Boxcars – The roof problem.

By Randy Hees

Author's note:

The following was written for the newsletter of the Society for the Preservation of Carter Railroad Resources. It originally appeared in three parts over a year. I have reassembled the various pieces and illustrations.

Defining the Problem:

If you visit Ardenwood Farm, and the Society for the Preservation of Carter Railroad Resouces museum during our winter rainy season, you will find that we have tarped two of our boxcars, SP 10 and SPC 472. (elsewhere in the park, Nevada Central 253 is similarly covered.) We have done this because their roofs leak. The roof on SP 10 is at best beat up and at worst rotten, but the roof on 472 is new, installed in 1997, and repaired and repainted in 2002. Additionally, some of the boards are showing signs of rot, and the roof will need even more work this spring. Sitting in storage are two more boxcars, SPC 444, and Pahjaro Valley 215, both currently carrying iron roofs installed after the carbodies became sheds. With the problem identified, we have started a process to research and understand 19th century practice.

Our study of 19th century sources suggest that our problems are not new, nor unique. As early as 1874 the then new Master Car Builder's Association (MCB) had formed a committed to research roofs. Their report, published in the July 1874 National Car Builder stated: "*In the Construction of freight-cars, the roofing is a matter of paramount importance. Experiments, with a view to more satisfactory results, have been made by car-builders with varying success. Almost every kind of material adapted to the purpose has been tried- -- double boarding in various ways, and tin and iron on top and underneath the boards. The great difficulty hitherto has been the natural expansion and contraction of the material, under varying extremes of temperature, and the injurious effects oscillations NS vibration when the car is in motion, making it almost impossible, apparently, to devise a substantial and durable water-proof roof."*

Fifteen years later, in 1889, railroad car expert William Voss wrote: *"A satisfactory if not a perfect freight-car roof is one of the problems still to be solved, and considering the condi-tions of service involved, it is safe to say that it will re-main a problem for some time to come. The first requisite of a good roof is an absolute protection against rain; it must also be reasonably safe to walk over, and conse-quently of a low pitch and of a material that is not slippery and not liable to be injured by the feet of train-men; the construction must be such that the vibrations and the twisting of the frame will have no effect on it, and lastly, it must be durable and reasonably cheap."*

As Voss noted, the Railroads were cheap and conservative in when considering new designs.

The Options

As usual, Voss was the first contemporary source we turned to, to learn what the car builders were trying. *"There are three distinct classes of roofs in use, and their relative value, if measured by the number at present ap-plied, is in the same order as they are mentioned: First, the double board roofs; second, the single board roofs cov-ered with tin or some other sheet metal; and, third. the various roofs of sheet metal, paper or composition, with an outside, and in some instances, also, with an inside cover-ing of boards to protect this material against injury."* (Voss, p 30)

On the other hand, in 1908, Kirkman had identified four possible roof types:*" There are in use*

four general styles of roof construction: (1) The double board roof; (2) the single board roof covered with tin or other sheet metal; (3) the sheet metal roof protected by a single layer of roughly matched boards; (4) a type of double roof consisting of an inside roof covered with felt, tar paper or asphalted canvas and an outside roof built over it to protect the roofing material from injury." (Kirkman p 39)

Early Efforts

Canvas covered roofs: The earliest roofs, mostly prior to the Civil War, were canvas or duck, stretched over the single board roof, and painted with multiple coats of a thick waterproof paint. These roofs were fragile, easily damaged, wore out quickly, but occasionally used on passenger cars, and were almost universally used on streetcars until after World War II. Two canvas roof can be found in the collection of the SPCRR, one on our 1886 horse car, Oakland Railroad 8, (built by John Hamond, 1886), and the second on the fragmentary remains of San Francisco cable car, 512 (Carter Brothers, 1894)

