the year, as well as water; and by the competition occasioned by other lines; and the necessity for operating perishable freight and live stock at different rates of speed.

5. To a certain extent, yes. In dull times more tonnage can be handled, under similar weather conditions, without overtime than in busier times, caused by the loss in meeting and passing trains. The economical "speed limit" can best be determined on each road according to its necessities and the character of fuel that it uses. The large locomotives are the means of reducing the number of trains—reducing the volume of accidents and the cost of the service.

The very decided increase in the cost of all kinds of material operates adversely, in connection with the increased cost of labor and reduction in rates, in producing the best results.

A. L. Moler, General Manager.

International & Great Northern Railroad Company.

1. Yes, I think the big locomotives are satisfactory.

2. I do not think there are any more failures in proportion to number of train miles than when we used the small locomotives.

3. The percentage of engine failures is due to overloading probably more than anything else.

4. Generally speaking, I believe it a good policy to load engines, when business is heavy, light enough so that they can make an average speed over the division of 12 to 15 miles an hour; and, when business is light, increase the load so that you can decrease your train mileage as much as possible.

5. It would depend a great deal as to how many slow trains you had moving as to whether or not the capacity of the road would be limited by time required by slowest train to make distance between side tracks of an average distance of six miles each.

G. L. Noble, Assistant General Manager.

X and Y Railway.

1. I consider big locomotives are, on the whole, satisfactory. I believe we have to adjust our shop and roundhouse work to new conditions and that some of the dissatisfaction with large engines is due to the fact that we did not realize immediately the necessity for this.

2. I believe locomotive failures have increased with the increase in the size of the locomotives, but not necessarily because the locomotives were larger. We did not immediately know how to take care of the large engines and some of their details were far from satisfactory. As defects in design are remedied and better attention is given to the large locomotives, I do not see any reason why these failures should be any greater in proportion to business handled than if the same amount was handled by small engines.

3. The answer to question 2 also answers this question. I do not think failures of large engines are, as a rule, due to overloading.

4. The load which engines should be required to haul, in my opinion, depends upon many matters. As a general policy I should say that your suggestion is right, namely, that when business is light they should be loaded heavily, but when business is heavy the engines should be loaded a little less heavily with a view of getting the maximum amount of freight moved by them in a given time. There can, however, be no fixed rule as to where the line on tonnage shall be drawn. I think it depends a good deal upon character of traffic and physical condition of the road. If one division had a few ruling grades not heavy enough for pusher service it would appear as if at all times the engines should be loaded with the maximum they will take over these grades, for on the other parts of the division they can make good time. On a low grade line the tonnage is seldom fixed by ruling grades, but is based upon the necessity for getting over the division in a reasonable time. The speed which the train shall be required to make under such circumstances may be further complicated by a heavy passenger service, as on our tracks, where we have to load the trains to a tonnage which will enable them to make a pretty high rate of speed while in motion; otherwise they would never get out of the way of passenger trains.

5. I think on a single track line one factor in limiting the capacity of the road is the *average* time required to cover the distance between side tracks. I do not think it is quite correct to say it is limited by the time of the *slowest* trains to make this distance. The number and schedule of passenger trains is also a factor. On a double-track railroad the time between side tracks will be a large factor or a small, and depend upon several other conditions; as for instance: The number and schedule of passenger trains, and the character of the freight traffic. If there were no passenger trains and all freight traffic was of a uniform character, and all trains could travel at the same speed, there would be no need for side tracks except to get out of the procession such trains as were in trouble, but with a large variety of freight traffic, some of it traveling at high speeds and some of it at slow speeds, freight trains must pass each other. A great many railroads are finding out that the limit of capacity of their roads is not so much due to the physical conditions between terminals as to the limits at terminals. Generally speaking, our terminals are not large enough and trains cannot be handled promptly upon arrival. This results in holding out trains, with the consequent loss of time of engines and also a congestion in the yards, which frequently involves serious loss of time in getting engines and their trains out of the terminals.

——————, General Manager.

——— ——— Railroad.

1. In a general way we believe that they are, when they can be loaded to their capacity. By large locomotives we refer to freight locomotives weighing not over 200,000 lbs., preferably of the consolidation type. We have had no experience with heavier ones. We do not consider these locomotives to be satisfactory where they are run much underloaded or at high speeds.

2. The wear of such locomotives is naturally much greater than that of the smaller ones which preceded, owing to the increasing weight of the parts; and owing to the great weight of the locomotives and of the parts forming them, the existing roundhouse organizations are less capable of making the small repairs, which, if neglected, require greater repairs. In addition to this, the tires and such parts with the heavier wheel loads give less life in service than did the lighter locomotives.

