	11.05
50	16.37	11.16
51	16.54	11.27
52	16.70	11.38
53	16.85	11.49
54	17.01	11.60
55	17.17	11.71
56	17.33	11.81
57	17.47	11.91
58	17.63	12.01
59	17.78	12.12
60	17.93	12.22
61	18.08	12.32
62	18.23	12.42
63	18.38	12.52
64	18.52	12.62
65	18.66	12.72
66	18.81	12.82
67	18.95	12.92
68	19.09	13.01
69	19.23	13.11
70	19.37	13.21
71	19.51	13.30
72	19.65	13.39
73	19.78	13.48
74	19.91	13.57
75	20.05	13.66
76	20.19	13.75
77	20.32	13.84
78	20.45	13.93
79	20.58	14.02
80	20.71	14.11
81	20.84	14.20
82	20.97	14.29
83	21.10	14.38
84	21.22	14.47
85	21.34	14.55
86	21.47	14.63
87	21.60	14.72
88	21.72	14.80
89	21.84	14.89
90	21.96	14.97
91	22.08	15.05
92	22.20	15.13
93	22.32	15.22
94	22.44	15.30
95	22.56	15.38
96	22.68	15.46

Weight of car ..... 32,000 lbs.

Weight of load ..... 60,000 lbs.

10 per cent excess ..... 6,000 lbs.

Total load ..... 72,000 lbs.

Velocity		Energy in Foot Pounds	
M. P. H.	F. P. S.	Light	Loaded
1.	1.466	1,102	3,304
1.5	2.2	2,481	7,443
2.	2.933	4,414	13,240
2.5	3.666	6,895	20,686
3.	4.4	9,926	29,781
3.5	5.133	13,514	40,543
4.	5.866	17,654	52,961
4.5	6.6	22,350	67,050
5.	7.333	27,589	82,771
5.5	8.066	33,379	100,145
6.	8.8	39,720	119,159
6.5	9.533	46,624	139,870
7.	10.266	54,090	162,269
7.5	11.	62,081	186,243
8.	11.733	70,634	211,901
8.5	12.466	79,749	239,246
9.	13.2	89,426	268,278
9.5	13.933	99,665	298,995
10.	14.666	110,466	331,398

Weight of car..... 39,000 lbs.

Weight of load..... 80,000 lbs.

10 per cent excess..... 8,000 lbs.

Total load.....127,000 lbs.

Velocity		Energy in Foot Pounds	
M. P. H.	F. P. S.	Light	Loaded
1.	1.466	1,303	4,244
1.5	2.2	2,932	9,548
2.	2.933	5,216	16,980
2.5	3.666	8,149	26,540
3.	4.4	11,740	38,220
3.5	5.133	15,970	52,000
4.	5.866	20,860	67,940
4.5	6.6	26,410	86,010
5.	7.333	32,600	106,140
5.5	8.066	39,450	128,500
6.	8.8	46,950	152,900
6.5	9.533	55,090	179,400
7.	10.266	63,860	208,000
7.5	11.	73,360	238,900
8.	11.733	83,470	271,800
8.5	12.466	94,250	306,900
9.	13.2	105,600	344,000
9.5	13.933	117,700	383,400
10.	14.666	133,300	424,400

Weight of car..... 45,000 lbs.

Weight of load.....100,000 lbs.

10 per cent excess..... 10,000 lbs.

Total load.....155,000 lbs.

Velocity		Energy in Foot Pounds	
M. P. H.	F. P. S.	Light	Loaded
1.	1.466	1,504	5,179
1.5	2.2	3,383	11,660
2.	2.933	6,018	20,730
2.5	3.666	9,402	32,380
3.	4.4	13,500	46,650
3.5	5.133	18,420	63,490
4.	5.866	24,070	82,920
4.5	6.6	30,480	105,000
5.	7.333	37,620	129,600
5.5	8.066	45,520	156,800
6.	8.8	54,180	186,600
6.5	9.533	63,580	219,000
7.	10.266	73,700	253,800
7.5	11.	84,650	291,600
8.	11.733	96,310	331,700
8.5	12.466	108,700	374,600
9.	13.2	121,900	419,900
9.5	13.933	135,800	467,800
10.	14.666	150,400	517,900

Consideration of these facts and figures makes one realize the enormous blows which a car may receive if not adequately protected by efficient and well maintained draft gears.

We are indebted to the Union Draft Gear Co. for the data and illustrations used in this article.

CHAPTER XIX.

GOOD PRACTICE.

Draft Gear—The draft gear is as important to the life of a car as all of the other parts mentioned, because of the relation it bears to all damage the cars receive in service. There is so large a percentage of the maintenance cost that is chargeable either directly or indirectly to the draft gear that a cheap device is always the most expensive. The draft gear that has the greatest foot pounds capacity with a reasonable life as to wear is what should be used, and none should be applied with a capacity of less than 12,000 foot pounds. The design of the gear, including its travel, and the space in which it is to be applied, should be left entirely to the judgment of the manufacturer as the placing of a limitation on these dimensions will tend to discourage improvement of the draft gear.

Cast Steel Draw Bar Yokes—The ability to pour cast steel in the desired shape and design led to the introduction of the cast steel yoke. A keyed yoke is a great advantage because a broken coupler may be easily renewed without taking down the draft gear. The cast steel yoke should be designed with extra strength at the back where abnormal strains come.

Cast Steel Draft Arms—To provide the proper protection to wooden underframe cars, when receiving betterments cast steel draft arms should be applied extending beyond and fastened to the center sills back of the body bolster.

Truck Bolsters—Truck bolsters must possess the maximum strength with minimum weight to fill the re-

quirements of the modern car. The box girder type of cast steel bolster is a strong and satisfactory design, and with its use failures should be practically eliminated and cost of repairs reduced.

Locking Nuts—On parts of the car subjected to incessant pounding, especially the truck, the nuts should be locked on the bolts so that they will not jar loose or work off. Many devices have been heralded as the cure-all for loose nuts, but a good many carmen are yet to be convinced that the old fashioned methods of holding on nuts have been improved upon.

Journal Boxes—The journal box plays an important part in the service of the car. For a time the cast iron box met the requirements satisfactorily. The excessive weight of equipment in proportion to the strength of cast iron caused the substitution of other metals and a few years ago the malleable iron box was evolved, giving better service with a reduction in weight.

The ordinary journal box lid has nothing to hold it in place but its bolt and cotter key. The usual spring action tends to draw the bottom portion of the lid to the box, but it forces the upper portion away. In case of a sheared cotter key from vibration the bolt drops out of place and the lid is lost. Journal box lids should have the spring so arranged as to be depended on at all times to hold the lid securely in place on all its edges regardless of the box lid bolts' condition.

Journal Box Wedges—The function of the journal wedge or journal bearing key is to align the journal bearing to the various positions of the journal box in service. The contour of the top surface of the wedge fore and aft, must be on a radius of 39 inches, and should prefer-

ably have a full bearing surface. The M. C. B. requirements allow either malleable iron or steel wedges for 7, 8 and 9-inch journals, but require forged or cast steel for 10 and 11-inch journals. Steel wedges seem to be favored by Carmen even in the smaller sizes.

Car Journal Bearings—To give the best service at a reasonable cost the journal bearing must consist of metal that will distribute and carry off the friction heat of ordinary service and also retain its shape under more severe heat conditions.