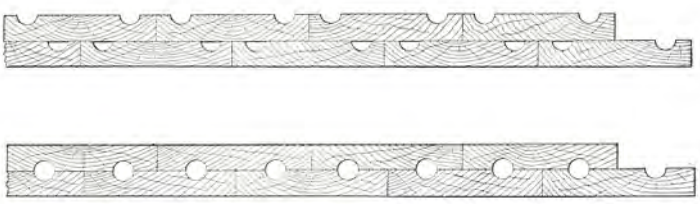
Soldered tin roofs: Soldered tin or terne metal roofs were tried on freight cars, but were found to be easily damaged by brakemen and others walking on the roofs. On passenger cars, where no one walked, tin or trune metal roofs, became the standard roof, used by the Carters and others. Both SPC 47 and SP 1010 in our collection carry tin roofs, in the case of car 1010 now 123 years old. Tin roofs were on passenger cars but not on freight equipment. Apparently the Carters used tin roofs on all the passenger cars they produced, including car 47, but the surviving specifications for a standard gauge car built for the Port Blakely Mill ignore this aspect of the car, only specifying the use of "*ruby and blue glass in the pivoted deck sash."*)

The common Double Board Roof

"The double board roof is perhaps the most used. (in 1908) *In the construction of this roof only the best seasoned white pine boards should be used. A common practice is to use boards dressed on both sides and edges to a uniform size of about 7/8 x 5 1/8 inches and have two semi-circular grooves of 5/8 inch diameter on one side, near each edge. (running the length of the board). The purpose of these grooves in the top course of boards is to catch and carry off as much of the water as possible, keeping it out of the joints; these same grooves in the under course catch and carry off such of the water as penetrates the joints of the top course. As the grooves in the under course are apt to become clogged with dirt sometimes the two courses are placed in contact so as to increase the size of the channel for carrying off the water. The boards of both courses are nailed to the plates, purlines and ridge pole. Wooden (sic) screws are sometimes used in place of the nails but they are expensive and troublesome. The edges and faces of the boards are always heavily coated with paint before they are laid. The pitch of the roof varies from 1 ¼ to 2 inches rise per foot. The steeper the pitch the better the protective qualities of the roof but the more dangerous to trainmen who have to pass over it."* (Kirkman p 39 & 40.)

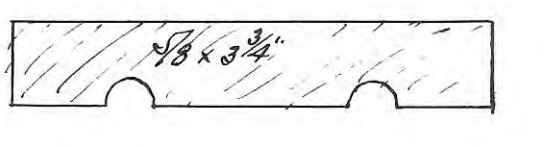
The Carter Brothers apparently used double board roofs for all of the boxcars they built.

We have two original Carter Brothers documents mentioning boxcar roofs; the first a set of specifications prepared as part of a quote for Pope & Talbot for equipment for their logging line in Washington, which describes the roof as



MCB standard "Double-board roof" from Kirkman

"Roofing double thick Redwood ¾ in. by 4 in.". No details of construction, or lumber quality information is provided. Separately, they included drawings of their standard roof board when redrawing their standard 28' narrow gauge boxcars sometime around the turn of the century. The drawing shows a 4" wide board with two grooves, identical to those shown in the Car Builder's Dictionary, (but as a Western builder the Carter Brothers were using redwood in place of the more common eastern white pine called for by Voss and Kirkman.) Late shop inventories are no help, as no roof boards are listed.



Carter Roof board from a circa 1901 drawing, Dr. Fisher collection,
California State Railroad Museum Library.

At the SPCRR our experience with double board roofs has net with mixed success. When restoring SPC 472, a 1880 Carter Brothers boxcar, we chose to replicate the roof shown on the Carter boxcar drawings. New roof boards were ordered cut from old growth, all heart redwood, the finest available. We read both Voss and Kirkman on the subject. We studied photos of SPC boxcar roofs to learn which way the roof boards were oriented (In all but one case we found the groves on the top boards were on the bottom, but we did find one photo showing both sets of grooves oriented upward). In the end we placed the groves on the lower course upward, with the grooves on the upper course point downward, lining up with those on the lower coarse, forming round holes. It was difficult to make the two layers line up well. We followed the painting instructions carefully. We find the roof leaks, and some of the boards start to rot immediately, while others seem immune.

