ADVANTAGES OF STEAM SPACE SPRAY BOILER CHECKS OR TOP BOILER CHECKS VERSUS SIDE BOILER CHECKS

Report by MR. K. D. RELYEA
Test Department, New York Central System

The patching and renewal of Firebox Side Sheets has been a major item in boiler maintenance for many years and has been a subject of intense research by the members of this association.

The experience of the New York Central has not been materially different from that encountered on other roads. It had been necessary to renew firebox side sheets at every shopping period and a large number of our locomotives have had to receive large patches between shoppings.

In the years 1940 through 1944 we accepted delivery of 115 new Mohawk type locomotives, the majority of which were for combination freight and passenger service. The boiler construction was the same for all with slight variations in cylinder and wheel diameters. While firebox troubles had been with us for many years, this group of locomotives after a short time in service, developed early side sheet failures.

One locomotive of this class after accumulating approximately 28,000 miles of service since construction developed wavy side sheets and leaking bolts. Several others required patches well under 100,000 miles and practically all required new sheets at approximately 120,000 miles.

Metallurgical examination of many sections of these failed sheets usually revealed the same result, that failure was due to fatigue cracks, particularly in the fire region.

These side sheets were purchased by the A.A.R. M-115 specifications for firebox steel. We went back to the original analysis of the steels, the inspection reports, our water treatment, washout practices, the method of making the staybolt holes and cylinder and feedwater pump lubrication practices, all in an effort to determine, if possible, wherein lay the answer to these failures.

The subject was given much thought and study by our engineering and maintenance divisions in conjunction with the manufacturers of the feedwater equipment.

Three courses of action were decided upon:

(1) The reduction of the amount of oil to the boiler by the strict regulation of the mechanical lubricators and the removal of the feedwater pump exhaust from the heater to the atmosphere on five locomotives.

(2) A trial application of alloy steel firebox sidesheets, and

(3) A trial application of a top boiler check and spray nozzle.

It was felt that these three approaches to the problem would yield the answer as to whether it was oil deposits in the boiler, firebox steel or coldwater entrance into the boiler.

The reduction of oil to the boiler gave some indication of improvement but was not the answer as patching and renewing of side sheets continued.

The application of alloy steel side sheets was made to ten locomotives of the "Mohawk" class in 1945. Application was made to alternate sides of the locomotives with the opposite sheet of standard A.A.R. M-115 steel. Four applications were made of manganese-vanadium to ASTM A-225-39T,

Grade A, three carbon-molybdenum to ASTM A-204-42, Grade A, and three of Mayari R Bethloc steel. Three of the ten were also equipped with the top boiler check and spray nozzle to obtain comparison with side check performance.

