Topic No. 6

PROCEDURE FOR THE WELDING OF STAYBOLTS

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To the Officers and Members of the Master Boiler Makers' Association:

As I have been appointed Chairman of this most important topic, this report comprehensively embodies the whole of the committee's ideas and thoughts upon the subject.

Seal welding of staybolt heads to firebox plates has been advocated and discussed at our meetings for the past 10 to 12 years and received authority in 1946 from Chief Inspector Hall of the ICC permitting us to seal welded staybolts for test purposes.

We have all taken advantage of this permission granted and am sure that you will all agree that the results obtained by seal welding staybolts has advanced far beyond the test stage and should, without any question of doubt, be adopted as standard practice for welding of all staybolts on new work.

With the advent of high pressure boilers, it was necessary to develop a new method of prolonging the firebox sheets to prevent excessive leakage and cracking and to compete with new motive power, keep locomotives on the road and eliminate excessive firebox repairs. The following reports of service obtained by seal welding of staybolts has proven that with proper precautions taken in applying and preparing bolts and plates with fully qualified mechanics furnished with good welding machines and proper welding material, the finished job will be satisfactory.

Opinions vary as to methods of applying, preparing and seal welding bolts which have all proven more or less satisfactory on the various roads.

Following is the procedure recommended in applying seal welded staybolts:

1. Clean off sheets by sand blasting or grinding before staybolt holes are tapped.
2. Tap out staybolt holes from outside of firebox.
3. Screw in staybolts from outside making sure they are snug fit.
4. Remove all oil from firebox sheets, staybolt holes and ends of bolts.
5. Cut off bolts to driving lengths at outer ends.

6. The following methods of preparing firebox end and welding meets the requirements insofar as safety is concerned and the life of firebox plates has been doubled and leakage reduced to minimum.

1. Staybolts that are seal welded are applied in the usual manner, heads driven on the outer ends and held on with a heavy dolly bar approximately 60 lbs. weight; then driven on the inside using a flat die in air hammer not working edge of head down to sheet, then a cutter used in air motor chamfers head 30° to junction of threads in sheet at same time removing mill scale and any foreign matter adjacent to staybolt end and clean bright metal is obtained 3/8 around outer end to be welded. Welding started at bottom center and continuing all way around without breaking the arc.

2. Chamfer the end of the bolt to a 60° angle before it is applied to the side sheet, then screw the bolt in with a snug fit so that the chamfered end projects 3/32 of an inch inside of the sheet; the welding of each bolt is made in two passes, the first pass starting past center top and down one side of the bolt past the bottom center; the 2nd pass in on the other side of the bolt and overlaps the other half of weld.

3. Apply bolt in usual manner; drive bolt on outer end with tit snap-holding on with 60 to 80# dolly bar; then drive inner end of bolt with tit snap; properly clean sheets and weld starting past center top and down one side of bolt past bottom center; the 2nd pass on the other side of bolt overlaps other half of weld.

7. Seal weld staybolts using 1/8 electro rods of the AWS classifications E-6010 or E-6012.

The above methods stated have practically eliminated the staybolt leakage on locomotives having seal welded bolts and have adopted the methods as standard practice on all large power having the sheets renewed.

Numerous combinations of firebox sheets and bolts have been applied for test and while the life of side sheets has been doubled in all cases, the additional service obtained by the different application would be a matter for each individual railroad to decide for themselves.

In addition to the above listed report that had been prepared by your committee, we had at later date received from one of the committee members, Mr. C. E. Tolen, Welding Instructor, Cle, Cin, Ch & St. Louis R.R. (BIG FOUR) the following on their practice with the welding of taper crown bolts, that has given very satisfactory results, and with the approval of President Mr. E. H. Gilley, we present it in addition to the committee paper.

Referring to Mr. A. F. Stiglmeier's letter of April 22nd relative to my being a member of your committee on Topic No. 6, "Procedure for the Welding of Staybolts":

We on the Cle, Cin, Chi & St. Louis Railway have not seal-welded any staybolts or water space stays up to the present time. Most of our experiences has been confined to taper bolts on our S-1, or Niagara, class locomotives carrying 275 lbs. steam pressure. We have in service twenty-three (23) of the S-1 type locomotives with 522 crown bolts on each locomotive that have been welded, and these are giving satisfactory service.

