division, a load which usually can be easily handled on the remainder of the division.

The engine has an extended wagon-top boiler, with a firebox between the frames, and the crown sheet supported by radial stays. The following are the leading particulars of the engine:

Fuel	Bituminous coal.
Gage of track	4 ft. 9 in.
Total weight of engine in working order	127,000 lbs.
Total weight on driving wheels	101,000 lbs.
Driving wheels base of engine	11 ft. 0 in.
Total " " " "	21 ft. 8 in.
" " " " " and tender	49 ft. 9⅛ in.
Height from rail to top of stack	14 ft. 7⅛ in.
Cylinders, high pressure, diameter and stroke	19 in. × 26 in.
" Low " " " "	29 in. × 26 in.
Slide valves	Balanced.
Piston rods	Steel, 3⅛ in. diam.
Type of boiler	Extended wagon top.
Diamoter of boiler at smallest ring	60 in.
" " " " back head	69 in.
Crown sheet supported by radial stays.	
Stay bolts, 1 in., hollow stay bolts, spaced 4 in. from center to center	
Number of tubes	256.
Diameter of tubes	2 in.
Length of tubes over tube sheets	12 ft. 5 in.
" " firebox ins de	108 ft.
Width " "	32⅝ in.
Working pressure	180 lbs.
Kind of grates	Cast iron, rocking
Heating surface in tubes	1653.0 sq. ft.
" " " firebox	152.0 sq. ft.
Total heating surface	1805.0 sq. ft.
Grate area	24.0 sq. ft.
Diameter of driving wheels outside of tire	56 in.
" and length of journals	8 in. × 9 in.
" of truck wheels	28 in.
" and length of journals	5 in. × 10 in.
" of tender wheels	33 in.
Type of tank	Level top.
Water capacity	4,000 U. S. gallons.
Fuel capacity	300 cu. ft.
Weight of tender with fuel and water	78,700 lbs.
Type of brakes	Westinghouse American Automatic.

Piece Work in Car Shops.*

G. L. POTTER.

The manufacturing and repairing of the parts of locomotives under the piece-work system had been practiced a number of years before the system was applied to car work, especially to the repairing of cars. This was due probably to the fact that the amount of money expended on locomotive work is so great per unit; that is, per engine built or repaired, and the labor such a large percentage of the total cost; in new work being about 45 per cent. and in repair work from 65 to 70 per cent., while the cost of labor in building new cars is only from 12 to 15 per cent. of the total cost, and in repairs from 45 to 50 per cent. It is also due to the fact that, on account of the much longer time required to perform the different operations on locomotive than on car work, it is much easier to determine the prices that should be paid, and with much less danger of error.

This trouble in determining the prices to be paid is not so great in building new as in repairing old cars. In new work it is customary in some cases to place prices on the body complete with all the trimmings; *i. e.*, doors, grain doors, air-brakes, etc., applied; in other cases the work is divided up and given out to different gangs of men, one gang constructing the foundation, another laying the floor, another putting up the upper structure, another putting on the sheating, another the roof, etc., so that it requires from one half to a day and a half in the first case, and an hour to five hours in the second, to complete the different operations; consequently the amount of time that should be required is comparatively easy to determine. This is also the case in manufacturing the parts for new work. While each piece can be manufactured in a comparatively short time, they are usually gotten out in large quantities, so that the time required to produce each piece is readily determined.

In repair work the conditions are different. Different cars will require different parts to be repaired, so that it is necessary to establish a price for removing and replacing and repairing each part. The difference in time required to remove the corresponding parts on different cars (even though they be of the same design), and the difference in the time required by different men to perform the same work, and the getting out of the parts in small numbers, are the main difficulties encountered in arriving at prices that are fair to both employer and employee. This can be accomplished only by thorough and careful investigation, extending over considerable time and averaging as many performances of the different operations as possible. When the work has been carried through to a successful issue, the results will well repay for the labor expended.

