framing of the car. The Pullman standard design and Pennsylvania standard of upper deck is built up on the floor as a unit and consist of pressed deck sill, upper deck carlins, posts, roofsheets, deck plates of pressed or rolled stock, the whole being applied to the posts after the lower framing is up. Side sheets, roof sheets, letter board plates, etc., are made of spliced sheets, or in one piece where convenient, the older constructions showing splices at posts with invisible joints and countersunk rivets, which have been found rather expensive in construction and weak as far as countersunk rivets in thin plates are concerned.

The permissible combined stresses for this framing, considering weight, load, and end shocks, the latter varying from 300,000 to 500,000 lbs., are usually taken within the range of 15,000 to 18,000 lbs. per square inch, but the weight of the car depends to a great extent on the selection of carrying members of the car, some designers preferring to build an underframe of which the carrying members are contained in the underframe only, as side sills and centre sills, thus keeping the centre of gravity of the carrying section within a small distance from the point where combined buffing shocks resulting from drawbar and buffing device are received.

Other designers take the construction of side plates, side sheets, belt rails and deckplates as carrying members of the cars into consideration and brace the sheets where necessary to prevent buckling. This construction has the advantage of permitting the use of a comparatively light underframe, but the centre of gravity of the whole section is thereby raised and larger bending moments resulting from buffing shocks are encountered, caused by the larger distance of centre of gravity from the centre of buffing shocks.

Roofsheets have, to my knowledge, not been considered for carrying members of this type of car, most probably on account of the comparative thinness of sheets and the minimum resistance to shear attained in the small sized rivets used for roof sheet connections, further on account of the complicated form of roof in general, although no buckling of sheets could be feared, since they are curved to fit the outline of the roof and stiff enough in most cases to resist compression stresses at the centre of the car.

The end framing of the cars is in most cases built up of heavy rolled sections, which are invariably stronger than the present day reinforced end framing of wooden cars, in order to prevent telescoping, some of the designers even using heavy platform posts back of the diaphragm as well, thus securing a double barrier against telescoping. There is no definite data as yet which would give a safe practical resistance to prevent telescoping, with the exception of the assumption of sections by the U. S. Postoffice Department, these being of a section modulus of 65 at a height of 18 ins. above the floor level.

Omitting the advantages of steel cars over wooden cars entirely there are many points which point in favor to the double deck car. The main consideration of most of the railways that has led to the adoption of the double deck steel passenger cars was their general outline, which follows the old type wooden car, so that the general appearance of a train when made up of wooden and steel cars will not be spoiled. The travelling public, used to this deck construction, looks with favor upon the inadequate but visible ventilating device maintained through the decksash opening, and overlooks the more efficient but less noticable ventilators applied to cars.

In sleeping cars the insufficient light entering the car through the deck sash is the only light besides artificial light that supplies the wants of an upper berth traveller for his early morning gymnastics called "dressing."

Not very much will be said in this place of disadvantages of the double deck type of steel passenger cars, since a comparison with the single deck type of car is inevitable.

THE SINGLE DECK TYPE.

The single deck car underframe is built up in a similar way to the underframe of double deck cars, but it is a very rare case, indeed, that calls for a fishbelly type of centre sills, a medium sized rolled shape being found to answer the purposes of construction in every way.

The superstructure up to the side plate above the posts, is the same as used with the double deck cars. A carlin connects the two side plates in a single sweep, and is in most cases made of pressed steel. The roof sheets are applied direct to the carlin, but it is quite a common practice to use tar paper at the spliced joints in order to get a water-tight connection between roof sheets. The application of tar paper for joints ought to be abandoned where roof sheets are carrying members of the car, since it is impossible to get and maintain an absolutely stiff joint in such places with this practice. The roof sheets are usually made heavier than in the double deck car type since a certain amount of deterioration is taken into consideration, so that after a series of years of oxidization the sheets are still strong enough to stand the strains they are subjected to. The carrying members of the car are as follows: The centre sills, side sills, side sheets, belt rails (if used in this construction) side plates and roof sheets.

The centre of gravity of the carrying section of the car is naturally higher than in a double deck type, and the buffing shock lever is naturally larger, but it is in almost every case possible to have a carrying cross section weighing less per lineal foot than in a double deck type of car, since the tension and compression members are spaced a larger distance apart.

I do not know of a case where a steel platform casting has been used in this construction, since it has always been the aim of the designers to reduce the weight of this type of car as much as possible.

Fibre stresses and buffing shocks are kept within the same limits as mentioned for double deck cars.

The advantages of this type of car over the double deck type of car are numerous. First of all the single roof construction, with slightly increased thickness of sheets and a deeper curvature of roof, permits the use of the roof sheets for carrying purposes, which also permits cutting down of the side plate since a heavy side plate would not increase the section modulus of the car materially. There is no need of a special bracing of the roof sheets, because the large curvature of the roof effectively prevents buckling of sheets. I would advocate in this type of car the omission of side plate and carlins entirely and have the posts pressed in such a manner that they would substitute the carlins, this means an extension of posts same as used on lower deck of Pullman standard sleeping car, opposite posts being joined at the apex of roof by means of a splice plate and covered with the roof sheets in the conventional way. It will be harder to press these posts, but incidentally the omission of side plates and carlins means a reduction in weight and labor, both of which facts mean a cheaper car, and, furthermore, an easy regulation of width of car over posts, which is found difficult to maintain in pressed carlins, as they are very liable to warp after pressing and while cooling, thus changing the width of car unless the carlins are repressed cold in a close fitting die, which process is expensive and therefore to be avoided.

The air volume contained in single deck cars, compared to the air volume of double deck cars of the same length, is larger, at the same time the outside cooling surface of the single deck car compared to that of the double deck car is smaller, the body construction (labor and material) is cheaper than the double deck type; this can also be said of the total cost of inside finish. There are not as many bends and joints to be made when applying insulating material, which is a very important item for the successful insulation of cars. The head room of the car is generally higher in the turtle back type.

As these cars cannot be ventilated by the use of a deck sash more efficient ventilators are applied, which are either working in conjunction with the lighting fixtures or applied separately, as is the practice of the Harriman lines.

The reduction of light caused by the elimination of the upper deck sash is a matter that might be taken as a drawback, but if one takes the amount of subdued light filtering through the old type art glass deck sash into consideration coupled with the amount of soot and dirt received through the same source, this advantage is turned to a decided disadvantage. In case the turtle back car should be used for a sleeping car design, the lack of light from the deck sash could be easily remedied by the application of skylights, consisting of a cast oblong concave glass let into the roof in the centre of the car, placed so that the convex side of the glass will project above the level of the roof, which will give the collecting soot and dust a chance to be blown off the smooth surface of the glass by the action of wind and rain.

A turtle back car would, on the other hand, provide decidedly more space for headroom in the lower as well as upper berth, since the roof starts up at the posts with an abrupt rise, giving about 8 to 10 ins. more total headroom at the centreline of berth than a double deck car, which would mean an increase in headroom of from 4 to 5 ins. per berth.

Despite the increased headroom and air volume per passenger, the turtle back car is easier to be heated, since there is no draft through deck sash, permitting heated air to escape when the ventilators