Here following I will endeavor to outline our procedure in performing this work:

The crown bolt holes are tapped and the bolts threaded and applied and

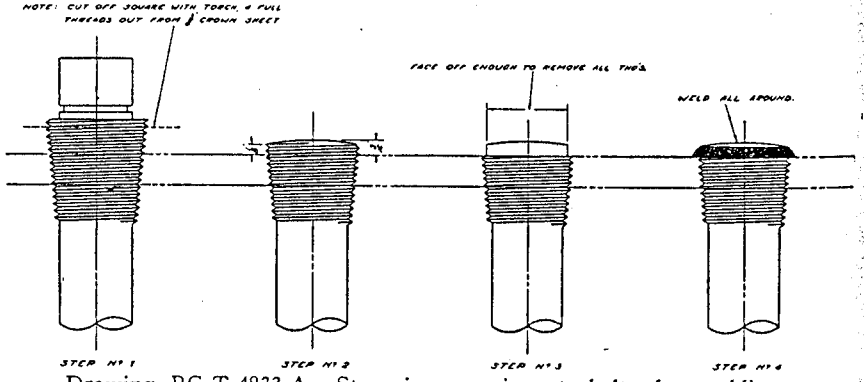
cut to length for driving on the wrapper sheet end: the crown sheet end is held on and the bolt driven.

After the crown bolts are driven and all other boiler work completed, the boiler is then filled with water and subjected to a hydrostatic pressure of 300 lbs. All crown bolts leaking on firebox end are replaced. Following the hydrostatic pressure of 300 lbs., the oil and other foreign substances which may have entered the boiler in course of repairs are boiled out as follows:

1. Remove dome cap.
2. Fill boiler with warm water to two (2) gauges.
3. Apply 200 lbs. of an approved chemical cleaning agent through dome cap opening.
4. Apply steam line to front corner mud ring washout plug hole and allow water in boiler to boil four (4)) hours.
5. After boiling for the prescribed time, apply warm water line to blow-off cock and allow water to overflow through dome opening for three (3) hours.
6. Drain boiler, remove plugs, and wash boiler.

For these particular locomotives we have found it advantageous to use an 800 gallon capacity mixing tank which is equipped with an electric-driven agitator. The approved chemical cleaning agent is dumped into the 800-gallon tank and thoroughly mixed by means of the agitator. The tank is then moved to the locomotive by an overhead crane, and by means of a large opening globe valve the solution is drained directly into the boiler dome opening.

Step No. 1—With water in the boiler, the firebox end of crown bolt is cut to length, leaving four (4) full threads projecting through sheet," by the use of an oxy-acetylene cutting blow torch." See Drawing BG-T-4833-A.