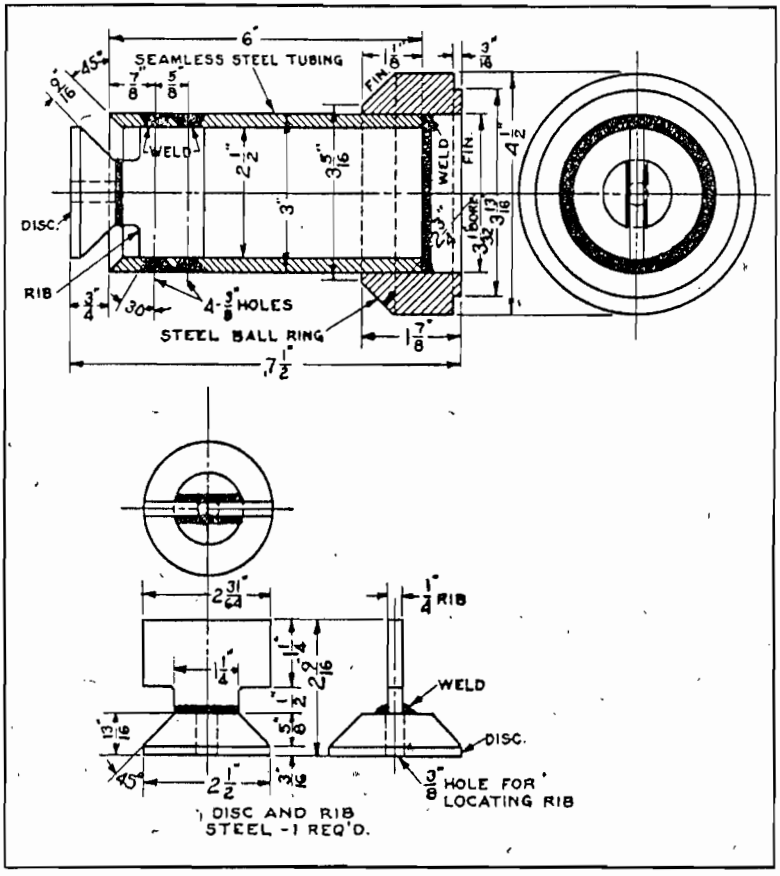


Fig. 1. Spray Nozzle Top Boiler Check

Three applications are still in service and are those equipped with the top check. The other seven alloy sheets, as well as the companion M-115 sheets have all been removed due to cracks at the staybolt holes. Metallurgical examination of the sheets indicated the steel to be of good quality but again failure was due to fatigue. The minimum mileage was 83,000 miles and the maximum mileage 155,000 miles. To date, the three top check locomotives have accumulated approximately 250,000 miles with all sheets in excellent condition and no noticeable difference in performance of the alloy sheets or the standard steel. It may be when the sheets are finally renewed, we may find some advantage to the alloy steels.

Top boiler checks are not new to our road or to many others. Our experience with top checks about 20 years ago was not very satisfactory and

resulted in their removal and application made to the side of the boiler. Top checks were left on most of the switch engines so equipped as they gave little trouble due to low evaporation and were not subject to large variations of boiler demand.

The object of the present applications was to positively assure that no relatively cold water could enter the boiler. It is characteristic for fireman to control the boiler pressure by the use of the feedwater pump and in cases when the locomotive is shut off quickly after heavy evaporation the pump is usually put on full. In the case of our open type feedwater heaters this permitted a large volume of cold water to enter the boiler at the time the firebox is at its greatest heat. As cold water will drop to the bottom and circulate along the hot side sheets there probably exists as much as 200° difference in the temperature between the top and bottom of the sheet. This situation causes continual changes in stress and leads directly to fatigue.

With this thought in mind it was decided to again try a top boiler check application except this time *a spray nozzle was incorporated* to diffuse the water. The spray nozzle used was designed by the Worthington Pump and Machinery Company for use with their heater applications.

The first application was made on January 13, 1944. The locomotive was not selected but was one of our L-4 class that was undergoing repairs at our West Albany Shops. This particular locomotive was built in December, 1942 and had accumulated 138,000 miles prior to this shopping. New side sheets of M-115 steel were applied at the same time the top check was applied. This locomotive was shopped again in June, 1945 and May, 1947 under class 4 repairs. The only firebox repairs necessary were a few scattered staybolt renewals. It was last shopped in June of this year, at which time it was necessary to apply ¼ side sheets on both sides. (The usual size has been ¾ sheets). The total mileage between firebox repairs was 485,416 miles.

We concede that this first application may be exceptional but several later applications are fast approaching this record.

Analysis of the boiler history of 65 locomotives of this class show a great improvement in firebox maintenance since application of the top check and spray nozzle. Mr. E. H. Heidel in his "Study of Defects in High Pressure Boilers" published in RAILWAY MECHANICAL ENGINEER in November, 1942, indicated six years of service for new sheets after application of top check and much of our data is bearing this out.

Of the 65 records analyzed, nine locomotives have received side sheet repairs at the first shopping period of approximately 140,000 miles after application of top check. Six of the nine are assigned to a specific territory of 200 miles and indications are that the cause of short life was due to faulty washout practice which was corrected upon discovery.

It might be well to present the complete boiler history of a typical locomotive prior to the application of a top boiler check so it may be readily seen why we are enthusiastic about the application.

(3034 Built January, 1941, new side sheets in November, 1942 after 131,000 miles, new side sheets in July, 1944 after 100,000 miles, patches on both sides in February, 1945 after 39,000 miles, patched again in September, 1945 after an additional 26,000 miles, patches again in May, 1946, July, 1946 and January, 1947, each period being approximately 25,000 miles. The locomotive was finally shopped in January, 1947 when it was necessary to renew the sheets again. In a total of 366,000 miles with the use of side boiler checks the side sheets had been renewed three times and patched five times. The locomotive has accumulated 112,000 miles since application of the top check with no firebox repairs whatever.

