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THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

VI.

(*Continued from page* 284.)

PIECE-WORK.

In nearly, or quite, all of the shops at Altoona, work is now done by piece-work, and almost all of it, even to such service as handling coal and ashes, cleaning the tubes of locomotives, washing windows, etc., has now been brought under that system. This was introduced at Altoona in a sort of rudimentary form as much as 25 years ago, and has been throughly tested and perfected since, and its great advantages have, it is thought by those who are in charge of the shops, been thoroughly demonstrated during that period, and they would as soon think of substituting the old hook valve-gear for the link-motion, or replacing injectors with pumps, or steel tires with those made of cast-iron, as of going back to the day-work system in their shops. Now, one of two things is certain, either those in charge of the machinery, the shops and the work at Altoona are very much deluded with reference to the advantages of that method of doing work, or those who are responsible for the management of other similar establishments are very blind in not adopting it, or, at least, acquainting themselves with the working and merits of that system.

It is claimed for it—and apparently on grounds which cannot be disputed—that it doubles the output of work from a given equipment and a given number of men. In proof of the latter it is said that in the old shops at Altoona, before work was done in this way, 50 new locomotives were built in a year. After piece-work was introduced 100 were built in the same time, with substantially the same tools and appliances and the same number of men. An equal increase has been made in the output of repair work in the locomotive and car shops.

As an illustration the following case was cited by one of the foremen: In 1880, in making the general repairs to locomotives, a gang of 32 men were employed for every three engines. By days-work it then took 28 days to rebuild three engines and the work in the erecting shop cost $270 per engine. When piece-work was first introduced 14 men and 2 apprentices were employed to do the same work and it cost 20 per cent. less. Now this work is done by 9 men, 3 apprentices and 1 laborer in 14 days and the labor costs $90 per engine.

In the construction of new engines the difference is equally as marked as in repair work. The cost of day's work in the erecting shops of what are known as class I engines was $290. Engines of the same general class, but about 15 tons heavier, now cost $95.75, and are done in half the time. Substantially the same equipment, such as traveling cranes was employed under both systems, although some appliances and methods for doing work economically were devised and adopted by the men and their foremen in order to facilitate and expedite what they were doing. By day's work it took three days to build a box-car; now it is done in 14 or 15 hours. The pipe-work on a locomotive formerly cost $137, and now costs $32.

In making up the schedule of prices for piece-work from the cost by the day's-work system a primary reduction of 25 per cent. was made. Since then other reductions in prices have followed, so that now, as has been stated, the cost of labor in the Pennsylvania shops has been reduced one-half, and the output of work by a given equipment and number of men has been doubled. If these statements have any basis of fact to rest upon, they are surely worthy of serious consideration by those who control similar expenditures in other great enterprises.

Another advantage is that the men make a great deal more money, in a given time, under the piece-work system than they do when working by day work; they are more interested in what they are doing, become more efficient in their duties and are better content in their positions. No driving of the men is required, because if any of them are disposed to loiter or "loaf"—as expressed in workshop vennacular—the time thus wasted is their own loss. To a great extent they can enjoy the independence of controlling their own time, and none excepting those who have endured it know how irksome it becomes in time to be tied down to fixed hours and inexorable conditions of service.

Another effect of the system is that it stimulates the ingenuity of the men to devise new methods and appliances for doing and handling work. They resort to all kinds of expedients to facilitate what they have to do and increase their output. This was especially noticeable in the blacksmith shop at the car works. In modern car construction many forgings of more or less complicated forms are required. To make these a great variety of formers, dies, clamps, etc., are needed, and each man who is paid for the number of pieces he can make in a day is interested in devising new appliances which will facilitate the doing of his work. A very interesting book might be written describing the means employed in this shop and showing how the different kinds of forgings are made.

It also results in a complete differentiation of capacity. That is if a man has any kind of special skill or apitude, he is employed only on work which requires such skill, while that which can be done by mechanics of a lower grade, or by ordinary laborers, is assigned to men of that class. In that way a process of specialization is instituted, which, to a great extent, becomes automatic in its action, so that each man does what he is best suited for. It also results in the speedy weeding out of the incapables and the unworthy.

If honestly and justly administered, it removes some of the chief causes of disputes between the men and their employers, and substitutes "sweet reasonableness" for contention and acrimony.