At least one person has suggested that we should have used quarter sawn or vertical grain lumber. We have reviewed contemporary records, and have found no specification calling for this. They do call for dry material, free from knots or sap, matched and grooved. It is possible that 19th century lumber buyers thought this was so obvious that they didn't need to tell us, but the commonly used illustration of the double board roof shows end grain, and the end grain shown is not vertical grain.

Apparently our experience with these roofs is consistent with those of our 19th century predecessors. While it is comforting to know we have accurately reproduced a 19th century roof, it is frustrating to have to suffer through the leaks and have to continually repair it. At some future date we will likely lift the top layer of boards and add a membrane of some type to make the roof more weather tight, much as described later by Kirkman. (end of part one)

The Other roofs

There was no shortage of roof designs, but apparently most had problems, either they didn't work, or they cost more than the railroad companies were willing to pay.

Variations on a wooden roof

The Plank Roof

One alterative to the double board roof seems to have been the plank or single board roof. To make this design water tight the boards were tonghed and grooved, The roof was covered with tin or iron sheet and the seam between the boards was cov-

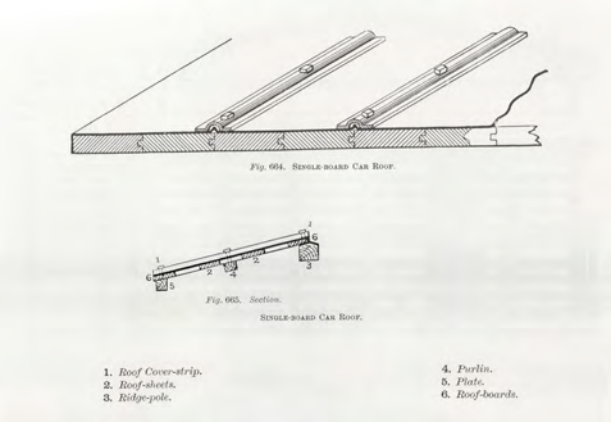


Fig. 664. Single-board Car Roof.

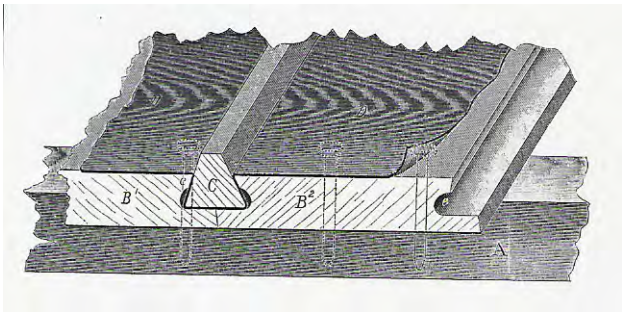
Fig. 665. Section.

Single-board Car Roof.

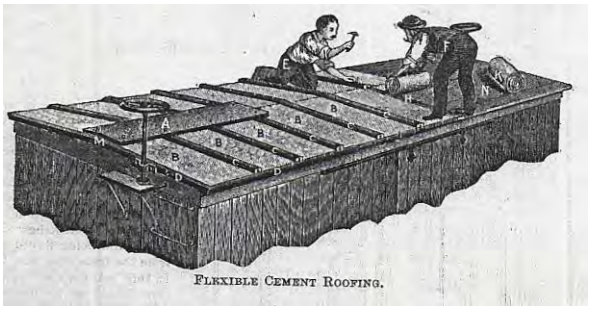
1. Roof Cover-strip.
2. Roof-sheets.
3. Ridge-pole.
4. Purlin.
5. Plate.
6. Roof-boards.

Single board plank roof, from the 1888 Car Builder's Dictionary, page E169

ered, with a "roof cover strip." This design apparently solved the problems of splitting seams found on the soldered iron roofs. But still was subject to damage by trainmen walking on the roof, and was little used.