It should be of a softer nature than the journal and should be manufactured with such care that the surfaces will be true to dimensions and will properly fit the wedge and box.

Car Journal Box Packing—Waste used for packing journal boxes must contain certain properties, namely resiliency, long fibre and capillary attraction. A type of packing has been developed which depends for its resilience (spring) not on the cotton or woolen threads, but on wiry, steel shreds. The body of this packing contains some sponge, so that it carries a large amount of oil, yet it does not require a high percentage of expensive wool. This type of packing is giving excellent service.

Carlines—The carline is the foundation of the roof. To construct a roof without the proper foundation or support on the superstructure is to shorten the life of that roof and the working life of the car. Pressed steel carlines can be made to best fill the engineering principles of design, giving greater depth at ridge pole and greater width at eaves. This design gives required strength and rigidity with minimum weight.

Car Door Fixtures—To protect against theft and

provide protection against the elements, car-door fixtures must be simple, strong, and easily replaced when broken. The lock should be so constructed as to allow easy and positive sealing and prevent opening the door without breaking the seal. While some roads advocate the use of steel castings for door fixtures, malleable iron has been and is used extensively, giving good service.

The Emergency Knuckle—An emergency knuckle is conceded to be a necessity by railroad men because of the danger of trying to chain cars together and operate them on the main line. In order to be in line with safety requirements, the emergency knuckle used should not increase the distance between cars, which means increasing the distance between the ends of running boards, thereby making a dangerous condition.

Car Replacers—The car replacer should be so designed that it will give maximum strength with minimum weight, this due to the fact that it often has to be carried the full length of the train and placed in position under the wheels where it is difficult to work.

For this reason, a lighter design should be used for lighter weight rails in order that the weight be kept at the absolute minimum for the kind of service the replacer is designed. It, however, must be built strong enough to rerail both cars and locomotives. Some efficient means should be provided for holding the derail in place without spiking.

Lighting Facilities for Railroad Work—In cases of emergency as in clearing wrecks at night, the value of powerful, portable lights is apparent. Such lights may be obtained, with self-contained or distributed unit generators. Lights of this character are a valuable addition to the equipment of a wrecking train.

Renovating Car Journal Packing—The best and most economical method of washing and removing foreign substances from dirty waste is by means of the oil vat. The process of bailing old and dirty waste in hot oil after dirt and short fibre have been removed and allowing it to drain before washing it again in hot, clean oil produces results unattainable by other methods of waste renovating.

Sand Blasting in Railroad Practice, Removing Paint—The need of some means for effectively and rapidly removing paint, scale and rust from steel cars and trucks, before painting, has led to the extensive use of sand blasting. This is a process by which sand or other good abrasive is forced through a nozzle by compressed air with sufficient force to leave the surface smooth and clean. This process is much quicker than the use of varnish remover and scraping.

The sand blast process, however, is neither so successful nor economical for outside use as it is for use where a special building can be provided. In the latter case, the sand or abrasive used can be reclaimed and can be used over and over again, while with the sand blast used out of doors, the sand or abrasive used is lost after the first operation.

Car Painting—The work of preserving the new materials applied in repairing cars falls upon the painter. Ordinarily this work is handled by the old methods of pail and brush. Some roads, however, are adopting new and up-to-date methods, using different types of sprayers, home-made and patented. The former owes its popularity to the fact that there are no special parts, and in case anything breaks it may be easily substituted.

If particular attention is given to the paint delivery pipe at its location of opening near the bottom of the paint receptacle, and to the mixing valves (which should be of the needle-valve type), with due regard to the syphon arrangement for thorough vaporizing of the paint particles, the results produced will be satisfactory and economical.

With a good paint Sprayer a given surface can be covered in about one-fifth the time required by using the ordinary brush. This means a great saving in labor. The surface can be covered more evenly and effectively, as cracks and crevices are well sealed by this process.

Fire Resisting Paint—A good fire resisting paint would save many cars which fire destroys. The fire proofing material in a paint must not, however, destroy the weather resistance of the paint. The fire resisting material in some paints, leaves the paint and penetrates the wood, thus leaving the paint thoroughly weather proof. This is the kind of fire resisting paint for cars, as it leaves the wood fireproofed even after the paint is gone.

Truing Cut Journals—Usually a cut journal requires the removal of a pair of wheels, although often the injury to the journal may be slight.

Recently, however, some railroads have been trying out an appliance for turning journals without removing them from the car. The utility of this tool and the savings it makes possible, make it look attractive for use at small as well as large repair points if it proves satisfactory and dependable in service.

Cutting Rivets—At points where extensive steel car repairs are made, much of the work may be done

with pneumatic tools. This work requires the cutting of many rivets and a rivet cutting gun is a great labor and time saver. With the gun the use of scaffolding is unnecessary as a long cutting tool can be used which will reach all the rivets on the side of a car. The gun can be used anywhere about the car for cutting and backing out rivets, draft keys or center pins.

Slid-Flat and Tread-Worn Wheels—Abrasive shoes were originally advocated for use on slid-flat and tread-worn wheels. However, they develop a larger co-efficient of friction than the ordinary shoe and where they are used it is found necessary to reduce the air pressure, to prevent sticking. If the brake pressure was reduced, then all cars in the train should have abrasive shoes and this is not justified in view of the small percentage of slid-flats. Abrasive shoes have recently been used on locomotives to retard the development of tread-worn wheels, as the air pressure may, if desired to depart from standards, be reduced on the locomotive in order to prevent the wheels sliding.

If a slid-flat spot develops on a chilled iron car wheel it will usually have to be scrapped, as generally the chilled portion will be worn off and the soft part beneath exposed. If the slid-flat spot is on a steel wheel it may be re-ground or re-turned and put back into service.

Car Wheel Grinders—Car wheels which become "slid flat" are unfit for further service unless some means is provided to restore the tread to its original contour. Regrinding is often resorted to, but chilled iron wheels should not be reground if the slid-flat spot has worn through the chill. The car wheel grinder, therefore, is of greatest value with steel wheels, of which, how-

ever, only about 5 per cent of our freight cars are equipped.

Selection of Lumber In Car Construction—Paragraph (h) of M. C. B. Rule 17, states that: "White pine, yellow pine, fir or cypress may be used when repairing siding, when of equal grade or quality to the material standard to the car. Fir, oak or southern pine may be substituted for each other in the renewing or splicing of longitudinal sills and side plates. Oak and southern pine may be substituted for each other in renewing end plates. Fir and southern pine may be substituted for each other in renewing or splicing end plank and side plank."

Timber subject to stresses must be "dense," that is, must contain certain properties which tend to increase its strength and elasticity. The better grades of southern pine, cypress and fir contain these properties and are well adapted for car construction.

Uncoupling Devices.—Operating lever chains become defective through excessive slack or failure of draft gear parts. An efficient uncoupling device must conform to the safety appliance requirements and provide for positive operation of the coupler, regardless of defective conditions of the draft gear or excessive slack.

Steel Car Paint.—The question of what to apply as a preservative as well as for appearance makes the subject of steel car painting a live one. The car is exposed to severe weather conditions both in summer and winter, and coupled with the fact that roadbeds are not all rock ballast, the action of cinders, sand and gravel form a cutting force which attacks the finished surfaces with danger of rust and corrosion getting in their work. Steel car paint must be of an inhibitive nature and of

sufficient weather resisting body to cling to the metal surface under all conditions, without becoming porous.