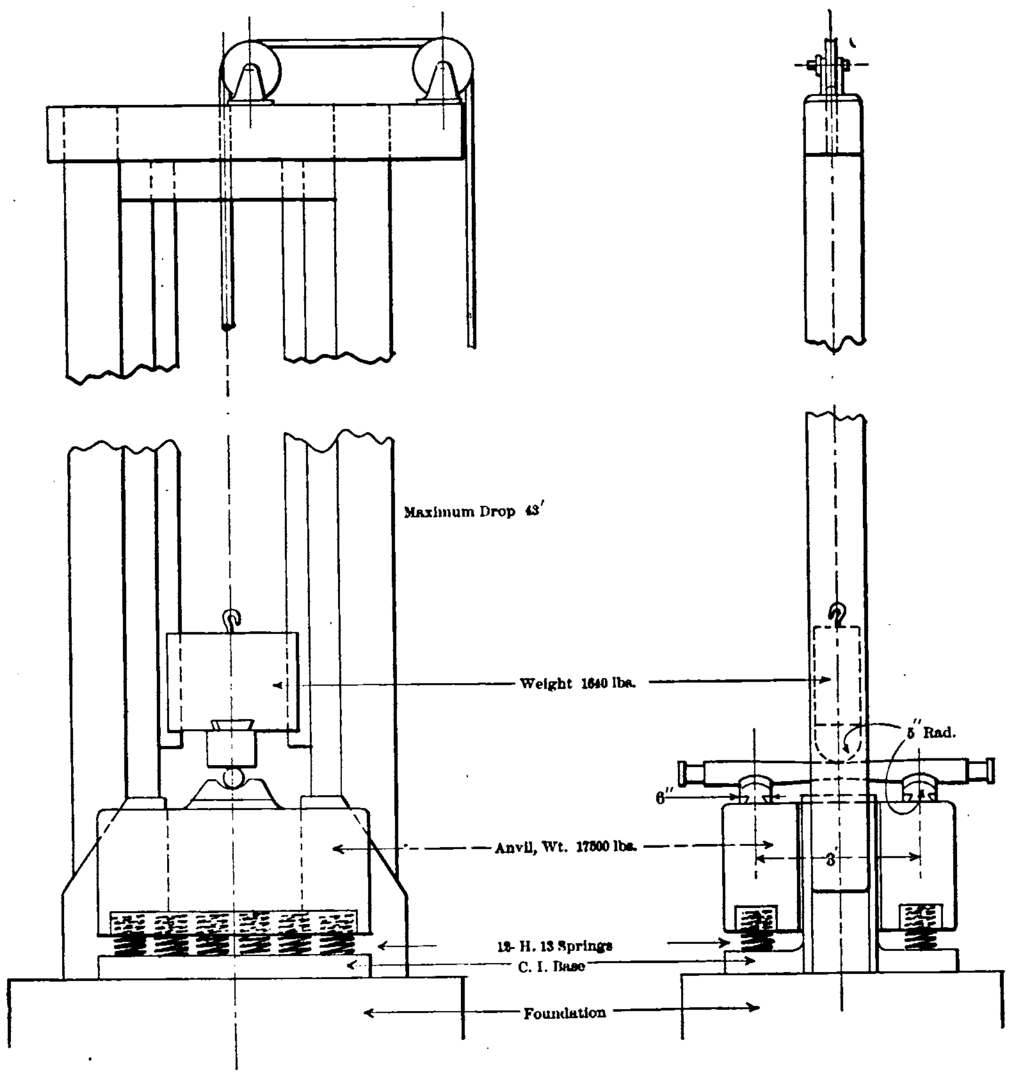
The benefits of the piece work system accrue not only to the employer, but also to the employee; to the former in that he pays for the work performed only what it has been found to be worth, can more easily locate and weed out the incompetent workman, and, with given facilities, will materially increase the output of the plant; to the latter in that he is paid for what he actually does and by increased exertion can increase his earnings, and the more competent workman is enabled to reap the benefits of his greater earning capacity.

There is probably more supervision required under the piece work than under the day work system, in the first place to see that only such parts that actually require it are repaired. There is a great tendency on the part of workmen to renew more parts than are actually necessary, especially if by doing so the earnings can be increased. To provide against this it is customary to have the car thoroughly examined before being taken into the shop, by a competent inspector, who notes on a blank the work to be done, and only such work as is so noted is allowed to be done without permission of the foreman in charge. In the second place the cars should be carefully inspected after completion, to see that all the work called for on the blank has been done and done in a proper manner, the inspector checking the items called for on the blank upon which the parts to be repaired have been entered against the parts repaired on the car. In the third place, there is danger of material being wasted by unscrupulous workmen, especially if parts can be removed more quickly and easily by destroying them. This is particularly the case in truck work, where it is easier to break the bolt off than to take off the nuts.

In starting the piece-work system in a railroad shop, the first impression that is usually formed in the minds of the workmen is that it is a scheme to reduce wages. It is necessary, therefore, to successfully establish a system, to disabuse their minds of this idea and to have them feel that the benefits will be mutual. Failures to introduce the system successfully, where it has been undertaken, can, I think, be traced in the majority of cases to unfair dealings on the part of those in charge, by reducing the prices when it was found that by extra or unusual exertions the workmen were enabled to materially increase their earnings, thus discouraging them and causing them to look upon the scheme with suspicion.

When the piece-work system has been established on a fair and equitable basis, it will be found that the cost of the output will be very much reduced, the workmen will be enabled to increase their earnings, and there will be much less dissatisfaction among them, and a great stride in the solution of the labor problem will have been made.