A. P. LaGross keyed roof system, National Car Builder, Dec. 1883, p 135



Flexible cement Roofing National Car Builder

Inventing a Solution: Canvas, Iron or other waterproof material.

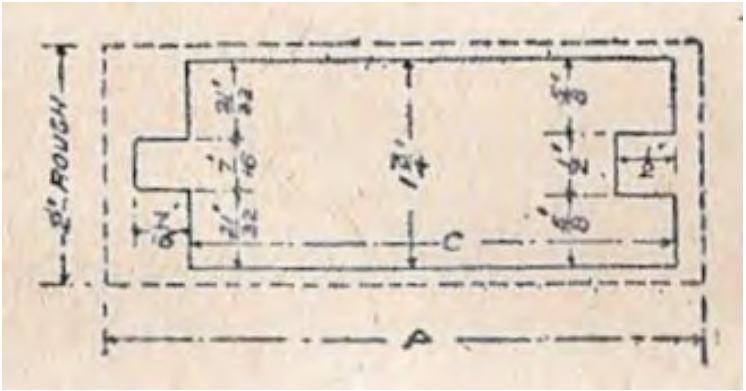
The 19th century railroad literature is full of possible solutions, many patented, others variations of one of several themes. Most of them were trying to move away from a wooden board as a waterproof material by adding an additional layer, either iron or some other water proof material. Kirkman divides these into two categories, The first "*with felt, tar paper or asphalted canvas"* and the second the various iron roofs.

Tar paper and other flexible roof membranes

Ad for Hutchin's Car-Roof, From White, The American Railroad Freight Car, p 229

The simplest solution was to add a layer painted canvas, or a tar or rubber impregnated paper to the existing roof. Experience had shown that any material on the outside was subject to damage from trainmen. This was not an issue on passenger cars, many of which used painted canvas.

The 19th century was a time of invention and innovation. By the 1830's tar impregnated paper or cloth was available. Patent searches located several patents for improvements for this material, several of which specifically mention railroad cars as a possible application.



Standard MCB roof board, from Kirkman's Science of Railways, p 27

Ad for plastic slate roof, National Car Builder May 1875, p 75 (Illustration D)

Still this material was much more fragile than today's roofing felt. This presented two challenges, how to attach it to the car roof, and how to

protect it from the trainmen working on the roof.

I located two attachment systems; the first, simply titled *Flexible Cement Roofing* was presented as part of a 1874 Master Car Builders study, simply used battens to hold the roofing down. The second was much more creative, involving a system of dovetails cut into the roof boards to capture a key holding the roofing felt down. The article did specify the use of lots of paint. The 1883 article noted that is was being tested on the Cincinnati and Lexington Railroad.

Car builders tried to protect the membrane car builders added a layer of boards over the membrane. Concerned about damage and nail holes from the upper layers they devised a variety of patent roofs, with boards, followed by a layer of asphalt cloth, followed by a framework of light stingers, then over that a second board roof. The 1888 Car Builders dictionary offers one such solution, the **Hutchin's car-roof**. It is described as "A patent form of roof consisting of two layers of boards with a species of dovetail joint to con-nect them, and separated by a continuous sheet of thin painted canvass."

Apparently Charles Hutchins the inventor was not satisfied with this system, and would later patent two variations using iron in place of the roofing felt, in the late 1890's.

The MCB Roof

By 1908 The Master Car Builders association adopted the standard MCB roof board, illustrated below. While the roof board now was standardized, it use was not.. Several options are offered in literature, in one case depending on the tongue and groves to seal the roof (with liberal use of paint of course) in the other by sandwiching a layer of roofing felt between two layers.

