

are closed and further the slightly decreased total roof surface should be a great factor in keeping the car warm on a smaller steam or fuel allowance than permitted for double deck cars.

CONSTRUCTIONAL DETAILS.

Constructional details are matters that should take the whole attention of the car department of the railway and that of the contractor. The simpler details are worked out the easier it will be to replace them when in service, and although I am a firm believer in pressed pieces for car construction, I will concede that it is easier to replace standard angles or shapes than to replace the former.

The use of windows of different height and size in one type of car, as well as the use of half elliptic deck sash of art glass above the window, are features that I think objectionable from the purchaser's standpoint, since it is necessary to shape the outside steel sheets as well as the inside finish in many cases to the shape of this half elliptic sash, which is an expensive job when executed in a repair shop without the aid of dies or presses. The different sizes of windows mean a larger number and more frequent change of dies in the contract shop, which operation takes time and money, on account of the greater number of templets and dies used and the work connected with these changes, the bill of which must be footed by the purchaser, without gaining any visible advantage excepting perhaps the rather doubtful pleasure of keeping a larger number of window panes or sash in stock to suit the different sizes of windows, since the saving in glass caused by different construction is a negligible quantity.

It is, however, erroneous to suppose that it is necessary to employ large hydraulic machinery, big squaring shears or multiple punches to do the repair work, as I have seen shops that built cars commercially successful without any of the heavier type of machinery used in freight car construction.

In regard to the means of permanent connection of several units in steel passenger car construction, we have at present only two methods that are to be mentioned here and these are rivetting and spot welding. The former, most commonly used, is a source of a great deal of trouble and expense in the erection of the cars, since it means a lot of preparatory work before a rivet can be driven. All material must be centre-punched, marked, punched to different rivet sizes, which causes in many cases rehandling of material on different machines, or resetting of single machines, assembling, reaming, and rivetting. Rivet holes never meet as perfectly as the drawings show them to meet, and the only means of getting the holes right is to punch them smaller and ream them to size afterwards when assembled. This is very expensive as to labor, and there is no assurance that the rivet will fill the hole after being driven. I have seen rivets driven in holes that were about $\frac{3}{8}$ in. too large, so that the hole was covered up by the rim of the rivet instead of being filled by the rivet shaft, but I must not forget to state that this was on freight car work.

Spot welding, though at present only out of the experimental stage, promises to eliminate all this trouble. Sheets and pressings are trimmed to size, placed in jigs, representing side or end of car and welded up with a specially designed spot welding machine. These welds will stand about 30% more in shear compared to a rivet of the same size in a punched hole, and the whole structure will be stiffer than a rivetted structure of the same design, since there is no surplus space in a rivet hole

that would permit the sheet to shift when under stress. These facts have been partly proven by personal experiments while connected with the American Car and Foundry Co., and further by those conducted by Chief Electrical Engineer, Mr. Osborn, of the same company. The testing of spot welded joints is as easy as the inspection of rivetted joints, but it would be advisable to have the inspectors watch the welding process, as well as inspect the weld after cooling. The former inspection will prevent a poor weld being made, by watching the flash between sheets, which is invariably a sign of perfect weld, the second inspection being confined only to rapping the weld with a hammer and judging the weld by the difference in tone to that of the unwelded portion of the sheets. Both inspection methods should supplement one another and should be especially applied to heavy welding work in carrying members of cars, since the use of spot welding in connection with steel inside finish would hardly call for more than a general inspection. There is no doubt at all that this is the future of the steel freight car, and I am certain that electrical spot welding will be successfully adopted for all steel passenger cars as well. The commercial success of this method is guaranteed, since this process will mean a considerable reduction in the price of cars, amounting to from 3 to 3½% of the price total of the car figured on a rivetted basis.

MAINTENANCE.

The maintenance of steel passenger cars is one of the most serious questions with railway companies, excepting, of course, those roads that are in a position to build their own cars and which, therefore, can take care of the repairs of their equipment with the machinery they use for the construction of new cars. Another item which was not heeded well enough in the first cars built, and which is now going to bother those members of the railway fraternity that have to keep the cars in working condition, is the question of rust protection in places not visible, between outside shell and inside finish of cars.