Of this group of 65 locomotives, 31 have been through one shopping and five through two shoppings without side sheet repairs. Two have exceeded 400,000 miles, four have exceeded 300,000 miles, 21 have exceeded 200,000 miles and 28 have exceeded 100,000 miles.

To date, we have applied top boiler checks and spray nozzles to approximately 500 locomotives. The same check has been used that was used for the side application and the spray nozzle has been welded to the steel ball ring. The nozzle assembly, see Figure 1, is fabricated at our shops in accordance with Worthington sketches. It has been necessary to relocate the sand box on some classes in order to locate the check in proper relation to the outlet of the dry pipe. The check has been located in the first course on top center. Deflector plates are necessary to keep the water from spraying directly upon the dry pipe.

As a large steam space is best adapted to top check applications some difficulty may be encountered in small boilers by the raising of water.

We have encountered complaints on our J-1 class of water carryover and have installed baffles in order to reduce this tendency. The J-1 or Hudson class has 143 cubic feet of steam space compared to 165 to 267 for other classes thereby making the condensation of steam more critical. In effect, a top check application makes it necessary for the locomotive to increase its rate of evaporation to compensate for the heat given up by the steam to the feedwater. Locomotives with ample steam space will not encounter any difficulty in this respect.

We believe the advantages of decreased firebox maintenance justifies the application of a top boiler check and spray nozzle to all classes of steam locomotives that are subject to repeated failures of their side sheets.

President Heidel: Thank you, Mr. Relyea.

Mr. Stiglmeier, have you a few words to say? We have a few minutes left.

Secretary Stiglmeier: Gentlemen, as I told you a few minutes ago, this is a preliminary report. I don't believe we should have any discussion. It only covers one Railroad. However, I believe it gives enough information for consideration to be given by other Railroads as to the application of top boiler checks, and, as stated, the executive board anticipates making this a topic for 1950. By that time we should be in position to get information from other railroads.

I move that the report as read by Mr. Relyea be accepted, Mr. Relyea be given a vote of thanks, and the Executive Board be instructed to make this a subject for the year of 1950.

The motion was seconded by Mr. Barrett. . .

President Heidel: It has been regularly moved and seconded that this report be accepted and that a topic be set up for next year's meeting. Any questions on the motion?

DISCUSSION

Mr. Fegan: I would like to ask the gentleman who has just spoken, since they have adopted this spray nozzle have they had any experience with the boiler shell cracking adjacent to the application?

Secretary Stiglmeier: Yes, we have had boiler shells cracking, that are equipped with the Top Boiler Check and Spray Nozzle, this is not a cure

all. Much stress for these shells cracking is laid to this so called alloy steels. Many of these boilers are being replaced with the all-welded shells of a different grade of steel, and the Top Boiler Check with the Spray Nozzle have given very satisfactory performance under those conditions. With this alloy steel that we had been using, I don't believe that a top boiler check is going to overcome cracked shells. The only thing that is going to overcome cracked shells is an all-welded shell.

President Heidel: Is there any question on the motion? All in favor will give the usual sign of raising the right hand; contrary the same sign. It is so carried.

This is the end of the morning session. This afternoon has been given over entirely to visiting of the Exhibits. We want everybody to take advantage of this opportunity. There are some new ideas there that we can take home and put into practice that will be beneficial to the Railroads we work for.

The meeting on Wednesday morning will begin promptly at nine o'clock. We will have an interesting program and I hope to see you all here on time.

If there is no further business, I declare this morning's session adjourned.

. . . The session adjourned at eleven-fifty o'clock . . .

MESSAGE BY MR. H. J. BURKLEY

Supt. Motive Power, Baltimore & Ohio R. R.

Mr. President, Officers, Members and Guests of the Master Boilermakers' Association:

Am keenly sensitive of the honor you have bestowed upon me in inviting me here to talk to you today.

The subject as assigned is: "Benefits of Minor Railway Mechanical Associations."

One thing I would like you to remember, gentlemen, this great America of ours is the only country where Associations, or Organizations of subordinates, such as these holding meetings here this week, can assemble for general discussion, and improvement of the product we represent, that is, the Motive Power of our American Railroads, the first line of defense of our Nation.