3. Probably to the first cause, rather than to the latter. In comparison to the tractive power, we should say that the large locomotives are not generally overloaded to the same extent that the smaller ones were.

4. We think that the conditions mentioned are not the governing ones. When the business is heavy it is very frequently unbalanced in direction from day to day, requiring light or partly loaded movements one way in order to balance the power. We think that this question will also be locally affected by the nature of the road and the number of tracks, and the same answer would probably not apply to single or double-track roads and those having more than two tracks.

— — ————, General Manager.

STEEL CAR DEVELOPMENT.

Pennsylvania Railroad.

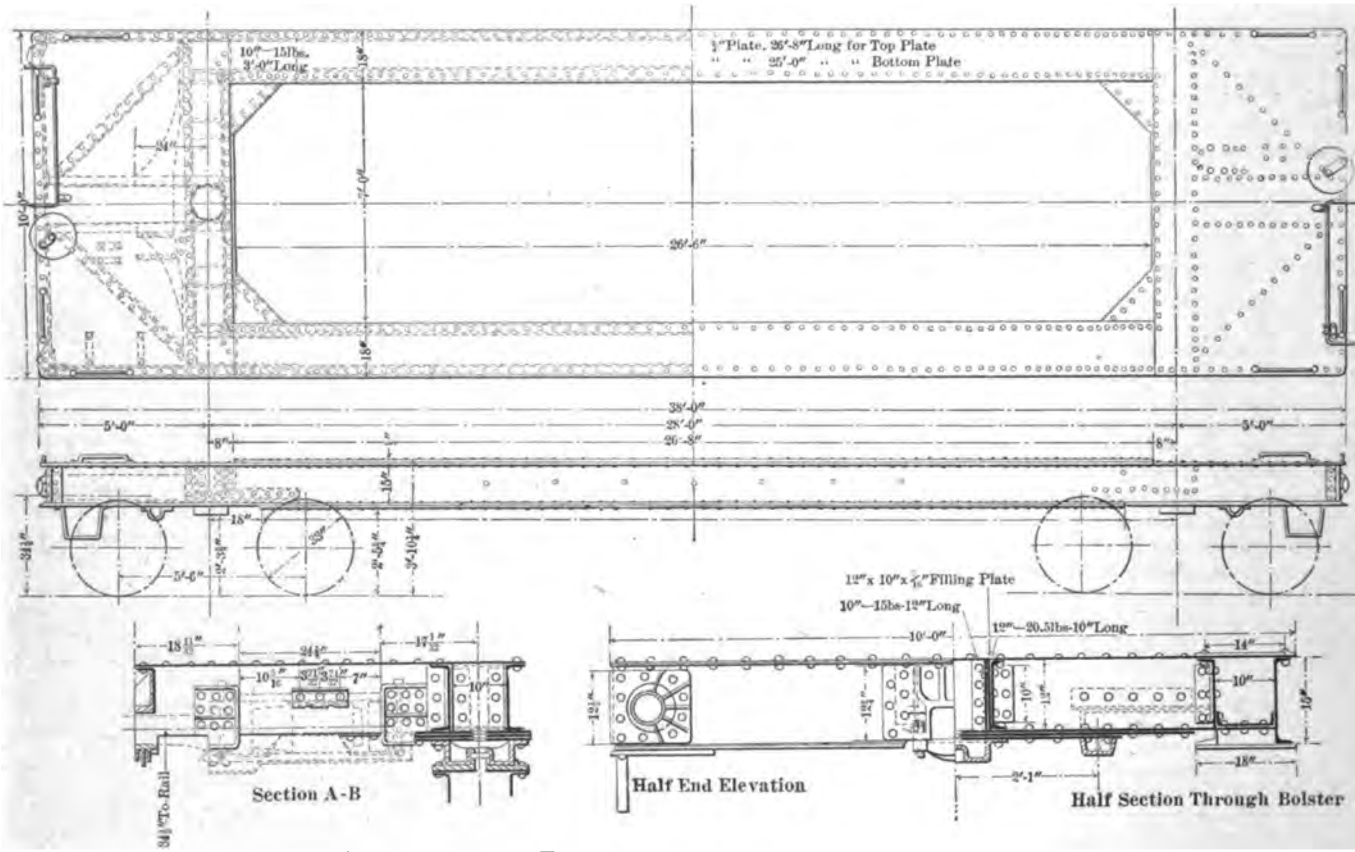
V.