Side Bearings—The derailment of cars, especially those of steel construction, is a matter to be seriously considered. As its frame is absolutely rigid, when such a car enters a curve where the outer rail is elevated four inches or more and the approach is comparatively short, the weight on the forward end of the car is carried almost entirely by the outer forward side bearings.

When rigid cast iron side bearings are used on these cars, the friction between them is often greater than the reaction between the wheel flanges and the rail, and as a result derailment occurs. An illustration of this was a heavy express car built new at a railroad shop, having a rigid steel underframe mounted on a standard steel truck. The car was 42 feet long over end sills, with a rather high center of gravity. Rigid side bearings were placed on a 60 in. center with a clearance of $\frac{3}{8}$ inch.

In order to limber up the car, it was sent out empty and at the first sharp curve, the outside leading wheel left the rail, the friction on the outer side bearing being greater than the reaction of the wheel flange against the rail. The car was replaced on the track and carefully run over the rest of the line. Believing that the first derailment was caused by the car being light, it was then loaded to about one-half its capacity and started back home. On leaving another sharp curve, the outer leading wheel on the rear truck left the rail, evidently for the same reason as in the first derailment. The car was then sent to the shops and carefully inspected, the trucks were trammed and

everything found to be in perfect condition, but it was decided to increase the clearance between the bearings to overcome the difference in the elevation of the rails and they were given about one-half inch clearance all around, making a bad matter worse. The car was then loaded to its full capacity and sent out. It took the sharp curves without any trouble but in running down a grade at a good rate of speed over a heavy fill, the car began to rock from side to side until the wheels on one side of the car were lifted off the rail and the car was badly wrecked. Roller side bearings with not over ⅛ in. clearance were then applied and the car has been in continuous service over the same line for a year and has never had another derailment.

At the present time, there are over one quarter of a million cars equipped with some of the different designs of anti-friction side bearings, many of the large roads having from 10,000 to 20,000 cars so equipped. About 75 per cent of all the cars recently built are similarly equipped and it is reasonable to assume that the results obtained have not been unsatisfactory. Consideration of these facts shows the necessity for using anti-friction side bearings.

Car Ends—A check of bad order wooden cars placed on the repair track, shows a large percentage of cars with ends bulged or broken out and some with ends pushed in. The original construction of the end of old wooden cars is not strong enough to withstand the shocks of ordinary service. The most frequent damage is a hole poked through the lining or sheathing or both. And a few cases occur of completely bursted out ends. It is of first importance, then, to increase the thickness of the end lining, and the end structure

can be further strengthened by reinforcing bars, braced at top, and firmly attached to sills at bottom. All cars with weak or defective ends should be strengthened when being repaired.

The Car Roof—The exponents of the various types of car roofs have defended their ideas so thoroughly that the issue is somewhat beclouded in the eyes of the Carmen who repair roofs.

The claim that steel without insulation will cause condensation seems well founded. Composite roofs where both boards and metal are integral parts of the roof, allows a possibility of movement between the wood and steel, which adds its part to the destructive action of the elements.

Flexibility is not considered an asset in steam or electric passenger car roofs, where great extra expense is incurred to make the body and roof rigid.

Therefore, that general design of rigid roof consisting of a heavy gauge metal for turning the weather with a thin layer of insulating material beneath to prevent condensation, seems to conform most nearly to the requirements of service.

Car Couplers—The M. C. B. Association adopted a coupler called the Standard D-coupler in 1916, which is heavier and more expensive than those previously in use. The coupler was developed by a committee of the M. C. B. Association, assisted by five coupler manufacturers.

The Standard D coupler not only has the backing of the M. C. B. Association but has the backing of these five companies which make practically all the couplers used.

In the interest of interchangeability the Standard D coupler should be specified on all new cars, and for replacements on old cars. Another reason which has often been advanced in favor of adopting a standard coupler was that competitive prices might be obtained from a number of companies on the same design. The main advantage, however, has been a saving in freight because couplers may be obtained at the same price, at any one of five locations scattered all over the East and Middle West.

MODERN CAR APPLIANCES AND EQUIPMENT.

CARDWELL FRICTION DRAFT GEAR

In a paper read before the International Railway General Foreman's Association, Mr. C. F. Baumann says:

"My study of broken or damaged cars leads me to believe that if a draft gear of sufficient capacity to care for the buffing shocks is used, it will be ample to care for the pulling forces, as I cannot call to mind a case of damage due to pulling unless the parts were first damaged and weakened by the buffing shocks; except very rare cases of coupler yokes breaking under pulling strains where the yokes were made of the old light section of 1″x4″ bars, and even of lighter section; but the new standard yoke section of 1¼″x5″ has put a stop to this failure and there are few of the old light section of yokes in use now."

In other words, to make your draft gear take care of the pulling shocks, all you have got to do is a matter of making the yoke strong enough. It is the buffing shock which causes all the damage to cars and tests the merit of a draft gear.

It is easy to see that the amount of buffing shock which a gear can absorb depends upon the work capacity of the gear. The greater this work capacity, the greater the shock absorbing capacity. The work capacity of a draft gear depends upon the average pressure and the amount of travel. And if the average pressure is maintained and the travel increased, the work capacity will be increased in like proportion. There is a limit for travel, determined by the length

of the air hose and other conditions. But up to this limit the draft gear manufacturer should have an opportunity to work out the travel of his gear so that he can increase its work capacity to the highest point without subjecting car sills to dangerous pressures.

It must be remembered that damage to car sills is caused by excessive pressures built up in them, and the function of the draft gear is to keep these pressures down to the safe working load of the sills.

It is understood by practically all Carmen that there are two general types of draft gear; spring gears and friction gears.

A spring is defined as "an elastic material which resists shocks." Note then that a spring gear does not absorb or destroy shocks; it merely resists them. What it really does, is to simply store part of the energy temporarily and then transfer practically all of the shock to the car.

A friction draft gear is different. When friction is set up, energy is absorbed in overcoming the friction. Therefore, a friction draft gear actually absorbs or destroys part of the shock which it receives; so that only part of the shock which a properly designed friction draft gear receives, is transmitted to the car.

Now these shocks, in overcoming the friction, cause the friction members to wear. Where the friction elements do not wear, you are getting no resistance.

For this reason, a friction draft gear should have some simple means for taking up the wear that occurs in service, which is so necessary in destroying a part of the shocks which the draft gear receives.

Of course, any "take-up" in the gear must be simple, positive and easily made, because it must be made by

Carmen all over the country, many of them located at outside points where both help and facilities are limited.

The absolute necessity of a take-up on any friction draft gear and the necessity for the simplest kind of a take-up were the considerations which led to the development of the Cardwell Friction Draft Gear.

The Cardwell Friction Draft Gear is different from all other gears in this feature and also in several others. It is the only draft gear where part of the members are carried outside of the sills and this allows building the draft gear larger and of higher capacity than would otherwise be possible, and also makes it easy to inspect.

The distinguishing features of the Cardwell Friction Draft Gear are high work capacity, simplicity and long efficient life. This long efficient life is obtained by a property original with and peculiar to the Cardwell Friction Draft Gear, that of adjustment or take-up as mentioned above.

The contact areas of the frictional elements are such that its initial efficiency with a normal application is maintained as long as that of any other draft gear; while the arrangement of the frictional elements is such that through the take-up feature, this efficiency can be restored twice, thus giving a working life equal to three draft gears not possessing the adjustment feature.