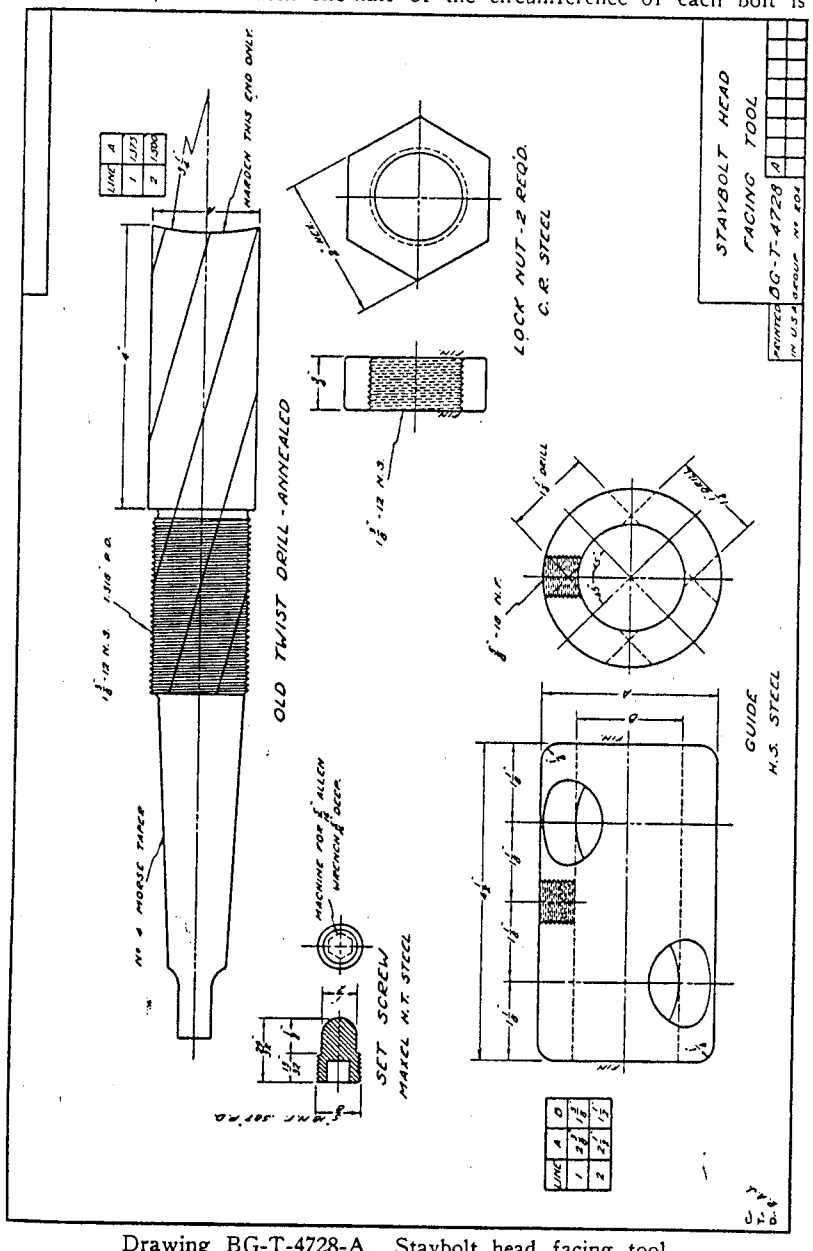


Drawing BG-T-4833-A. Steps in preparing staybolts for welding

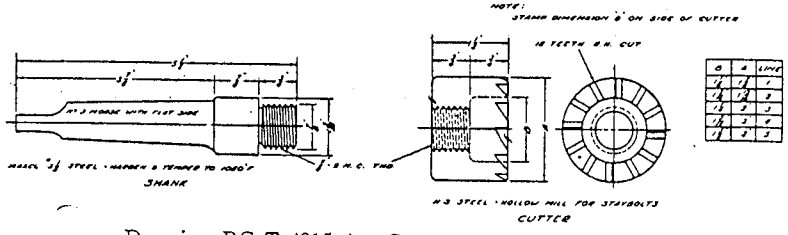
Step No. 2—The crown bolts are then faced off, using facing tool. Drawing BG-T-4728-A.

Step No. 3—Remove threads from bolts projecting through fire side of crown sheet preparatory for welding, using special tool Drawing BG-T-4815-A.

Step No. 4—After the crown bolts are prepared for welding, the entire area of crown sheet where crown bolts are to be welded is dry sand-blasted, after which one-half of the circumference of each bolt is



Drawing BG-T-4728-A. Staybolt head facing tool



Drawing BG-T-4815-A. Staybolt head facing tool

welded. All crown bolts are again sandblasted to remove the flux, after which the unwelded part of crown bolts is welded. After the welding of all crown bolts is completed, thoroughly clean by sandblasting for final inspection. (Material used for the welding of crown bolts is AWS-6012-$\frac{5}{32}$" diameter electrodes, or equivalent.)

The boiler is then tested 25% above working pressure and all welds inspected under pressure.

All operations and workmanship throughout the entire procedure are subjected to rigid inspection by supervisors.

We are enclosing the above mentioned illustrations.

I trust that the above information will be of some benefit to the membership and their railroads, and I hope to have the pleasure of again serving as a committee member.

President Gilley: Gentlemen, you have heard the reading of this topic. What is your pleasure with the same?

Mr. Desmond: I move that the report be accepted as read and opened for discussion.

. . . The motion was seconded by Mr. Johnson, Florida East Coast Ry., and upon vote was declared carried . . .

President Gilley: This welding of staybolts has always been a very live subject so let's get going on it, fire a lot of questions. There is a lot of you here that have welded bolts, there is a lot that haven't. We would like to hear from both sides on what is being done, how it is being done, and the results.

GENERAL DISCUSSION ON TOPIC No. 6

Mr. Seeley: We will open the topic for discussion and we will try to answer any questions. I hope all the Committee members are here.

Mr. Heidel: Mr. Chairman, with a broken taper radial what is the method of renewing the bolt? This is speaking of a welded staybolt.

Secretary Stiglmeier: For certain reasons, Mr. Tolen could not attend this meeting today, however, in his absence I shall be glad to substitute for him in answering that question. The bolt is applied, cut off on the outside only, the square on the bolt is not cut off, it is then held on and driven on the outside, after which the boiler is given a water test of its service pressure. If the bolt should leak, the head on the outside is removed, bolt

backed out, this being the reason that square on the inside is not removed until after boiler had been tested.

Does that answer your question?