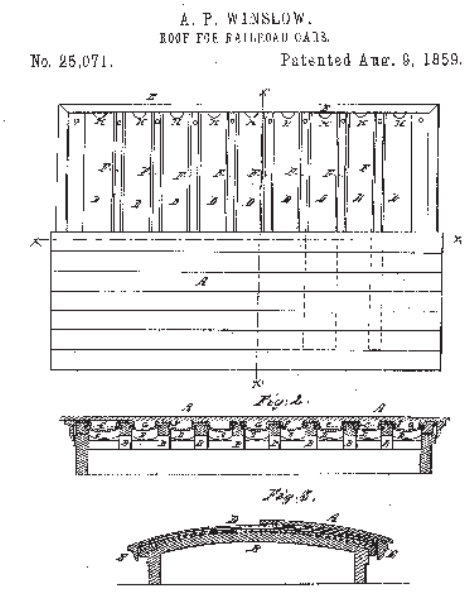
Kirkman offers the following:

Specification for construction of a new boxcar roof

Roofing.- Is dry white pine, free from sap, dead knots and shaky places. The under course is of "B" "first common" grade, 27/32 of an inch, thick by 5 1/4 inches wide, surfaced on both. sides, matched and grooved; each piece is nailed, to the fascia board, plate, purlines and ridge pole with not less than three 8-penny cut nails at each place, one nail may,: be driven blind. One heavy coat of No.1 minera1 paint is then to be applied to the top of roof, over which will be placed a layer of plastic roa1ing paper which will be furnished by the Railway Company. The top course of boards is first-class sid-ing, 27/32 of an inch thick by 5 ¼ inches wide, matched, and grooved with two half round grooves worked in top face. It is to be nailed with three 10-penny cut nails in the same manner as the lower roof and must be cut off to project 1% inches over the fascia boards on the side. The plastic roofing must be laid in such a manner as to have it cut off with the boards. Care must be taken in securing the roof, not to drive any bf the nails so that they will -miss plates, car-lines or ridge poles. The quality of lumber as indicated in these specifications will be found in Judson's Revised Edition of the Lumbermen's Hand Book of 1891, "Chicago Yard Grading of Pine."… "Long leaf Southern pine must be used in all instances where Southern pine is mentioned." (Kirkman, p 145, 146)

Interestingly, the "plastic roofing paper" was one of only 5 items which Kirkman thought should be provided to the builder by the railway company (the others being the draw-bar springs, automatic couplers, air brakes, and paint stocks) (Kirkman p.145)

With this specification we can assume that a double board roof with a layer of roofing paper was becoming a standard acceptable design, but it appears that by the time they worked out the details, the era of wooden bodied freight cars was coming to an end, and iron roofs by Murphy and others were fast coming do dominate new car construction.



In our collection at Ardenwood, boxcar SP 10 has a double board roof with roofing paper between the layers similar to that described by Kirkman. The roof seems to work where it has not been exposed to the weather, rotting the upper layer of boards and exposing the roofing paper, The design has some significant advantages. It is cheap. Wooden roofs were always the cheapest alternative, and with the addition of the roofing paper, lesser quality boards can be used, further lowering the cost. (end of part 2)

The Winslow Roof

Left—the Winslow Roof patent, as designed

Below— "*The Winslow Roof patented 1859, no. 25,071,* from National Car Builder, 1874" as offered

Sources used for part 2 include:

The Railroad Car Builder's Pictorial Dictionary, (Original edition by Forney, Matthias The Railroad Gazette, New York, 1879) (reprinted by Dover Publications, New York, 1974), additionally we used the 1888 and 1906 versions, both from the Gregg reprints