* Read before the Western Railway Club in February, 1896.



Drop Testing Machine with Spring Supported Anvil—Pennsylvania Railroad.

A Spring-Supported Anvil for Drop-Testing Machines.

In drop testing machines the effect of a weight falling from a specified height is considerably modified by the weight of the anvil and the character of the foundations under it. So greatly does this influence the results obtained that couplers and other articles of manufacture which have met all tests satisfactorily under one drop have been known to fail under others having more substantial anvils or foundations. All axle or coupler drop-testing machines have until recently been constructed with anvil blocks which were not heavy enough to resist with their inertia the whole force of the blow, but had to depend more or less upon the foundations under them. The heavier the anvil the less duty the foundations were called upon to perform, but in all cases the latter had to take much of the force of the blow, and they introduced an element of doubt into the results which prevented reliable comparisons between the data obtained on different machines, or upon the same machine at different seasons of the year.

To overcome these difficulties the Pennsylvania Railroad has reconstructed its axle drop at Altoona, putting in an anvil heavy enough to meet the force of all blows with its own inertia, and supporting this anvil on springs. Through the courtesy of Mr. F. D. Casanave we present the accompanying illustration of the drop as it is now arranged. It will be seen that on top of the foundations a cast-iron base is placed that forms a seat for the 12 springs which support the anvil. This anvil is a solid block of cast iron approximately 4 feet by 5 feet by 2 feet, and weighing 17,500 pounds. The axle supports are separate pieces dovetailed into the upper face of the anvil and placed the regulation distance apart of three feet. The springs which support the anvil are each composed of two coils, the outer one being 8 inches in diameter and made from steel $1\frac{3}{16}$ inches in diameter, while the inner one is $5\frac{1}{4}$ inches in diameter and composed of $\frac{13}{16}$-inch steel. The springs are $9\frac{1}{8}$ inches high when light and $5\frac{1}{4}$ inches when solid. Compressed to a height of 7 inches the total supporting power of the 12 springs is 80,000 pouuds.

It will be evident that in practice this anvil always presents the same resistance to the action of the drop falling from a given height. This resistance is chiefly made up of the inertia of the mass of iron, weighing 17,500 pounds, and any movement of the anvil that may take place is against the force of the springs which support it. Constant conditions are thus obtained and the rigidity of the anvil is not altered by the freezing of the ground or other changes that are unavoidable. This is an excellent improvement and if others using the drop testing machine to test their outputs or to test materials received would employ the same construction and weight of anvil, the results obtained would always be comparable with the work done on other machines of the same design, something which cannot be said of the drops in use at present.

Wear of Tires on Passenger Engines of the New York Central for the Past Twenty Years.

Comparing the weights upon the drivers a few years ago with those in present use shows an increase in the static or dead load of some 65 per cent., while the increased speed of the trains now produces dynamic effects more than double the static loads, yet by increasing the width of the head of the rails as they were renewed and the higher standard of track maintained, the rate of the wear of tires for the heavier locomotives has not increased, but, on the contrary, decreased. In 1883, on the 65-pound rails, deep and narrow type of heads, drivers carrying 13,360 pounds ran an average of 19,400 miles for a loss of $\frac{1}{16}$ inch in thickness of the tires. This was the second type of 65-pound rails, the first one having been rolled in England and had a wider head.

In 1884 the 5 inch pioneer 80-pound rail was put in service, the head being $2\frac{11}{16}$ inches wide. Its use was yearly extended, and by 1889 locomotives on the Hudson division made nearly one-half their mileage on the 80-pound rails. Engines then carrying 17,600 pounds per driver ran an average of 19,300 miles per loss of $\frac{1}{16}$ inch in thickness of tire.

In 1891 passenger engines on the Hudson division made their entire mileage on the 80-pound rails, while those on the Mohawk and Western divisions made about three-quarters of theirs on the same class of rails; drivers carrying 20,800 pounds ran an average of 19,400 miles per loss of one-sixteenth inch in thickness of the tire. This refers to the loss by wear and returning for future service.

In 1892 the 100-pound rail, head 3 inches wide, was laid on the the Harlem line, which carries the combined passenger traffic of the three railroads entering and leaving Grand Central Station, New York City. The renewing of the entire line of the New York Central & Hudson River Railroad from Mott Haven Junction to Buffalo and return with 80-pound rail was completed in 1892. In 1894 the 100-pound rail was laid from Spuyten Duyvil to Peekskill, making about one-quarter of the Hudson Division laid with 100-pound rails.

In June, 1895, I asked Mr. William Buchanan, General Superintendent of Motive Power and Rolling Stock, for the mileage of some of the class "I" engines running over the 80 and 100-pound rails. When the class "I" engine was de-