Mr. Heidel: Another question then. With a broken welded taper bolt how do you go about renewing the bolt? Do you reweld, or do you put in a taper bolt and hammer up without welding?

Secretary Stiglmeier: Our instructions are that rewelding taper bolts is prohibited on our Railroad, we do not reweld a bolt; if the bolt should develop a leak after it is in service, that bolt has got to be removed. We do not allow any taper bolt to be rewelded. These are our instructions.

Mr. Desmond: Mr. Chairman, I want to talk a little bit on this welding of staybolts. I have been in this organization for a good many years, I have been hearing these fellows talk about leaky staybolts, and then the question has come up of welded staybolts. Some of them get up and say they don't have any leaky staybolts. I have not seen those engines that don't have leaky staybolts and I want to go on record as saying that I think the welded staybolt is one of the greatest things that ever came into this organization. I have had engines come into my shop with a complete set of welded staybolts and I have noticed them in the last few years and they are as pretty as any fireboxes I ever saw in my life. I have seen other engines out of the shop for three months and they were a disgrace to be on the Railroad. That isn't only one Railroad, I have seen it on a whole lot of Railroads in the 49 years that I have been on the Railroad. Those fellows who don't have leaky staybolts have the best water conditions, best water treatment they possibly could have, because I know when we sunk wells at the Washington Terminal that we were renewing fireboxes every six or seven years until we went to the water treatment and then we got a good long service out of our fireboxes. But I think that this is a wideopen subject and that everybody needs to hear some discussion on it.

I thank you.

Mr. Christopherson: Mr. Chairman, I would like to clarify to the Master Boilermakers that before the first staybolt was seal welded, the Interstate Commerce Commission gave us a ruling and this is what we have to remember. The staybolt or crown bolt you put in and sealweld and that weld for any reason fail, you cannot reweld that bolt either in a shop or at an enginehouse. The staybolt or crown bolt must be removed and a new bolt be applied and welded.

Mr. Johnson (Missouri Pacific R.R.): I am a member of this Committee on the seal welding of staybolts. We welded two engines, 285-lb. pressure, that have run about 200,000 miles. I would say that out of 1,000 of those bolts there were about 200 of them that hair-cracked at the front and back end of the bolt. They hair-cracked I would say possibly two months after they were applied; however, these bolts never leaked a drop, there has never been a bolt renewed, and one thing it did eliminate if it did not do anything else, it eliminated the curling of staybolt heads and cinder cutting due to a little overhanging on the weld.

If there is anybody in here that has had trouble with staybolts or sheets cracking I would like to hear from them. Personally, I think the seal welding of staybolts means the same thing as the seal welding of flues. If you do a good tight job you will have a good seal welding staybolt and it won't leak.

Mr. Service: We have on the Santa Fe one locomotive that I spoke of last year when I was here that has an application of 1" mild steel staybolts

applied to the side sheets. It was an expensive operation because we had to secure oversize material to make the 1" size from; nevertheless, we did apply the L-210 mild steel staybolts. These staybolts were applied, the firebox was turned over on the side and the welding was all done in a downward manner, using E-6013 ⅛" diameter electrodes for single bead work. I looked at locomotive in the last thirty days and there hasn't been a man in that firebox to touch one of those staybolts. That of course is the best one.

We do have some locomotives that have the iron staybolts. I am referring now to the old design of piled iron when it is manufactured. They were applied into the firebox and these are welded in a vertical manner, welded from the top down. Some of these staybolts hairchecked as referred to by the gentleman from the Missouri Pacific; we also have had some slight cracking at center of seal welds and on outer edges of welds where there is no undercutting around the bead. We checked into the cracking of plate on firebox and found that it goes in approximately 1/64" to 1/16" deep, and we find them mostly at the second annual hydro test by close inspection. This defective plate of course has got to come out. We do not reweld any staybolts that have seal welds broken, they must come out and new bolts applied.

Now I would like to know what material is being used for stay bolts to give the best results on this seal welding because this laminated piled iron that I am talking about when you weld that staybolt it opens up the laminations or pilings in the bolt material. We found this at first hydrostatic tests where the seepage would come from head of staybolts and not the seal weld, but through the laminations. However, you don't get that with a steel bolt. That is evidenced by the test that we made. So if you are using iron of a certain type, like Byers iron, manufactured from a puddling process, there is less possibility of this condition causing this trouble. I would like to know which has given other members the best results.

Mr. Seeley: First we used iron, and then we went to steel and we are getting results from steel bolts. With iron bolts you will develop that check in the bolt where your weld will seep through.