We know that a body kept at a certain low temperature, and afterwards transferred to a place of higher temperature with a high percentage of humidity, will sweat or condense moisture on its surface, until the body has risen in temperature to that of the surrounding air, at which point the condensed moisture will be slowly absorbed by the air. The amount of moisture taken up is largely dependent on several factors, like the ductility and temperature of the condensing surface, thickness of sheets, moisture, temperature and volume of surrounding air, etc.

In steel passenger cars the inside face of the outside steel shell is that part of the car most subject to this occurrence, and what conditions are prevalent at this particular place? The steel sheets were sand-blasted, and after that given either a coat of red lead mixed with an indifferent grade of linseed oil of the quick drying "gasoline" variety, or the car was coated on the inside with two or three coats of poor varnish. On top of this was applied by means of wooden strips or o.h.s. straps a layer of $\frac{3}{8}$ to $\frac{1}{4}$ in. hair felt insulation quilted in paper, the whole being enclosed by anything but an airtight inside finish.

In the winter the temperature in the car is kept about constant, the humidity is rising, caused by exhalation of the passengers, reduced ventilation only takes place, and the result of this is that a highly humid air current is set up in the space between outside and inside shell of car, caused by leaks in the inside finish. The outside shell is constantly cooled through the movement of the car, condensation takes

place on the inside surface of the outside shell, the force and extent of which is dependent on the care and material with which the sheets have been coated. The condensation freezes between the hairfelt insulation and the outside shell. Warm weather sets in, the ice thaws, and the water settles at once in the hair felt, from which place it is hard to dislodge. Meanwhile freezing and thawing have some influence on the sheet insulation material, the coat of paint, naturally poor, has given way in the form of cracks, flaking off sets in and the moist hair felt will start rusting in a very short time.

A better system of rust protection has been introduced of late, consisting of the application of an elastic coat of varnish applied to the sand blasted inside surface of the outer shell, which is covered before setting with a blast of finely broken cork dust. This process can be repeated several times until the treated surface becomes almost non condensing, by reducing ductility through the cork layer, after this the hair felt is applied by means of nails previously welded to the inside surface of the outside shell, by means of their heads, the points projecting inwards. The hair felt or other insulation material is impaled on these nails and the latter bent over after the insulation sheets had been pushed to the outside sheets. This prevents the movement of hair felt on the surface of inside shell and consequently keeps the cork surface in good condition. I think it would be worth while to improve further on this system by means of a waterproof coating on top of the quilting and a careful pasting down of insulation joints in order to prevent every possibility of water condensing on the sheets.

In an experimental way the use of calcium chloride, applied in fixed receptacles between outside and inside shell, would be worth while trying, since the latter is a powerful moisture absorbing agent without doing any harm to steel or other metals. In all cases the inside finish ought to be applied as tight as possible and all fissures closed. The application of sheathing to the outside of steel cars, in imitation of wooden cars, consisting of a series of sheets, pressed or drawn to the well known keystone shape and fastened to the carrying sheets by means of screws or rivets placed in the depressions of the sheets, which in turn are covered by keystone shaped steel troughs, fitting into the dovetails of the first applied sheathing and placed in position by sliding them into place from the side sill edges of the car, after the troughs have been coated with a specially prepared varnish, has not proven very successful. The composition material smeared into the keystone openings of the later used wooden blocks, visible on the bottom edge of the cars, have dropped out in places in the course of time, moisture got in and you can imagine the result in some of the cases, after a lengthy exposure.

A handy tool for the repair of damaged steel cars and for any class of passenger car work as well, is one of the gas welding outfits with cutting attachments now so popular in the car shops of this continent. The system used is more or less dependent on the work to be done and the facilities on hand.

Oxygen hydrogen welding will be welcomed at those places where direct electrical current is obtainable at low prices and the use of a supplementary acetylene tank for the mixture of hydrogen with acetylene for welding purposes will permit the raising of welding temperatures from 3,900° for the oxygen hydrogen system to 4,900° which temperature is more than enough for any kind of work in the steel