The first objection, which is made by those who have little or no knowledge or experience with the practical working of this system, is that it results in bad workmanship, and it is assumed that it is an utterly hopeless task to undertake to so classify all the multifarious operations required to repair locomotives or cars, as to be able to assign a fair price for each distinct operation. Some idea of the complexity of this task may be formed when it is said that in the locomotive erecting shops there are 180 seperate items and prices for stripping an old engine and 360 for erecting it anew. Besides locomotive work considerable is done in this shop on signals, water-stations etc,, for all of which there are separate scales of prices, making about 1,000 items in this one shop. In all the locomotive repair shops there are probably from fifteen to twenty thousand distinct prices and at the car and Juniata shops as many more. Only about one per cent. of the work in the erecting shops is done by days work. In the boiler shops there is a price assigned for putting in stay-bolts; riveted work is counted at so much per rivet, caulking and flanging is paid at a given price per foot.

The following are some of the items taken at random from the schedule of prices in the boiler shops, the prices themselves being omitted:

PATCHING BOILERS AND FIREBOXES.

Putting in cheek patches and other small patches with less than 20 rivets, per rivet.....$
For larger patches in boilers and fireboxes—for first 30 rivets, per rivet.
All over 30 rivets in same patch, per rivet.....
Putting new bottom in smokebox 65 to 80 inches long.....

ASH-PAN REPAIRS.

General repairs to include new side sheets or sides straightened and patched, bottom straightened and patched, new shields, top and bottom, new collar pieces or collar straightened, one back plate, side pocket and lid straightened, new damper bearings.
Ash-pan cleaned and painted, classes J, K, P and R, each.....$
Flanging ash-pan collar.....
" " damper.....

Examining boiler and stays	
" firebox and staybolts	
Cutting out old brace and fitting and riveting new one	
Making new brace	
Cutting out old crow-foot and fitting new one	
Renewing bolts in sling stays; for the first 4 bolts each	
Over 4 bolts and up to 8	
All over 8 bolts	
Renewing stay bolts in erecting shop for first bolt	
For second bolt	
All additional up to 50	
All over 50 in same engine	
Riveting leaking stay-bolts	
Cutting out old back flue sheet and fitting in new one	
Chipping, riveting and caulking back flue sheet	
Caulking hot boiler in erecting shop	
Repairing fire door	
" " " and frame	
" " " catch	
" " " latch	

About 250 men are employed in the boiler shops and two clerks are required to keep the accounts. Here, too, the schedule of prices includes about 1,000 items.

In the repair of old cars and the construction of new ones piece-work is employed, as in all the other shops. Probably many of our readers entertain the same opinion that the writer did before investigating this subject which was that in the repair of cars there would be such a multiplicity of different defects and operations that it would be impracticable or impossible to make a schedule of prices covering all the work to be done. Experience has, however, shown that car disorders are analogous to the diseases of human beings. They are not all afflicted with the same ailments, but there are various kinds of infirmities from any one of which many people and many cars may suffer. The diseases of men, women, children and cars may all be reduced to classes and subclasses, and the remedies are the same in all similar cases. This makes it possible by intelligently analyzing the repairs of cars, to make schedules of prices which will cover all the infirmities to which they are subject. Of course, making such a schedule and fixing rates which would be fair to both parties to the transaction was a task of gigantic proportion and could only be worked out by the exercise of the most intelligent and painstaking care and an unwavering disposition to do justice to both sides.

In the erection of new cars and the repair of old ones the men work in gangs of about ten, and the work done is credited to the gang and then divided up among the individuals who compose it. In all cases where work can be done to better advantage by the co-operation of a number of men this system is adopted. If men of different degrees of skill are employed on one job, as where helpers or laborers compose part of the gang, these get a smaller proportion of the earnings according to their rating.

The persons best able to judge of the efficiency of piece-work are the shop foremen. In going through the different departments careful inquiry of the men in charge of them was made with reference to this point. All were agreed that the amount of work turned out was immensely increased by piece-work, and the cost greatly reduced. This reduction was estimated by different foremen at from 33⅓ to 65 per cent. The information obtained in the car works confirmed what was learned in the locomotive department. If anything the increased output in car repairs and construction and the reduction in cost is greater than it is in the locomotive shops. Surely such facts as these cannot be disregarded by those in charge of railroads whose work is done under the old system of day labor. With the advantages which result from the adoption of the piece-work system before us, it would be just as reasonable to object to the use of locomotives because each one with its tender consists of over 12,000 or 15,000 separate prices, as it is to condemn the piece-work system because that number of pieces are required in doing work under it, or a man for a similar reason might object to wearing a pair of trousers because if they were unravelled they would consist of some thousand separate threads and perhaps millions of distinct fibers of wool. The fact is, as Herbert Spencer has explained, evolution is "from the homogeneous to the heterogeneous," and in highly developed enterprises complexity becomes unavoidable.