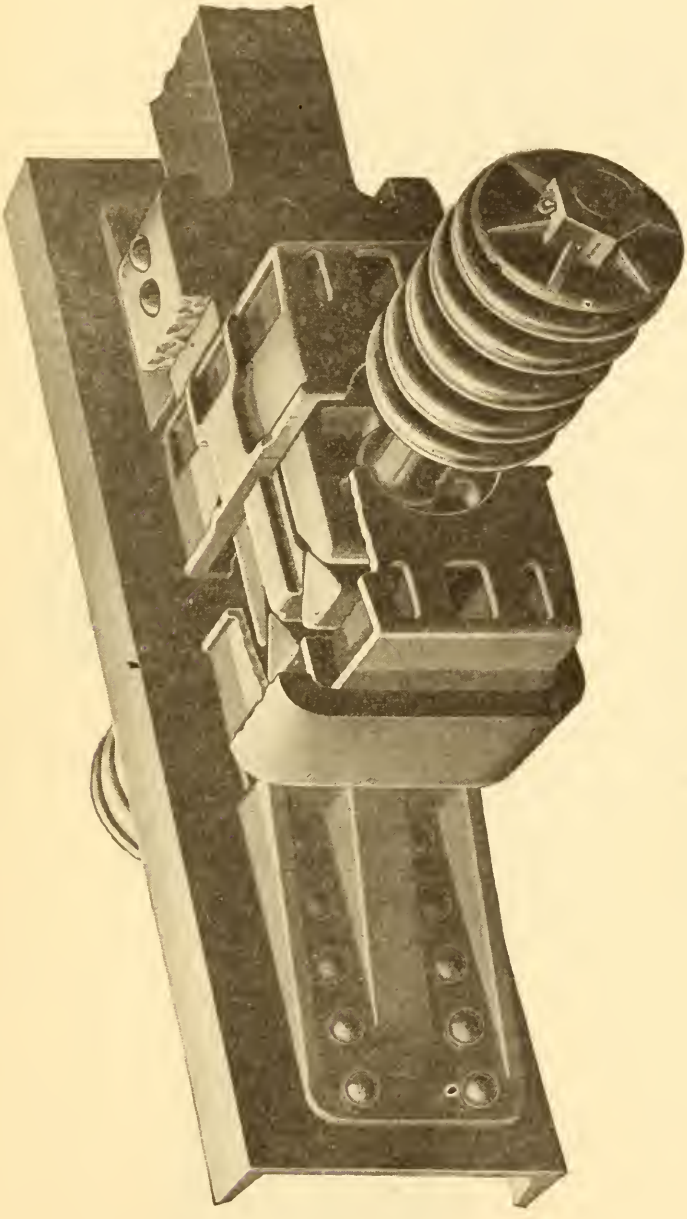
It is easy to tell when a Cardwell gear needs adjustment and that is about the only maintenance it ever requires. The springs are in full view of the inspector. And by simply taking hold the spring and pushing on it, he can tell whether it is loose or not. If it is

loose, adjustment should be made. Everything being in plain sight and the adjustment being made outside the center sills, this work is as easy to do as its necessity is easy to discover.

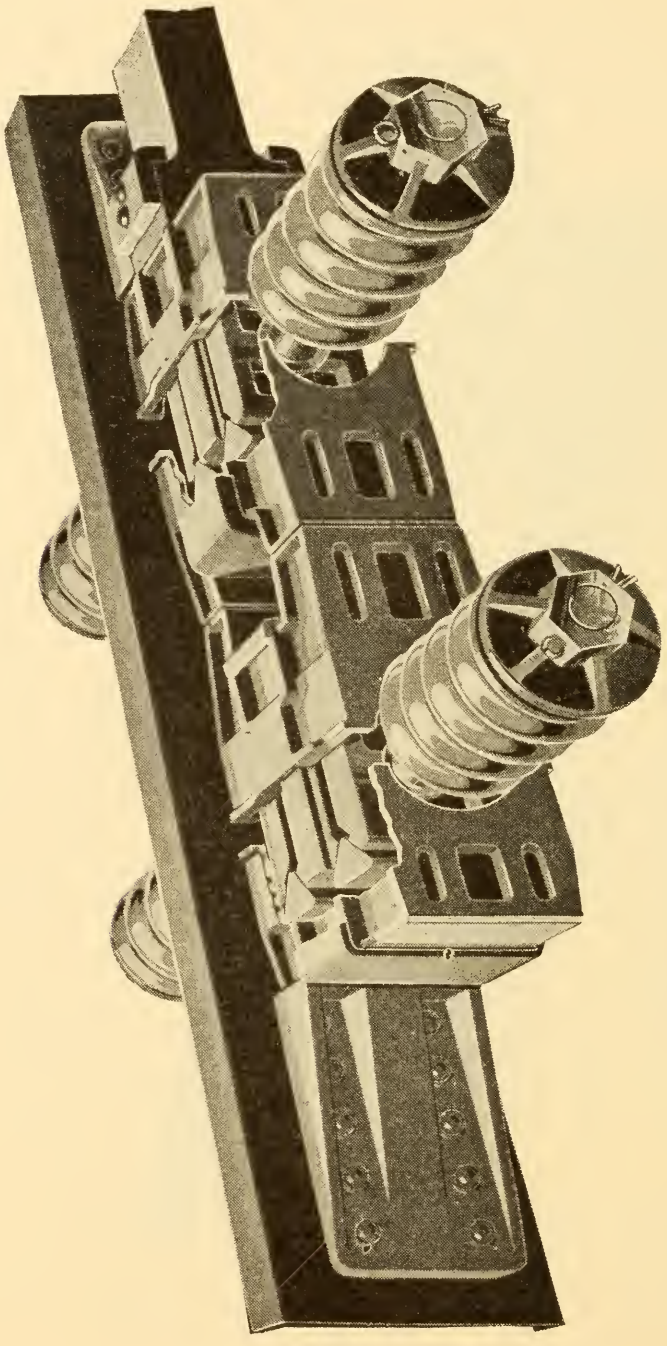
The necessity of proper maintenance of draft gear is apparent. The enormous importance of good draft gear for protecting the car and its contents cannot be overestimated. Many failures of parts of the car remote from the draft gear may be caused by inadequate protection afforded by the draft gear.

Draft Gear Capacity—Mr. Baumann stated in his paper: "It is only a short time since the 80,000 capacity car, which would weigh about 125,000 pounds on rails when loaded, was the heavy type. This was followed by the 100,000 pound capacity car weighing 150,000 lb. on rails when loaded. Next came the 70 ton or 140,000 pound capacity car, which loaded weighed 200,000 pounds. The 90 ton or 180,000 pound capacity car came next with a total loaded weight of 250,000 pounds. The next heavy capacity car to make its appearance is the 120 ton or 240,000 pound capacity car with a loaded weight of over 300,000 pounds. When it is understood that these increases in rail loads per car all came into use during the last fifteen to eighteen years, and the wide difference in the amount of energy developed in these different weights moving at two or three miles per hour, the need for improved draft gear will be clear to all."

This shows the undesirability of placing unnecessary limits on the draft gear manufacturer. The increased weights of cars in the last few years, means that the draft gear must do much greater work now than for-



Cardwell Friction Draft Gear, Type G Class 11 A.



Cardwell Friction Draft Gear, Type G Class 11-A Compound.

merly and every opportunity should be given the draft gear manufacturer to meet these conditions.