(For previous article see page 3, January, 1904.)

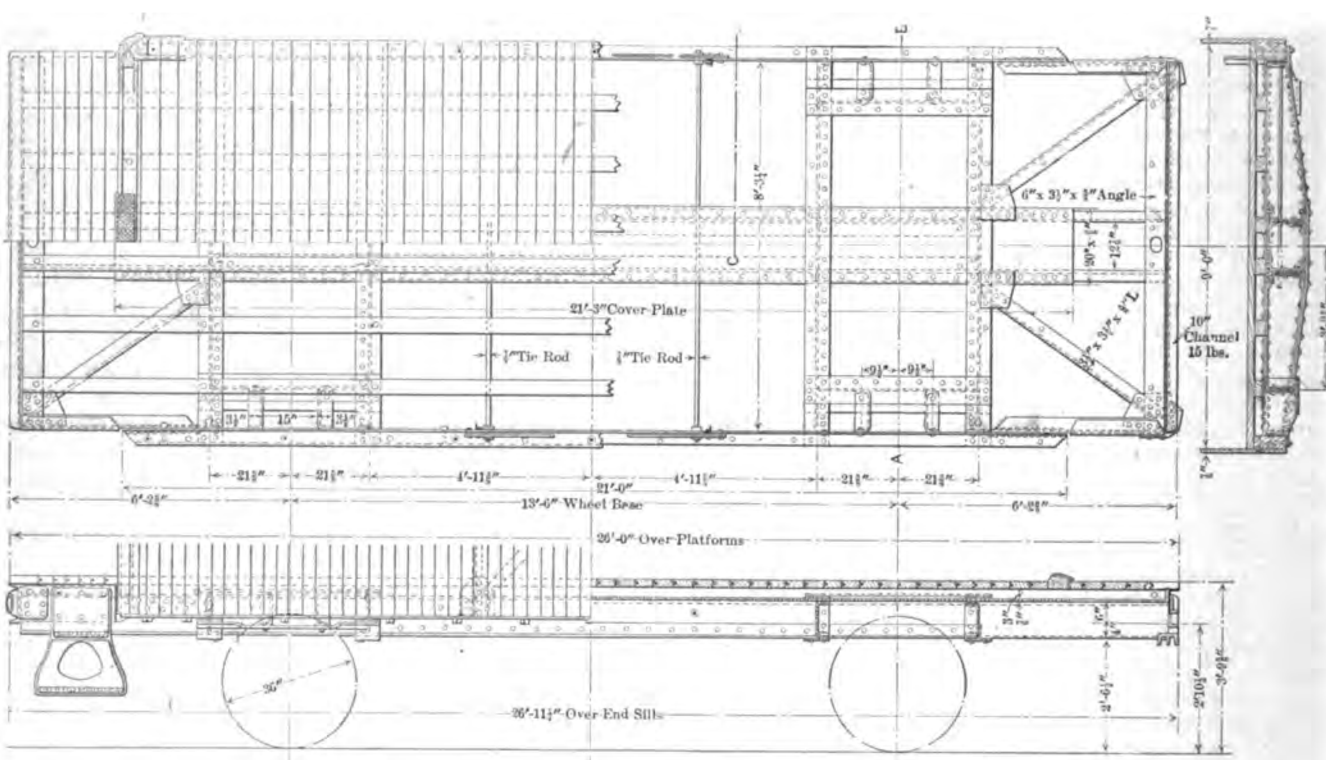
While it is out of chronological order, the special steel car known as class Fn is the next design to be described. This is a flat car built entirely of steel and has a carrying capacity of 100,000 lbs., the car weighing 34,800 lbs. It was specially designed for use in transporting large castings and electrical machinery, the floor of the car having a large opening through which the load may extend downward in order to come within clearance dimensions. This car is designed to carry the entire load, if necessary, concentrated within 4 ft. of each side of the center, or a distance of 8 ft. along the length of the car at the center. If a load is carried outside of this distance it may be 120,000 lbs.

The bolsters are connected by two box girders, one on each side, of 15 in. channels with ¾ in. cover plates 18 ins. wide, extending the full length of the opening. The bolsters are of 12 in. channels in pairs, with three bottom cover plates of different lengths and one top cover plate. The upper of the three bottom cover plates extends the full width of the car and the box girders are reinforced at the bolsters by short pieces of 10 in. channels laid flat. The upper of these three bolster cover plates extends towards the end of the car in the form of two gussets, which are cut away at the center to give room for the draft gear. The drawings show the corner bracing of the car and the heavy gusset bracings at the corners of the central opening.