Undoubtedly the risk of bad workmanship under the piece-work system must be encountered, but for this an adequate and effective method and organization for the inspection of work is found to be a sufficient safeguard. The success of the system is dependent upon such inspection. Without it piece-work is as impracticable as civil government would be without a judicial department. The fact that skillful, honest and intelligent inspection is required in doing piece-work is no more valid objection to it than it would be to find fault with civil government, because the same characteristics are required in our courts and judges. It should be recognized at the outset that piece-work is impracticable without adequate inspection, and without it it will fail utterly. Great care, labor, integrity of purpose and patience in its organization and in formulating scales of prices, in the classification of work and its general supervision, are required. It must be admitted that much more intelligent supervision is needed to introduce and maintain it successfully, than is demanded with the ordinary method of so much pay for so many days or hours of work. Any disposition on the part of those in charge of shops to deal unfairly with the system or "beat" the men, or to lower the prices so much that they cannot earn somewhat more than they can by days work. is certain to defeat itself. The piece-work system must be conducted justly, intelligently and impartially, and unless it is it is unworkable. and will fail. Do the results compensate for the employment of a much higher order of intelligence in its supervision?

One purpose of this article is to answer this question, and another will be to describe how the system has been introduced, how it works, and what the results are.

At first sight it may appear, as has been intimated, as though a subdivision of the multifarious operations involved in the construction and repair of locomotives into distinct operations, and assigning a price to each which will be fair and just under all the conditions which arise, would be utterly hopeless. That it is difficult to do this must be admitted, and that an enormous amount of labor, time, patience, knowledge, intelligence and integrity of purpose had to be expended in creating a system like that which now exists in the Altoona shops is also true. The magnitude and complexity of the undertaking will be indicated by an enumeration of some of the different trades and occupations in which the employees are engaged. Among these are machinists, blacksmiths, boiler-makers, iron and brass founders, carpenters, tinsmiths, sheet-iron workers, painters, upholsterers, etc. It may be thought, too, that while the system is practicable on a road like the Pennsylvania, where a great deal of new work is done, and standards of construction have been adopted to a greater extent than on most other roads, it may not be workable on other lines equipped with a larger variety of rolling stock and which do only repair work. As a matter of fact, there are more classes of engines on the Pennsylvania road than may be supposed. These are designated by letters and are as follows, the numbers preceding the letters indicating the number of varieties in the class: 2 A, B, B A, C, C A, 2 D, E, F, G, H, I, 2 K, L, 3 M, N, 5 O, 7 P, 2 Q, 4 R, and N. In some of these classes there are, of course, many engines which are substantially alike, and which, of course, facilitates the operation of the piece-work system. But we have here 20 classes, and besides these 25 sub-classes. all of which are repaired under the piece-work system.

Doubtless it will occur to the reader, as it did to the writer, to inquire how the system was devised and introduced and perfected. Through the courtesy of Mr. Casanave, the General Superintendent of Motive Power, and the heads of different departments and shops, who granted the privilege of investigating the subject, and of asking innumerable questions, and who answered them with a degree of patience which only Job could emulate, we have been able to obtain some idea of how the system was evolved and perfected. Although piece-work had been in vogue to a limited extent for a number of years preceding its general introduction it was not until 1880 and thereafter that it was thoroughly systematized and introduced into most of the departments. At that time Mr. Casanave was Assistant Master Mechanic in the shops, and he was largely instrumental in extending it generally in all the departments.

The method pursued was this—the work in some one department, like that of the erection of a locomotive, was selected and the separate operations or "jobs" were divided and subdivided, and a careful account was kept of the time expended on each

and the cost of the time. This was repeated a sufficient number of times until it was certain that the average cost had been ascertained, and that the subdivision had been carried far enough to establish and apportion the prices for doing work. Those for piece-work were then fixed about 25 per cent. lower than the cost by day's work, and this schedule was then put in operation. It of course required a great deal of subsequent revision, which had to be done with the most conscientious care and intelligence, and with a disposition to deal fairly with both the men and the company. Prices had to be revised, and the classification changed whenever experience indicated it was required. This has been the work of years and the system still requires occasional revision. After piece-work had been adopted for some time, and the men had shown how much work they could do, further reductions in the prices were made, care being taken that by diligence the men could still earn more money than they would by day's work. It should be said here that each man is rated at a certain price per hour, at which rate he is paid when it is necessary to do time work, and an account is always kept of both the time occupied and the amount of work done, and his compensation is estimated in both ways to indicate whether the prices are excessive or too low. The following figures taken at random from a book in the boiler shop indicates the earnings of ten men for the month of June estimated in both ways. Of course they were paid piece-work prices:

Earnings estimated by day's work.	Earnings estimated by piece-work.	Earnings estimated by day's work.	Earnings estimated by piece-work.
$45.25	$53.81	$20.76	$24.72
39.82	47.41	22.26	26.50
20.76	24.72	24.78	29.50
35.40	42.14	34.40	40.96
15.12	18.00	20.52	24.44

During this period the shops were running short time, but it will be seen that the earnings of these men were considerably greater—nearly twenty per cent.—by piece-work than it would have been by day's work. Consequently piece-work is very popular with the workmen, and any proposal to abandon it and return to the system of day's work would be resisted and met with general disapproval and discontent.

Another cause of its popularity is the greater independence which it gives to the men. If any of them are suffering from malaria, lumbago or pain in the stomach, and is disinclined to work hard, it is his own affair. If disposed to condemn any pernicious political doctrines or candidates such as those advocated by the late Mr. Bryan, during working hours, a workman may do so without let or hindrance. It removes both the fact and the feeling of being driven by a taskmaster, and substitutes a sense of freedom for a feeling of servitude.

One of the results of the piece-work system, it is said, is that there are no trades-unions in Altoona, but there are many building associations and churches which are prosperous. The increased earnings of the men enables many of them to own their own houses.

One of the objections which have been made to piece work is that the men over-exert themselves and finally break down, and on this ground it has been often opposed by many of the trades-unions. This evil has appeared at times in the Altoona shops, but it is said can easily be checked. Of course, if those who are in control reduce prices too much, it will compel men to over-exertion in order to earn adequate wages, which leads to the reiteration of the statement that piece-work is practicable only where those in charge are disposed to deal fairly with those under their control, the moral of which is that geese which lay golden eggs should not be slaughtered.

Among the useful organizations at Altoona is a foremen's association, at which papers are read and discussed which relate to their various occupations and duties. At one of their meetings Mr. Thos. McKernan, General Foreman of Carpenters, read a paper in which he referred to one of the incidental disadvantages of the piece-work system which is worthy of consideration. It relates to that much-neglected individual, the apprentice. In the course of his observations Mr. McKernan said:

"That the piece-work system which has been established in the shops (though a very good thing in many ways) has a tendency to operate against the apprentice is manifest without explanation. The foreman does not always do his duty by the apprentice: the boy is not seen for days, neither inquiry is made as to how he is getting along, nor encouragement given him. This is not right, but decidedly wrong; for there is a moral obligation that every foreman assumes as foreman, to teach the apprentice a trade, and the foreman should do his best for the boy. A modest, unassuming lad frequently becomes discouraged; matters do not go right and he does not like to ask the journeymen, for he might receive the answer, 'I have no time.' The apprentice wants the sympathy and encouragement of his foreman. The foreman should talk and sympathize with him, and reach his better nature, stirring in his soul a sense of confidence, infusing in his young mind new desires, and encouraging him to have a higher aim and a nobler ambition."

There certainly is much force in this statement. Those of us who can remember the bleak desolation of our early apprenticeship, the dreadful feeling of isolation and loneliness which comes to a boy when he is first cut loose from home and friends, will sympathize with Mr. McKernan's remarks. That the evil, though, is remediable seems plain. The piece-work system demands the services of inspectors of work; these might be delegated with the additional duties of instructors of apprentices. Piece-work probably fosters, to a greater or lesser extent, the principle of every man for himself and the devil take the hindmost. What seems to be needed is a kind of supplemental good angels to look after young apprentices. It should never be forgotten that these neglected people of to-day are those who stand behind us and will certainly slip into our shoes in that very near future when we will be expected to step down and out.

As an illustration of the educational influence of piece-work it was told the writer that it often happens that men are put to work in gangs in which each man is entitled to a certain percentage of the earnings of the gang. The mathematical knowledge of some of these men is often so limited that they do not know how to calculate their proportion of the earnings. It is said that under the stimulus of this system, in a very few months, the most ignorant men learn how to calculate percentages as well as the best of them.

