Draft Gears on Railway Rolling Stock.

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Draft gears have been much discussed by railway people for a great many years, and there are many phases of this subject. The attempt will be made in this paper to give a few points that appeal to me in regard to this subject. There are three things that draft gears may do in the handling of railway cars. These may be divided in general as follows: (1) Produce slack in starting trains. (2) Control slack in the movement of trains. (3) Reduce the impact force in the switching of cars. In all of these the principle involved is the same, viz., producing the same speed in two cars that may be coming together, or going apart, because of differences of speed. The draft gear, to be effective in doing this, must have a capacity that is relative to the difference in speed. What I mean by this is that for a difference of speed of, say, one mile an hour, a draft gear of small capacity will suffice, but if the difference in speed is four miles an hour, it will take a much larger draft gear, namely, 16 times as large, to prevent a shock, for the energy of a moving body is proportional to the square of its velocity.

Draft gear capacity is the number of foot-pounds of work required to just close the draft gear, that is, it can be represented by an area, as shown in Fig. 1. The lower line of the chart in fig 1 represents the travel of the draft gear and the upper distance represents the force on the coupler until the draft gear closes and the horn strikes. This is the force on the draft gear. Now, if we assume a draft gear with a travel of 2 in., or from A to C in this figure, a final pressure of 150,000 lb., or from C to B. and that the pressure necessary to close the gear under discussion was directly proportional to the movement, the line of action of the gear would be a straight line, and would be represented by AB. The capacity of the gear then would be represented by area ABC. If we wish to increase the capacity without increasing the slope of the line AB, we must increase the travel, and if we should increase the travel to double that shown in the shaded area, we would have four times as much capacity as we had before. That is, if AC equal half of AF, the area ABC is one fourth of AEF. If we wish to increase the capacity of the gear and not the travel, we will have to increase the slope of line AB to AD, in order to keep this pressure 300,000 lb. or below, and will only get an area represented by ADC, which is only twice that of ABC. The slope of the line AD is much greater than of the line AB, and should we want to get four times as much area as we had in ABC and still have the same travel, we will have to increase the pressure to 600,000 lb., and then the area of AGC will be four times ABC, or area AGC will equal AEF, and the capacity of these two gears will be the same. The 2 in. travel gear will have twice the final force that the one with the 4 in. travel will have. This final force is what a great many people have called the capacity of a draft gear. The comparison shown in fig 1 is ideal. I think it would be almost impossible to construct a draft gear that has a slope equal to line AG. But this figure was merely given to illustrate the advantage of long travel gears.

As I said before, if we have a draft gear that has a capacity equal to one fourth the difference of energy of two cars in impact, the cars will not receive a shock above the maximum force necessary to close the gear. That is, if a car is going four miles an hour and strikes a car standing still, it will produce in the standing car approximately half of the speed of the moving car, or, in other words, put into the standing car one fourth of the energy that was originally in the rolling car. The rolling car will retain approximately one fourth, and coast down with the second car, but half the energy is gone and it must be absorbed in the draft gear or some part of the underframe. Of course, some of this energy may be absorbed, due to the shifting of the load, but it must be destroyed in some manner. If it is not done in the draft gear, it is bound to be done on the underframe or the coupler.

This shifting of the load amounts to considerable, in some kinds of freight, such as coal and ore. If the load should shift 1 in., this would be equal to increasing the draft gear travel 1 in.; also, any give in the underframe would be equal to increasing the travel of the draft gear. There is considerable difference in the give of cars. Steel cars only give half as much as wooden cars below the elastic limit, assuming that both have the same ultimate strength. This is one thing that has been entering into wooden car construction. There has been considerable give in the bolt holes, between the draft timbers and sills. Thus the car itself has been absorbing the shock and there has not been as much need for a draft gear of a large capacity. But when we are now using all steel cars, with no give in the rivets, the draft gear must do all the work of absorbing the difference in energy between the two cars coming together in impact, or the coupler or some other part of the car will have to do it. If the coupler is stronger than the other part of the underframe, the underframe will have to do it.