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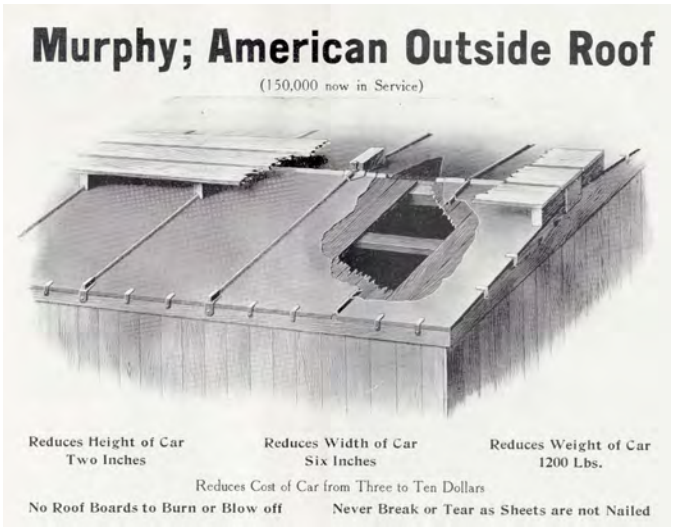
United States Patents, accessed both via the Patent office web site, as well as Google patent search.

Box Car Roofs, part III

The Iron roofs… "*The cost of a tin roof is not much in excess of a first class double board roof, and if it were in all other respects satisfactory, would perhaps be more used than it is*. (William Voss, 1892)

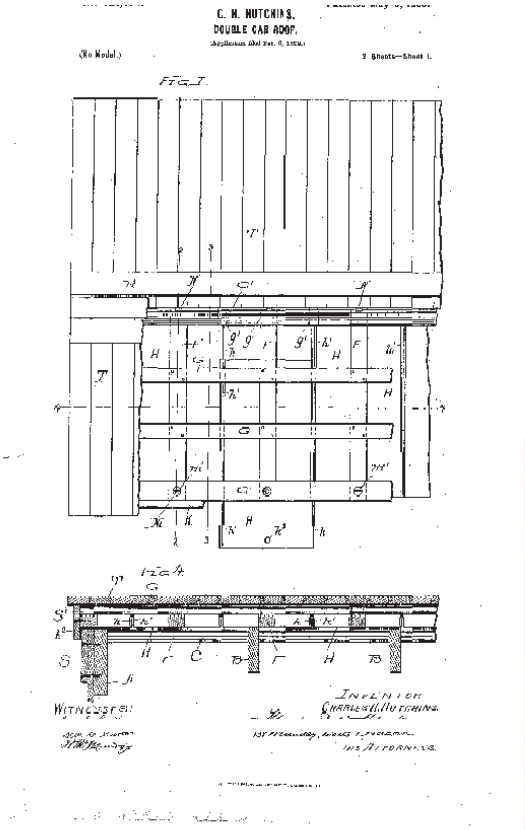
While there were patented metal roof systems available as early as 1859, (A. P. Whinsow, Patent No. 25,071) metal roofs were generally a later development, only coming in to common use after 1890. To date, I have located 71 patents of various metal roofs, issued between 1859 (most after 1872) and 1913 and many more for "paper" roofs, roof clamp systems, roof walk systems and car-

lines. Many of the patents are derivative, involving small improvements in a previously patented roof, or are reissues of earlier patents. Railroads, citing problems with the various designs, and particularly the increased cost were slow to adopt metal roofs.



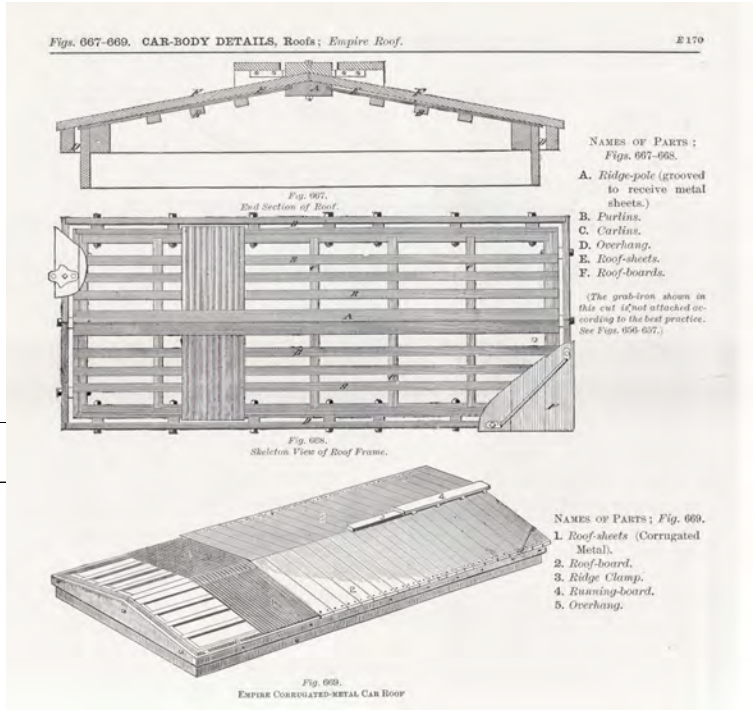
"Murphy outside roof, patented 1905, no. 779793, from the 1906 Car Builders Dictionary"