Another amusing incident was related. When piece-work was first introduced into the locomotive shops the W. C. accommodations were considered insufficient for the number of men who used them, and it was intended to extend their precincts. After the new system it was found that they were ample and there was room to spare.

Piece-work withal is very popular with the men, and, as one of the foremen remarked, a proposal to return to the day's work system would probably produce a strike. Wherever, as is sometimes the case, it is necessary to put men at work, temporarily, on day's work, it causes grumbling and dissatisfaction. On careful enquiry among, not only the heads of the various departments, but of the foremen of the various shops, it was found that the saving in the cost of work was estimated at from 35 to 65 per cent., and all were agreed that the amount of work turned out was doubled. The possibility of halving the cost of labor and doubling the output of work in a railroad shop is a result which certainly ought to be worthy of investigation by those who control expenditures, especially when the system may be introduced in a partial and experimental way with so little risk.

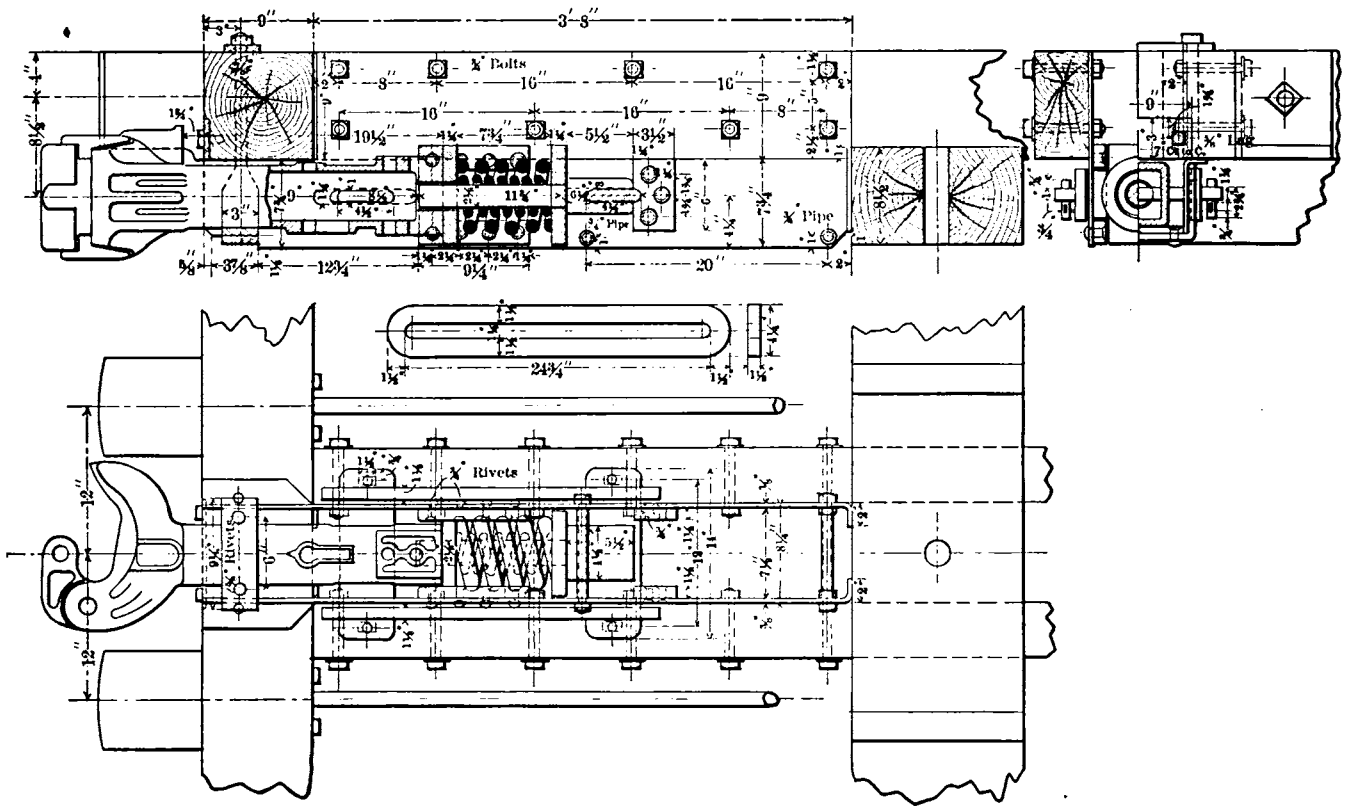
To illustrate the importance of this, it may be said that the cost of maintenance of equipment on the Pennsylvania Railroad last year was, in round figures, $9,500,000. About half of this cost, or $4,750,000, was for labor. To reduce this one-half or even a quarter is an object worth accomplishing. Besides such a saving an increase of business would be sure to demand additional shops, tools and other facilities for doing repairs before long. If the capacity of existing shops and their equipment can be doubled, as it is claimed in Altoona it has been in their shops, the extension may be postponed for a decade or longer. There is only one difficulty in the way of its introduction and successful operation in any railroad shops, that is the need of intelligent, careful, faithful and *righteous* supervision, without which it is doomed to failure. It is because it has had this in Altoona that it has succeeded to the extent it has.