The end sills are of 15 in. channels cut out for the coupler shanks and the openings reinforced by steel castings. The deck plates at the ends of the car form top cover plates for the bolsters. This car is mounted upon 100,000 lbs. capacity trucks. It is fitted with Westinghouse friction draft gear, the draft gear car, it having been found necessary to strengthen the entire frames of cabin cars which are used in severe pushing service. This frame has a backbone of 10 in.-25 lb. channels, with a cover plate on top only and reinforced at the bottom by 3½x3½x⅜ in. angles. The cover plate extends beyond the



CLASS Fn CAR.—PENNSYLVANIA RAILROAD.



STEEL UNDERFRAME FOR CLASS Nd CAR.—PENNSYLVANIA RAILROAD.

stops being held by nine rivets, a construction which has proved sufficient in service. This is a remarkably strong car and it has been in demand for special service, particularly for carrying large electric generators.

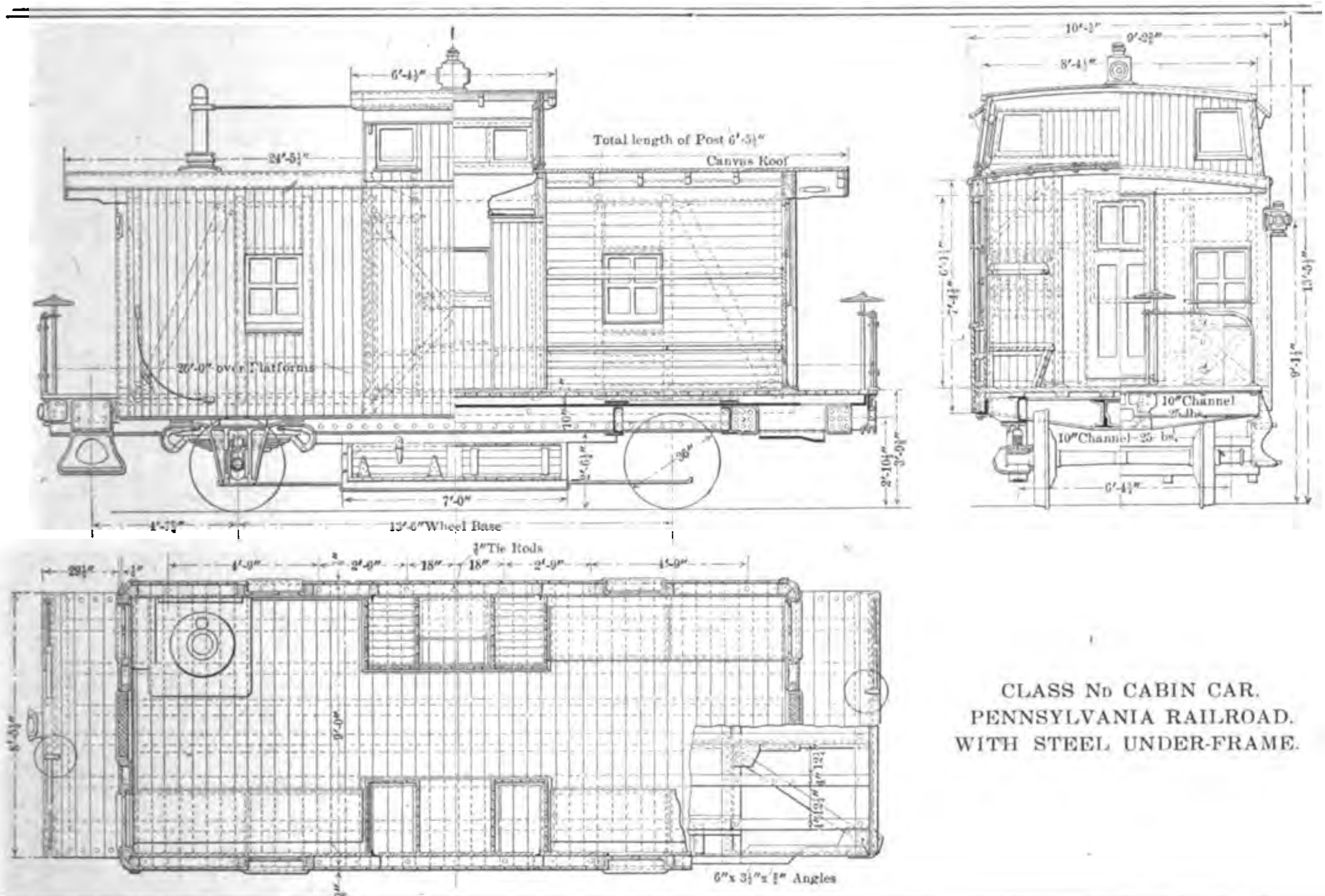
The other car described is the Class Nd, cabin car.