In order to illustrate what energy is necessary to be absorbed for different speeds of cars in switching service, table 1 is given. Column 1 of this table gives the speed in miles per hour; column 2 gives the foot-pounds of energy in the moving car at the speed given in column 1; column 3 gives the capacity of the draft gear that should be used in each car for the speed represented in column 1 for two cars weighing loaded 150,000 lb.; column 4 gives the height of drop that the 9,000 lb. hammer should fall before it shears off 19/32 in. rivets to have the capacity given in column 3. This column was obtained by multiplying the values in column 3 by 12 and dividing by 9,000 and adding 3. The first part of this deduction is to obtain the height of drop to close the draft gear. The 3 added at the end is the added height in inches that it will take to shear off the rivets after the full capacity of the draft gear has been taken up.

Table I—Comparison of car, total weight 15,000 lb.

Speed in miles per hour	Approximate energy in foot-pounds	Capacity of gear in foot-pounds to just close	Approx. height of drop of 9,000 hammer to shear nine 19/32 rivets
1	5,000	1,250	4.7 in.
2	20,000	5,000	9.7 in.
3	45,000	11,250	18.0 in.
4	80,000	20,000	28.7 in.
5	125,000	31,250	44.7 in.
6	180,000	45,000	63.0 in.

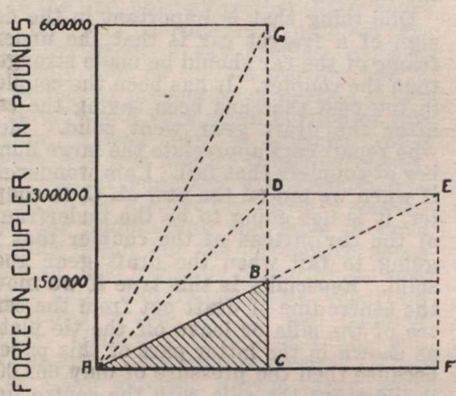

Fig. 1. Travel of draft gear.

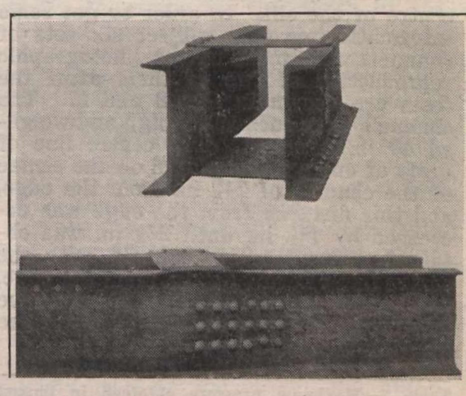

Fig. 2.

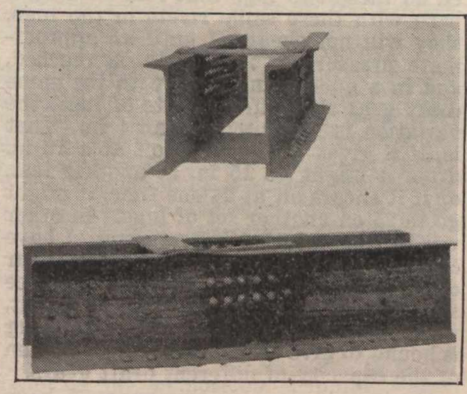

Fig. 3.

It will be seen that a very small capacity is necessary for one mile an hour, namely, a drop of 4.7 in. of the hammer, but a draft gear that is many times as large is required for a difference in speed of 6 miles an hour, or 63 in. This height should be the total fall of the hammer to just touch the dummy coupler used, plus the travel of the draft gear. That is, if the fall of the hammer was 15 in. before it started to close the gear, and the travel of the gear was 3 in., the total capacity of the gear would be represented by 18 in. I, personally, think that we should take care of four miles an hour switching speed in the draft gear design. If we should do this, that is, if the draft gear would just close under a speed of four miles an hour and never close under a speed of less than that, it is certain that the coupler or any part of the car would