Am sure you are all aware of the trend of the times, and the disturbing elements at work in our country today, putting forth every effort to discourage, in general, our American way of life. What the eventual outcome may be, if those against us are ever successful, no one knows. So lets keep our eyes open to our surroundings, and fight, and fight hard, to retain the Freedom and Liberty we have all known since the birth of our Nation, and which, by our God given right, and free enterprise system of Government, has protected our American Railways, and permitted them to become the greatest, and most efficient all year around transportation agency in the World.

The success of our railroads, in turn, has made these annual meetings possible, where so many railway representatives can come together in one common brotherhood, to exchange greetings, expression of thought, ideas, etc., with the view of bettering, in general, the great industry we all serve.

Now, to reminisce a little. Let's Stop, Look, Listen, Think and Consider for a moment, the stride, or improvements made in American Railroading as a whole in the past 50 years. I do not consider myself a boy any more, nor do I feel that I am an old man, however can remember well the "Camel" engine; the American 8-wheel passenger engine (both large and small) the first Mallet locomotive ever built in this or any other country, and on down the line up to the present day. The old Link and Pin days before the advent of the automatic coupler; the old steam jam before the day of air brakes; the pump connected to the rear crank pin before the days of the injector; gauge cocks only, without either water glass, or water column, to determine water level in locomotive boilers. 165 lbs. steam pressure as against the high pressures of today; wood pilots, hand sanders, wood boiler lagging, etc.

Boiler gadgets, such as flue plugs, (many of these plugs carried in tank boxes, and used by crews on line of road for plugging burst flues, and many others driven in by shop forces at terminals for the same purpose. Have seen as many as 25 flues plugged in one boiler by this method when I was a boy, and no tie rods in them either.) Soft plugs, many of which were plugged by enginemen on line of road with a rat tail file, after same had fused. account of low water. Patch bolts, and rivets driven by hand throughout the entire boiler, and fire box. Copper plugs for lacing cracks in side sheets and flue sheets. Spark boxes at the bottom of the smokebox for sparking front ends. Sectional sheet iron convey pipes, crown bar boilers, button head crown bolts, staybolt iron issued from bar stock cut to length, and ends squared in the smith shop, threaded in bolt cutters, and that, without any tell tale holes whatever.

Arch tubes, and brick arches, siphons and circulators were unheard of. Water treatment was unknown, and for leaky fire boxes, mud rings, etc., in those days, manure, saw-dust, rice, blue vitrol and brown paper, all had their part to play in leak stoppage, and materially assisted in getting locomotives over the railroad.

Have often wondered about the poor old boilermaker "hot man" and how he ever lived through it. Have seen hot men go into fire boxes and disappear in a cloud of steam from leaking conditions, eventually he would dry up enough bolts that his torso was again made visible from the deck. From then on it was in and out of the fire box. In as long as the human body could stand the heat, then out for a breath of air, and a cooling off period, then back in again. This procedure being repeated until the leaks were dried up, and fire box made ready for another trip, at the end of which the same ordeal for another of the craft assigned to handle this character of work.

Why don't these same conditions exist today? Because you boilermakers, Boiler Foremen, and General Boiler Foremen, through your local meetings, district meetings, general meetings and conventions such as this, these many years, have kept insisting that improved means and methods should be developed, and suggestions offered whereby the conditions as mentioned, could be improved upon, and as a consequence, from year to year, through continued persistence, conditions gradually improved, thus the hazard from boiler and fire box failures and appurtenances, injury to employes, was greatly lessened.

The enactment of our present boiler laws, with their demand for a higher standard of boiler maintenance, improvements in design, and use of better materials, further improved the general situation.

Then came the development of chemical compounds for boiler water treatment; the greatest single aid of the age, in my opinion, for boiler and fire box protection, and steam locomotive performance.

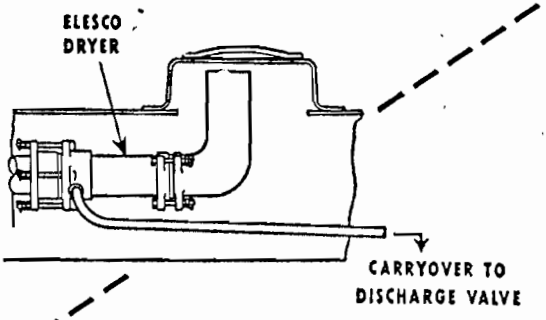
The inauguration of air tools, together with improvements in other boiler tools, and machinery, have also played their part in improving the boilermaker's profession, and increased his efficiency.