This also shows why draft gears which were applied from 7 to 10 years ago should in most cases be replaced by gears of greater capacity. For instance, take the Cardwell Friction Draft Gears type "B". These were designed when the 80,000 capacity car was in common use, which only weighed 125,000 pounds on the rails when loaded. The Cardwell type "B" gears were made more than strong enough for service on these cars.

The Cardwell type "B" gear designs, however, have all been superseded by Cardwell type "G" Friction Draft Gears which are designed with sufficient capacity to take care of heavy present day equipment.

It is safe to assume that wherever a Cardwell type "B" gear is now found on a car, it has given from 7 to 10 year's service—which is extraordinary service for a draft gear. It is also perfectly evident that such a gear should be replaced by a high capacity Cardwell type "G" gear because heavy cars are constantly bumping into the lighter cars.

A further improvement in draft gear, especially designed to be used under the heaviest service, is the Cardwell Compound and Duplex Gears, which are by far the highest capacity draft gears on the market today, and no gears of lesser work capacity should be applied to heaviest present day equipment.

The Carman realizes the enormous importance of the draft gear in keeping shocks out of the car structure and superstructure. He realizes the great importance of maintaining draft gears so that they will be operat-

ing at maximum capacity for receiving shocks and thus be giving maximum protection to the car.

He knows that the inspection of a draft gear to determine whether it is in good condition, is one of the most important parts of inspection of the car. The cost of good inspection and good maintenance of draft gears is trifling when the immense amount of money to be saved by preventing damage is considered.

Carmen are cordially invited to visit the Union Draft Gear Co.'s laboratory at Chicago, and get first hand information on draft gears and their capacities. Any railroad man who sees the actual tests can draw his own conclusions as to the merits of different draft gears and the action of draft gears when subjected to shocks.

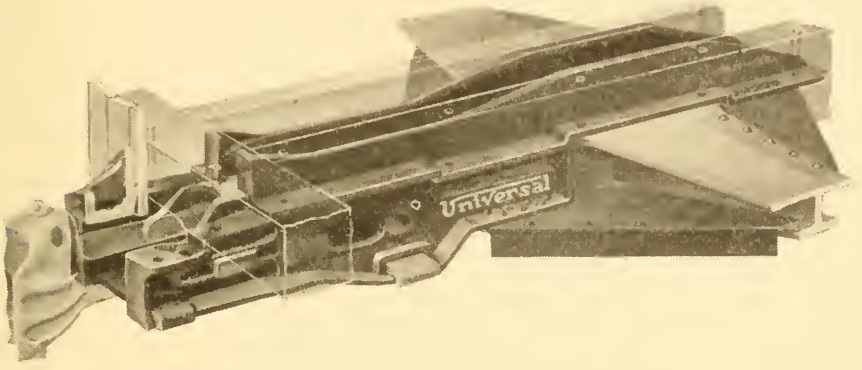
Cardwell Friction Draft Gears, of which you see so many in service, are made by The Union Draft Gear Co., Chicago.

UNIVERSAL ATTACHMENTS

Draft Arms—As a general proposition it can be safely said that the cost of maintenance of draft gear and its attachments is greater than on all other parts of the car combined; indeed on a wooden car it would be safe to say that where cast steel draft arms are not used the maintenance of the attachments or connector **between** draft gear and car, is the real offender. This defect is by no means confined to wooden draft timbers, as structural steel for this purpose on wooden cars is not infrequently of little more value than wooden timbers

The **Universal** draft arm is a one-piece steel casting and forms an indestructible connector between the draft gear and the car sills and bolsters that ef-

fectually prevents the breakage of sills and displacement of the draft lugs and numerous plates, straps, bolts and rivets. Actual service has demonstrated that an old wooden car equipped with cast steel draft arms,



Universal Cast Steel Draft Arms as Applied with Gussets.

is not only stronger than when new, but will more than double its life. The **Universal** arm possesses the following special features:

First—"Z" section back of the rear abutting shoulder. This supplies additional strength to resist abutting stresses at a vital point, possible by no other means.

Second—Coupler and draft gear carrier plates are placed on top of the lower flange; this relieves the securing bolts from all tension strains and effectually prevents the sagging or loss of these parts.

Third—A successful means is provided for making a tight fit at the bolster; this by means of a riveted plate immediately back of the bolster, and is a very important feature.

Fourth—Universal Gussets when applied connect the two draft arms and bolster in one compact

unit; movement of arms with reference to bolster or the turning of bolster due to shock in starting or stopping car is effectually prevented.

Universal Draft Arms are adaptable to any type of car, wooden, composite or steel, new or old, and can be made to accommodate any type of draft gear.

Application of Universal Draft Arms—For wooden underframe cars of the usual construction, the following method of applying **Universal** Re-enforcing Draft Arms has been found to be both practical and economical.

Coupler, yoke and draft gear are dropped and old draft timbers removed. Nuts on bolts securing body bolster to car are then taken off so that when car is jacked up truck may be run out with body bolster still in place thereon. Such framing as may be necessary to center sills and end sill is then done and truck with arms and bolster in position thereon is run back under the car, which is let down and the arms and bolster bolted to place.

When arms are secured to bolsters by means of gusset plates, the plates are riveted to arms and body bolster while they are in place on the truck, arms being blocked up in a horizontal position. It is usual in this case to put draft gear, yoke and coupler in place **before** running truck under car and bolting arms and bolster into position.

Methods of applying the draft gear, yoke and coupler, vary with types of draft gear and yoke used. With the **Universal Key** Connected yoke, it is a very simple operation in any case. Sub-sills or stiffeners same width as center sills and 6″ to 8″ deep, should

next be applied, extending from bolster to bolster and cut to such lengths that it is necessary to force them into place.

With **Universal** draft arms, friction draft gear and sub-sills properly applied, the old wooden car receives a new lease on life and will actually stand more punishment without repairs than similar cars when new or re-enforced by steel underframes.

Universal Yokes—The advent of steel underframe cars transferred the weak link in a car train from the draft sills to the yokes and couplers. Rivets used for securing yokes to drawbars have been a source of annoyance. To produce best results a rivet must hold tightly. The connection between yokes and couplers should be flexible.

The Universal Keyed Cast Steel Yoke.

The result is, where a riveted connection has been used it has proved unsatisfactory, the rivets not only becoming loose and thus reducing efficiency, but there is frequent breakage with consequent delay in train service. A strong and flexible connection that can be readily made is therefore more efficient and reliable.

Universal yokes are designed with the view of:

First—Elimination of coupler rivets, blacksmith labor and the handling of couplers to and from shops.

Second—Permitting quick and economical exchange of couplers without disturbing yokes or draft gear.

Third—Providing greater strength than is possessed by ordinary wrot yokes.

Fourth—Greater flexibility of couplers.

Riveting yokes to couplers means that each coupler ready for service must have a yoke, and as there are 10 or more sizes and lengths of yokes, the investment in extra couplers and yokes is entirely out of proportion to the actual service rendered.

By careful design and the use of first class, thoroughly heat treated materials, the **Universal yokes** are practically unbreakable in service and therefore where used, nearly all "break in twos" are almost invariably due to failure of couplers and these can be easily, and in a few moments, replaced without disturbing the draft rigging or other parts of the car. It is conceded good practice to reduce to the minimum the classes and sizes used, and any device that will permit of this reduction should be considered with favor.