Steel construction has been employed in the framing of this bolsters at each end to within a short distance of the end sills. The end sills are of 10 in. channels. The side sills are 6x3½x⅜ in. angles, extending almost to the end of the car, where they are continued by shorter pieces of angles reaching to the end sills. The transoms are built up of three pressed diaphragms, of which there are two at each end of the car.

They have 6½x½ in. top and bottom cover plates. The pedestals are bolted to girders of the form of presssed steel diaphragms extending between the transoms, with top and bottom cover plates, forming footings for the pedestal castings.

The car is really an elongated four-wheeled truck with a house built on it. The steel frame carries 4x8 in. side sills and six nailing strips on which the house is built. The drawing of the frame shows the corner bracing angles to receive poling thrusts from the corner castings. Two ⅞ in. tie rods hold the light side sill angles together near the center of the car and these have nuts inside and outside of the side sill angles.

The central portion of the house is built over a steel frame riveted to the side sills, which serves to stiffen the cupola. It has diagonal braces and steel carlines of angles. The diagonals are of 3x⅜ in. flat steel. The cupola is braced by bent angles secured to the roof of the car and extending up the side walls, stiffening this part of the structure. The wheel base of the car is 13 ft. 6 in. Its coupled length is 277 ft. 10¼ in. The wheels are 36 in. in diameter. The car weighs 28,000 lbs. This cabin car is somewhat larger than has been used on this road previously, and affords more comfortable quarters for the men, who frequently live for some days at a time in the cars. This car has proved to be entirely satisfactory and capable of withstanding the force exerted by two class H6 locomotives pushing against it, and these are the heaviest freight locomotives on the road.



CLASS ND CABIN CAR.
PENNSYLVANIA RAILROAD.
WITH STEEL UNDER-FRAME.

VAUCLAIN 4-CYLINDER BALANCED COMPOUND.

4-4-2 TYPE PASSENGER SERVICE.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

In this journal in March, 1902, page 72, was illustrated the first four-cylinder balanced compound built by the Baldwin Locomotive Works, and in June, 1903, page 210, the construction of the further development of this type, as built for the Atchison, Topeka & Santa Fe, was presented. The present engravings show the construction of another example which is now being completed by the Baldwin Locomotive Works for the Chicago, Burlington & Quincy Railway, but has not yet been put into service. This locomotive embodies the principles of the other two designs which have been mentioned, and especially arranged, in the matter of detail, to meet the conditions of the Burlington. The following indicate some of the leading differences between the Burlington and Santa Fe designs:

	Burlington.	Santa Fe.
Diameter of driving wheels	78 ins.	73 ins.
Weight on drivers	100,000 lbs.	90,000 lbs.
Total weight	192,000 lbs.	187,000 lbs.
Total heating surface	3,216.9 sq. ft.	3,029 sq. ft.
Grate area	44.14 sq. ft.	49.4 sq. ft.
Largest diameter of boiler	64 ins.	66 ins.
Length of tube	19 ft.	18 ft. 1 in.

This indicates that with the same size cylinders, 15 and 25x26 in. in both engines, the tractive effort of the Burlington is less than that of the Santa Fe, the tractive effort of the former being 21,400 lbs., whereas that of the latter is 24,000 lbs. in compound working for both cases. In the Burlington design advantage is taken of the balancing of the reciprocating parts in order to increase the weight on driving wheels, which, in this case, is made 100,000 lbs., a rather unusual weight for four wheels, except on the Pennsylvania. It should be stated that the weights of the Burlington engine are estimated at the time of writing, the locomotive not having been completed. This engine has outside journals for the trailing wheels, the construction of the frames being the same as that illustrated on page 119 of our April number, 1902. The crank axles are forged, and 4½ in. pins are forced in through the crank pin portions. The crank cheeks are banded by tire steel hoops, finished all over, then heated, bent to shape and shrunk on. The following ratios and list of dimensions will be convenient for record:

VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE.

4—4—2 TYPE—C., B. & Q. R. R.

RATIOS.

Heating surface to volume of high-pressure cylinders	606.9
Tractive weight to heating surface	31.08
Tractive weight to tractive effort	4.67
Tractive effort to heating surface	6.65
Heating surface to grate area	72.88