There are a great variety of iron boxcar roofs, but most can be described as either outside or inside roofs, depending on whether the iron was covered by a layer of boards or not. Voss in his 1892 article would also include the older tin roof, referring to soldered tin plates, similar to what was used on Passenger cars including 1010 in the SPCRR collection, as a third type of metal roof of which he wrote.; *Its objectionable features are the liability ot injury from being walked over and the difficulty experience in attaching the running boards, grab-irons and brake-rest all of which are apt to wear holes in the covering by chaffing….* (in his 1905 book Kirkman noted that tin had been replaced by heavier sheet iron or steel for this style of roof)



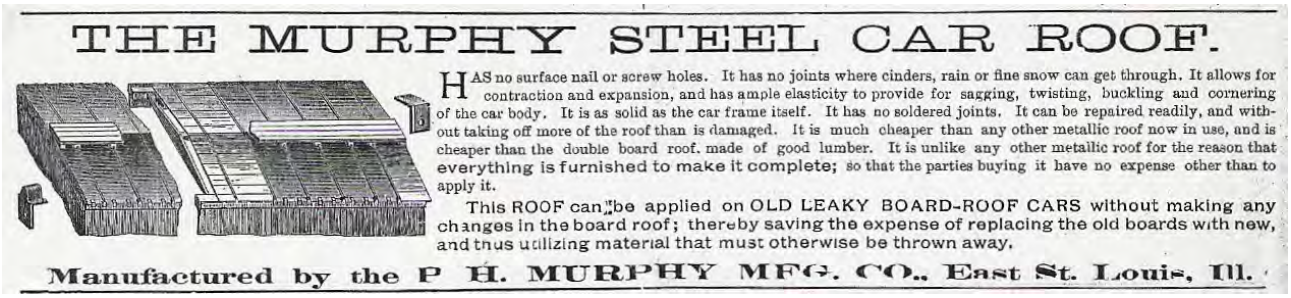
Hutchins Roof patent no 624,654

In 1892, roof design was far from perfected. Voss was skeptical of metal roofs. Voss defined three designs, or classes of metal roof, 1, the tin roof described above, 2, the outside iron roof; *Its objectionable features are the liability of injury from being walked over and*