The **Universal** attachment for couplers means to the user:

First—Practically no surplus yokes.

Second—Minimum supply of drawbars.

Third—Minimum expense and delay in applying couplers.

Fourth—Maximum service for cars.

The **Universal** yoke permits of backward movement of couplers, as in buff, without corresponding

movement of yokes. This is a very important feature as it lessens the wear of parts and permits the application of draft gear in otherwise prohibitive spaces.

Universal Draft Arms and Yokes are marketed by The Universal Draft Gear Attachment Co., Chicago, Ill.

WOODS ANTI-FRICTION BEARINGS

Since the earliest days of the double truck in railroad car construction, mechanics have realized the desirability of providing for comparatively free turning relation between the car body and the truck. With the advent of the large capacity freight car, and later of the steel

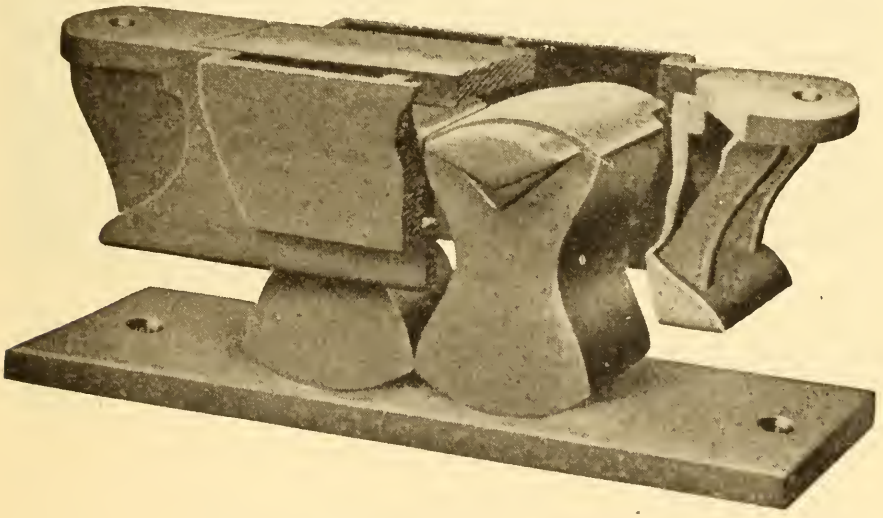


Fig. 1—Woods Tip Roller Side Bearing.

wheel, the subject has received still more earnest attention, for the reason that the recognized desirable condition of yesterday becomes the demand of today.

Frictionless side bearings facilitate the free action of the truck on curves, eliminate the danger of derail-

ment and materially reduce flange wear, adding greatly to the life of the wheel. They also necessarily reduce train resistance by the elimination of friction.

The importance with which the anti-friction side bearing is now regarded is evidenced by the fact that, based upon past experience, the leading railroad systems of the United States and Canada have adopted the frictionless side bearing as standard upon all classes of equipment, including heavy locomotive ten-

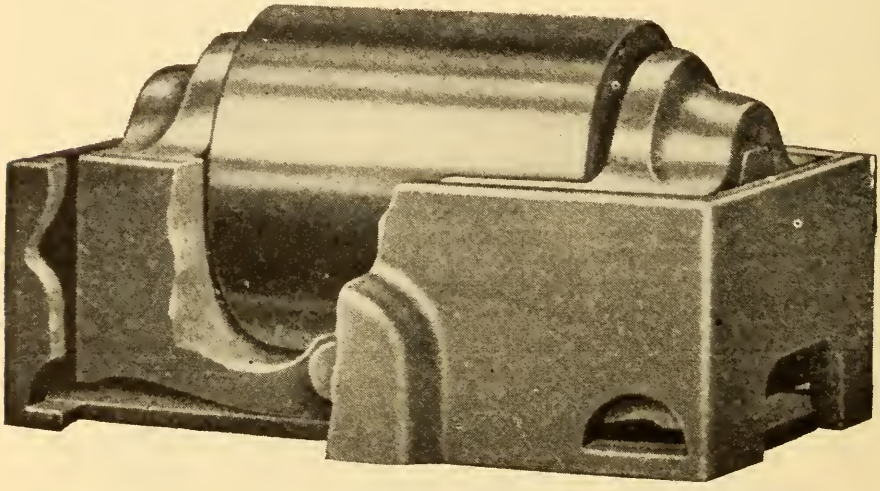


Fig. 2—Woods X L Side Bearing. Designed for Attachment to Truck Bolster.

ders, and it has also been recently adopted as standard for all equipment by the United States Railroad Administration.

An anti-friction side bearing to function properly should be simple and strong, composed of few parts and so constructed that it will not collect or accumulate foreign substances and that it will be in a condition to function properly at all times and under all conditions. These features are embodied in the

Woods "Tip Roller" side bearings illustrated in Fig. 1.

This side bearing has two or more rollers with hard iron wearing surfaces adapted to roll between upper and lower spring steel plates arranged in a horizontal plane, which prevents lifting the car body when operating on curves. The casings are made of malleable

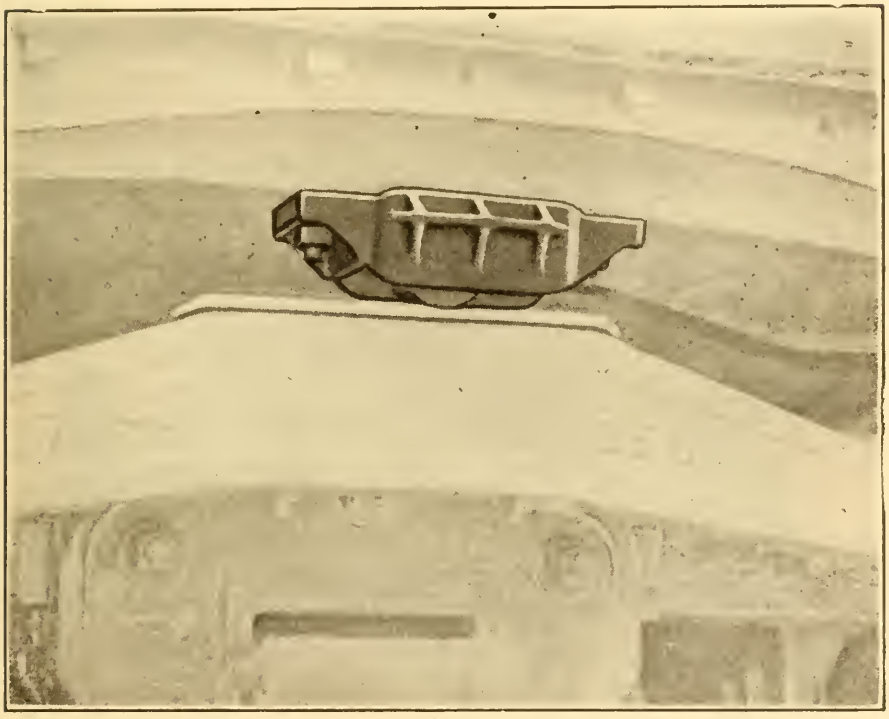


Fig. 3—Single Roller Body Side Bearing for Passenger Cars.

iron, the rollers being introduced through the top of the casing, and are so constructed that the rollers, when free, gravitate to the center. By increasing the number of rollers, these bearings can be made for any capacity required, and at the same time sufficient travel allowed for ordinary working conditions.