It may be added, in the form of a postscript, that the information with reference to the results attained by the piece-work system in Altoona was not obtained from any one source, but was the result of independent interviews with the heads of differen

departments, beginning with the General Superintendent of Motive Power, Master Mechanic, the foremen of most of the principal shops, the workmen themselves and independent observation of the writer. As remarked in the beginning of this article—either *all* these people are very much deluded with reference to what they are doing or the economy which results from paying for work done by the piece, instead of by the day or hour, is a matter of very great importance to all railroad companies and their stockholders.

A New Freight Draft Gear.

Mr. J. G. Tomlinson, Superintendent of Motive Power of the Queen & Crescent Route at Meridian. Miss.. has had in service for the past 13 months several cars equipped with a new draft gear designed by him, and from drawings ,kindly supplied by him we have made the accompanying engraving. It shows the draft gear in vertical section and in inverted plan. The first thing to be noted is that the usual draft timbers are omitted and their places taken by ⅝-inch steel plates, which are bolted on the inner faces of the center sills and extend 7¾ inches below them. These plates are flanged against the inner face of the end sill and also against the body bolster. They extend under the end sill to its outer face and have flanges bearing against its under surface. The carry iron is in the form of a U-shaped bolt, 3 × ⅝ inches, in section



A Freight Draft Gear with Steel Draft Sills.

with ends ⅞ inch in diameter. This fits against the outside faces of the plates and has a piece of 3 × ⅝ inch steel riveted to it between the plates, this piece keeping the plates spread and also forming a bearing strip for the coupler shank. The drawbar stops are riveted onto the inner faces of the plates. and instead of a drawbar pocket or strap there are two keys 4½ × 1 inch in section united by links outside of the plates. One key passes through the drawbar shank in much the same manner as in the American continnous draft gear, and the other key passes through the plates behind the back follower and transmits pulling strains to the latter through the socket shown. This socket has a spindle which extends through the followers and spring to hold them in place.

When the draft spring is compressed by buffing strains the force is transmitted through the followers and springs to the inner key, which is prevented from moving inward by the ends of the slot in the draft plates. The back end of the slots are reinforced by steel pieces 1½ inches thick riveted on them as shown. When the draft gear is subjected to pulling strains the strain is transmitted through the outer key to the links, thence through the inner key to the back follower.

It will be seen that the design does away with all vertical bolts through the center fills, and that therefore the entire draft gear can be taken down without entering the car. This is a great advantage when repairs are to be made to loaded cars. The gear appears to be of ample strength. Mr. Tomlinson, in writing to us regarding it, says: "It may be adapted either to cars with one or two draft sills, or may be applied between sills without draft timbers, or to cars with steel or iron body framing. I have only applied it to three cars, for the reason that I wished to test it fully and beyond all question, and for a reasonahle time. The test has extended for 13 months, and at the expiration of this time a careful examination shows that no repairs are necessary, and that in detail each part is in as good condition as when applied, so that I am now having the gear carefully gone over and parts redesigned to suit the various types of cars, and it is quite possible that the draft plates will be made of pressed steel, with follower guides formed integral therewith. The ease with which each individual part can be removed and replaced, the large factor of strength we are able to obtain while maintaining great simplicity of construction, together with the absence of vertical draft bolts and of bolts and nuts in all removable parts, leads me to believe that we shall obtain very satisfactory results."

The gear was first designed for dump cars having one center sill, and was afterward adapted to cars having the usual two sills. The readiness with which it can be applied to single center sills is evident. The draft gear has been patented.

The builders' trial trip of the *Iowa* took place last month, and the vessel averaged 16.27 knots in a strong gale during a four hours' run, the engines developing about 11,000 horse-power at 112 revolutions. The contract speed is 16 knots.