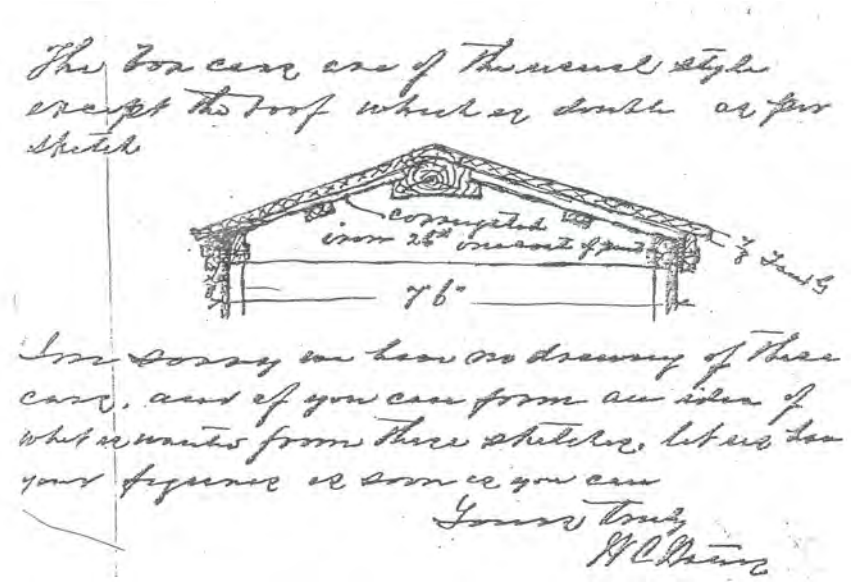
Empire roof from 1888 Car Builders Dictionary

the difficulty experience in attaching the running boards, grab-irons and brake-rest all of which are apt to wear holes in the covering by chaffing…. The fragility of tin has led to the use of sheet-iron or steel of considerable thickness as a substitute. As this material cannot be shaped and worked the same as tin, it is necessary to lay it with standing seams instead of the locked and soldered seams of the later… The iron sheets of the same width as the carlines are laid parallel with those with the ends turned down over the fascia and nailed to it. Additionally Voss described the two different types of cleats, either of used to join the sheets. made of either wood with saw kerfs



"Murphy Inside roof, patented 1893 no.

to engage the sheets or in or cast iron. In either case, the cleats were bolted to the carline. Painted canvas was used as a sealing gasket both at the cleats and anywhere else the sheets were perforated to mount running boards, grabs or other appliances. Within a short time several systems of pressed steel cleats would be offered, particularly the Excelsior car roof and the 1905 Murphy design (patent No 779793) both of which used various clamps cleats both to replace the battens, but also to hold the tops and edges of the roof sheets. Ultimately the outside iron roof would come to dominate railroad car construction, particularly the outside Murphy roof which is found on most of the surviving narrow gauge Denver and Rio Grande Western box cars. But as far as we can tell, no outside iron roofs were ever fitted to California narrow gauge box cars.



Roof detail for Pajaro Valley boxcars, from order specifications, copy from Bruce MacGregor

Voss' *third class of iron roofs*, (commonly known as inside iron roofs) the designs of which he said; *"are more numerous and can therefore not all be described in detail…* (a reference to the many competing designs.) *They are to some extent a combination of the other two, the roofing material consisting of light galvanized sheet iron or prepared paper placed directly on the carlines or roof strips, or on a course of matched boards, while above this is constructed a wood covering, resembling the ordinary roof."*

For a more detailed review of inside roofs we can turn to inventor Charles Hutchins who in his 1899 patent (624,654) (he had previously patented a similar roof using tarred paper in place of the iron sheet, which we discussed in our previous article) defined three types of what he called *double roofs*, The first was a roof where the boards were laid directly on the metal sheets, and secured by nailing or bolting through the metal sheets to the roof frame. While this resulted in a continuous metal roof, it suffer from leaks due to the nail holes. The second was a roof where the metal sheets ran from carline to carline. In this case the sheets of metal are not pierced by nails or other fasteners, but are not continuous either, leaving gaps where carlines are found. Hutchins believed the joint between the metal sheets and

Author's Note: in the article above, you may find my changing use of terms *Metal, Iron, Steel* and *Tin* confusing. The period covered by this article, roughly 1860 to 1910 was one of rapidly evolving technology and metallurgy. Steel which had been expensive and rare prior to about 1870 became cheaper and as a result into more common use. Still, the contemporary writers used iron and steel interchangeably during part as generic terms for various iron based alloys. Voss at times used the term *tin* for all metallic roofs.

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No study of American Freight cars can be made without reviewing Jack White's The American Railroad Freight Car, (John Hopkins University Press, Baltimore, 1993)