The "**xl**" side bearing illustrated in Fig. 2 is de-

signed to afford unlimited travel where that is desired. It is attached to the truck bolster and has lateral play, which insures the alignment of the roller for its entire width with the opposite bearing. The rollers are hard iron with steel bushing revolving upon steel pins, the whole being carried in malleable iron casings as illustrated.

Fig. 3 illustrates a single roller, body side bearing applied to six wheel arch bar trucks under passenger

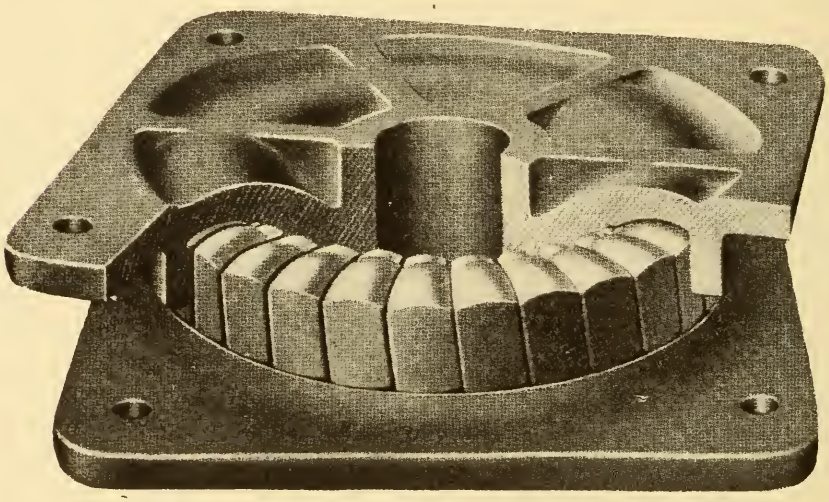


Fig. 4—Woods Anti-Friction Center Plates, Body and Truck.

equipment, which has been standard upon this class of equipment in the United States and Canada for a number of years.

It is equally important to provide free turning movement at the center plate, and for this purpose a frictionless center bearing has been designed as illustrated in Fig. 4. The important basic principle involved in this center bearing is the sustaining power, largely increased by the use of flat sided balls. The

flat sided ball was devised following an investigation of the physical properties of balls and plates under load, both below and above the elastic limit; it being recognized that stresses in excess of this limit must ultimately result in impaired efficiency, due to flattening of balls, indentation of plates or both.

Fig 4 shows the **Woods anti-friction center plates,** both body and truck. The anti-friction elements shown

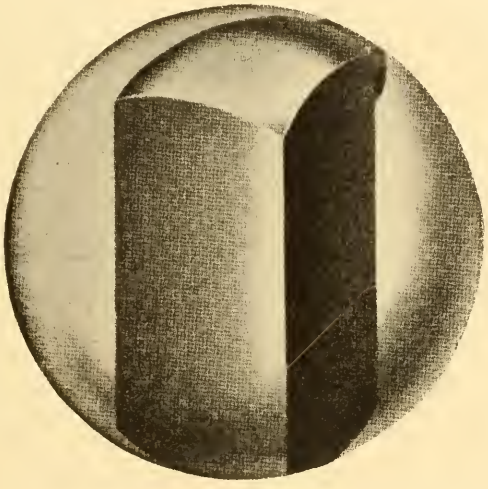


Fig. 5—Flat Sided Balls Used in the Woods Center Bearings.

in this illustration are 2½" in diameter and have sufficient width to accommodate a 70 ft. car on a 35 degree curve. The same plate will hold eight full sized balls of the same diameter, which is less than ⅓ as many as the flat sided type.

It is apparent that the carrying capacity of each one of the above balls is the same, they being of equal diameter and width. Hence the plate having 26 flat sided balls has a carrying capacity of more than three times that of the same sized plate wherein balls or

rollers of full circular cross section of equal diameter are used.

Application of Wood Side Bearings to Rebuilt Cars—Owing to the demand for increased carrying capacity in car equipment, it has become necessary, in rebuilding old cars, to either apply steel draft sills or an entire steel underframe, which in either case requires renewal of the body bolsters, as well as the application of new side bearings. This affords an opportunity to replace the old plain side bearings with the new and improved frictionless type.

In assembling the steel underframe of a car, it is the ordinary practice to place the sills, bolsters and end sills on trestles face down, which gives a better opportunity for riveting everything in place, the center plates and side bearings being riveted on to the bolsters at the same time.

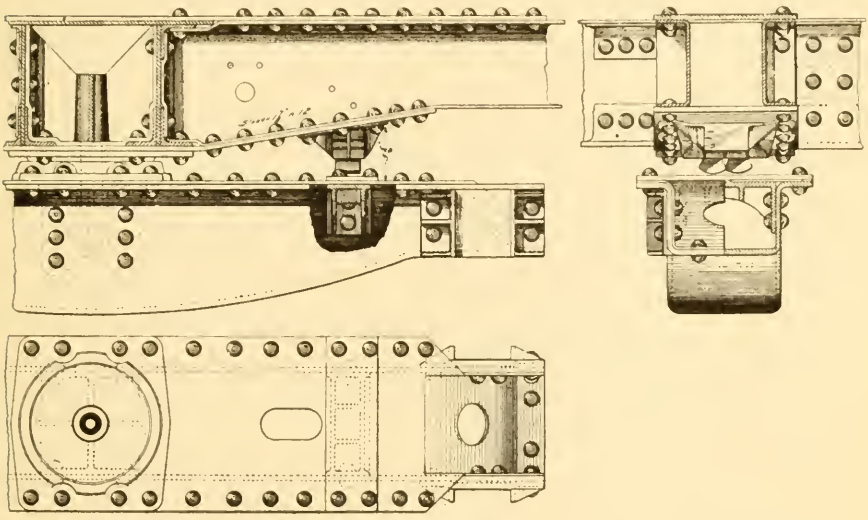
The frame is then turned over and placed on the trucks. Where cast steel body bolsters are used, it is better to rivet the side bearings in place before the bolsters are applied to the car.

On old equipment where the body bolsters have deflected so that the ordinary side bearings are in contact, causing excessive flange wear, and often derailment, frictionless side bearings can be applied and save renewing the bolsters, as any "Tip Roller" bearing is of sufficient capacity to carry the load under these conditions.

Side Bearing clearance is designed to allow the trucks to curve without excessive friction between the side bearings, but as they only operate on curves,

while one or more of them is always in contact, the amount of clearance is of little account except to prevent excessive rolling of the car body.

Now with a well designed frictionless side bearing in which the factor of friction is less than two per cent, it is immaterial whether there is any clearance or not as far as the curvature of the truck is concerned.



Inasmuch as the Woods Tip Roller Side Bearings are applied to the body bolsters, it is a simple matter to rivet them securely in place, the bearings being designed to fit the angle of the bolster and provided with lugs to take the rivets as spaced; and as the wear plates for the truck bolsters are furnished with the bearings it is only necessary to rivet them to the bolsters, or shim them up to the proper height to give the required clearance, thus allowing a wide variation in the distance between the body and truck bolster without requiring a large number of patterns for the different heights of bolsters.

Where repairs entail the removal of the old truck bolsters and substitution of new ones, an opportunity is afforded for the application of the frictionless type of truck side bearing where that is preferred to the old plain truck side bearings.

Woods Side and Center bearings are made of anti-friction design in order to reduce the amount of work required to turn the truck with reference to the car body.