The process of welding by use of the electrode, the idea of burning and cutting by use of the acetylene torch have further made yours a craft of genius. Therefore, down through the years, by "bull dog" tenacity, and determination on the part of you boiler men, and those of your craft gone on before you, you have by your fighting spirit greatly assisted in the development of the modern locomotive of today, with its more than a million pounds in weight, and a boiler and firebox of the last word in material, and construction, and a piece of motive power par in excellence, surpassing by far any locomotive of any other nation in the world.

Master Boilermakers, your organization, and the Association of American Railroads, has every right to be proud of you, and am sure that the individual railroads that you represent, admire you for your accomplishments.

The first Mallet locomotive ever built, and to which I have referred in my remarks, was built for the Baltimore and Ohio by the American Locomotive Company at Schenectady Works in 1904, and the shop number was 2400.

This locomotive was an 0-6-6-0 articulated compound with 2 - 20 x 32 HP and 2 - 32 x 32 LP cylinders and carried 235 lbs. steam pressure with 72 square feet of grate area and 220 square feet of fire box heating surface, with 71,500 lbs. tractive effort and weighed 334,500 lbs. Quite a locomotive for 45 years ago, don't you think.



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The designing and engineering of this locomotive was largely taken care of by Baltimore and Ohio personnel, and was quite a pioneering feat for that day when consideration is given to boiler design, dimensions and general construction, as against the largest of other types of locomotives in existence at that time.

This, gentlemen, was the origin of the Mallet locomotive, of which so many of you are familiar today, and it was my thought these details might be of interest to you in mentioning.

Vice President E. H. Gilley (Gen. Boiler Foreman, Grand Trunk R.R., Battle Creek, Mich.): Mr. Burkley, it is indeed an honor and a pleasure to me to be able to respond to your very fine address. The fact that you are Superintendent of Motive Power on the region on which I served my apprenticeship makes it doubly so. Your talk was very inspiring and instructive to us and I am sure that each one of us present will be greatly benefited by your remarks. On behalf of the officers and members of the Master Boiler Makers' Association, I wish to extend to you our thanks and appreciation for your coming here and addressing us today, and it is our hope that you will attend future meetings of this Association.

Thank you. (Applause)

President Heidel: We will now have a report on Topic No. 2—"Recommended Practices for Staybolt Application and Maintenance." This covers (a) Staybolt threading standard, staybolt threads, tapped holes, thread gauges, taps, dies and chasers, (b) Application, (c) Seal Welding of Staybolts, and (d) Maintenance. Dr. G. R. Greenslade is Chairman; Mr. S. E. Christopherson is Vice-Chairman.

This is the third of the papers on this topic. The information that has been gathered together is of much value. We hope that we are setting a standard of staybolt threading taps and dies. Dr. Greenslade.

Dr. Greenslade (remarks in preface to reading of the prepared report): Mr. President, Members of the Master Boiler Makers' Association, and Friends: In starting out I am going to discuss briefly the unified thread. This subject has been introduced as a sort of preface to the final report concerning staybolt threading standards—a subject that has been under discussion at the two annual meetings prior to this. It is not proposed that the remarks concerning the unified thread are to form a part of the threading standards which follow. They are included as a matter of record inasmuch as the unified thread design may, at some time in the future, modify our boiler shop practice.

During the last world war, when machinery, guns, and all types of mobile equipment were supplied to the Allied armies by the United States, Britain and Canada, a great deal of trouble was experienced due to the fact that at one location they might have American guns, tanks, and trucks, while the bolts and other threaded parts available were of British manufacture with Whitworth threads. Many times they were slowed down considerably because these threaded parts were not interchangeable. For this reason the governments of Britain, Canada, and the United States have gotten together and have signed an agreement, or accord, proposing and describing a unified thread.

I will read parts of the paper only, as our time is short.

. . . Dr. Greenslade read the first portion of the paper entitled, "The Unified British-Canadian-American Screw Threads" . . .