They are the result of many years of study, experimentation and service. The bearings are manufactured by **Edwin S. Woods & Co., Chicago, Ill.**

STECOS JOURNAL PACKING

Stecos Journal Packing—is the latest development of an idea originated by a former locomotive Engineer, who made a study of the causes of hot boxes. He conceived the idea of adding steel shavings to the waste to give resiliency and keep the waste up to the Journal. Later he added sponge to carry the oil in suspension. Stecos Journal Packing after a good many experiments embodies the ideas of some of the most practical men in the Railroad business—and is now composed of No. 1 Wool, Long Cotton Fibre, Sponge and Shredded Steel. Cotton being the base of the packing, capillary attraction is assured from the bottom of the box to the Journal. The wool gives body and helps to prevent the cotton from becoming soggy. The sponge adds resiliency and its great absorbent power carries the oil in suspension acting as a reservoir throughout the waste. The added shredded

steel gives resiliency, prevents the surface from glazing, and acts as a filter for the added free oil.

In practice Stecos Journal Packing gives a constant even supply of oil to the journal. By carrying the oil in suspension, it does not drain to the bottom of the box thereby saving the loss caused by the oil splashing out. Stecos Packing carrying more oil in suspension, it is not necessary to add free oil as frequently as with other packing saving oil and labor. Its composition makes it almost indestructible, and it will last longer without repacking and may be reclaimed in the ordinary manner.

A Car Inspector who made an exhaustive investigation of Stecos packing recently, says:

"The packing holds its shape remarkably well, therefore a perfect wick contact. This cures a rather old sore for the oilers and the cause of many hot boxes.

"It absorbs all free oil. This saves considerable oil that is thrown from box when running, where common packing is used.

"As to the shredded steel wire, I find it retains its temper and resiliency. The sponge as part of the packing is very good; it not only holds the oil from overflow and loss, via the dust guard and front opening, but keeps it up from the bottom of the well.

"It is my opinion this packing is the best on the market and will reduce the cost of oiling on any road."

Stecos Journal Packing is manufactured by The Stecos Journal Packing Co, 140 S. Dearborn St., Chicago, Ill.

PYRO-NON PAINT

The advantages of rendering wooden structures more or less completely fire resistant by means of

painting them has long been apparent, particularly to railroad men.

This result has been finally accomplished by a company known as the Pyro-Non Paint Co., who have perfected regular oil paints with as great or greater durability than the best grade ordinary paints and at the same time with the peculiar properties by which the wood itself upon which the Pyro-Non Paint is spread becomes gradually fire resistant. This is accomplished by means of certain chemicals mixed in the Pyro-Non Paint, which in other respects is regular linseed oil paint of the highest grade.

The principle upon which this Pyro-Non Fire proofing takes place is that the chemicals mixed in the paint impregnate the fibres and cells of the wood itself so that at the end of six months the fire-proofing effect is greater than at the time it was put on, and at the end of six years it is even more fireproof irrespective of whether the paint coating is intact or not.

Then the effect is that, if fire strikes the Pyro-Non painted surface, the chemicals themselves are driven in advance of the flames still further into the wood. The peculiar operation of this results in the fire, if prolonged, merely burning a hole in the wood in the same way that an oxy-acetylene flame will burn a hole through steel, without setting fire to the wood itself.

In nearly all cases the outside agency of flame or burning brand or hot coals or whatever it may be, rapidly becomes impotent if the wood itself with which the flame comes in contact does not carry the conflagration. That is the secret of the remarkable tests which Pyro-Non Paints have undergone and which

warrant far more than the modest claims which the Pyro-Non Co. make for their products.

One railroad which used Pyro-Non on its coal chutes found that it cost them only $20.00 to make repairs on account of a fire on one of the chutes, which under ordinary circumstances would have destroyed the entire structure with heavy loss. The same is true in the case of a frame freight house, which caught on fire, and where the flames were stopped by a wooden partition near the center which had been painted with Pyro-Non. The balance of this building was saved.

Pyro-Non Paint is furnished by the **Pyro-Non Paint Co., Inc.**, 110 West 40th Street, New York City, and further information and resutls of tests will gladly be furnished to interented Carmen.

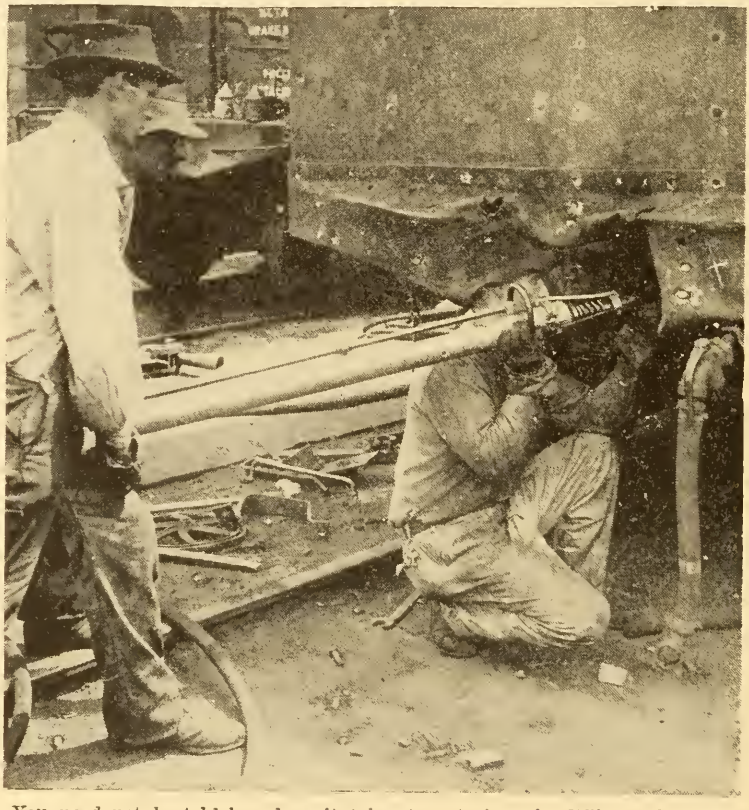
You Can Save More Than One-Half of Your Labor Cost With

The Cincinnati Rivet Cutting Gun

THIS statement does not come from us alone. Over one hundred of the leading railroads of the country have proven this and many of them are enthusiastic in saying that this estimate is decidedly too low. You save more than one-half the cost in cutting on straight surfaces, but in difficult positions it would be hard to say how much the Cincinnati Rivet Cutting Gun saves you, **but it is surely a tremendously big amount.** Cutting rivets by hand around draft gears or in any position where it is difficult to handle the bar and sledge, or cutting loose rivets, **is so slow and difficult that there is no way to estimate really how much labor and money is lost, but the waste is tremendously big.** The Cincinnati Rivet Cutting Gun clips these rivets off in a few seconds. Wherever it is asked to perform **it performs quickly and most satisfactorily.** The patented features of the gun make it withstand long and hard usage. **Railroad foremen and railroad men who have used the Cincinnati Rivet Cutting Gun will tell you that it is the biggest economy investment they have found in years.**

THEY STAND THE WEAR—

Patented features make the Cincinnati Rivet Cutting Gun most sturdy and durable. They are also easy to operate.



You need not be told how long it takes to cut rivets in difficult places such as these. We cut them off in a few seconds.

RIVET CUTTING GUN CO.

CINCINNATI, OHIO

INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y