Mr. Service: Could I ask what kind of steel you are using?

Mr. Seeley: Moly sheets.

Mr. Johnson: We use a nickel steel on the Missouri Pacific.

Mr. Service: I have had experience with the Moly bolt in the last six months. I got 67,000 miles out of the side sheet and had to take all the patch out and the bolts, too. I had iron bolts on the other side and got 260,000 miles with the same method of welding with the exception of the electrode.

Mr. Christopherson: Mr. Chairman, during the test of about 20 steam locomotive boilers, we used "Iron," "Molybdenum," Steel, "Nickel Copper." In the iron staybolt we found that after being upset with the standard Liverpool die and the head formed, numeral cracks showed up at the edge of bolts. After being seal welded cracks would open causing leaky bolts, in fact, on several occasions, crack would extend into side sheet plate. To overcome this, we made up a die, which had the same diameter as the bolts used and the cup depth of 1/16". In using this type of die on iron staybolt we found that no cracks would develop in the formed head. And no further trouble was experienced when staybolts were sealwelded. We had good success with the "Moly" steel and the Nickel Copper staybolts were excellent on one locomotive and failed on two.

Secretary Stiglmeier: Gentlemen, there must be many men here that have applied seal welded staybolts for the reason that there was an article pub-

lished in the *Railway Mechanical Engineer* with regard to the AAR minutes of their last meetings It reads something like this:

> *Seal welding of staybolts.* Early this year the Committee on Locomotive Construction of the AAR Mechanical Division surveyed Railroads on their practices of seal welding staybolts. As a result of data obtained from 90 roads it has concluded that the practice has been sufficiently extended to warrant consideration of a recommended practice.
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> Of the 90 roads that reported, 28 equipped locomotives with seal welded staybolts, 5 reported 50% increase in the life of firebox sheets, 4 reported 100% increase, and 1 an increase of from 300 to 400%. Among those 28 roads, 1306 locomotives have seal welded staybolts 17 roads seal weld all staybolts except crown bolts, 7 seal weld the side sheets only, 3 seal weld all staybolts, and 1 seal welds the taper crown bolts only.

From this one must assume that there must be gentlemen here that have had experience in seal welding staybolts and I believe we should hear what they have to say so the members here will benefit from their experience.

Mr. Milligan: Mr. Chairman, we started to seal weld staybolts in 1944, but discontinued the practice a little over a year ago because hair cracks had developed around the edge of the seal weld in the side sheets of one engine. However, we have one locomotive 275 lbs. boiler pressure with seal welded staybolts in one side sheet and staybolts hammered up in the conventional manner in the opposite side sheet. Since this application, this locomotive has accumulated about 600,000 miles and we have no trouble or leaks developing in either side sheet. It is operating in a district where we had considerable side sheet trouble at one time. Seal welding of staybolts alone is not the answer to your side sheet troubles, nor is it a cure-all. You must maintain proper boiler feed water treatment. The cooling down of your boiler for washout or for any other reason must be done in a proper manner, allowing sufficient time for all boiler plates to cool down to equal temperatures, close to the temperature of your washout water, and the same consideration given when lighting up.

Secretary Stiglmeier: Gentlemen, in this report they made mention of tapping staybolts and driving on the outside. Is there anybody here that can give us information with regard to seal welding flexible staybolts? What is the process in seal welding flexible staybolts?

Mr. Seeley: On our Road the seal welding of flexible staybolts is done in the regular manner. They are cut off, driven in a tit shape, the sheet ground and sand blasted before it is applied; then before the welding is started we use a whiting with alcohol, paint the sheet and seal weld it after the bolts are driven.

Mr. Service: Did I understand you to say that you do the cleaning off of the fire surface of the sheet with whiting and alcohol?

Mr. Seeley: We use alcohol and whiting for what oil is left on the bolt and around the surface after the driving is done.

Mr. Service: That is to eliminate any grease?

Mr. Seeley: That's right.

Mr. Service: I am glad to know that. I have been trying to find a compound that will do an efficient job because that is one of the things that the

welders complain about. There is no question that if there is oil involved they do have trouble.

In regard to seal welding of the bolt, we are using a center punch in the center of the rigid solid bolt and spreading the surface metal of head of staybolt to compensate for the contraction of the seal weld and trying to overcome this hair cracking that is referred to. Time of course will tell us what results we will get from that. I am in hopes that it will do some good.

President Gilley: There are a lot of questions to be asked, there is a lot of good information here in the room. All of you get into the discussion, those that are not welding and those that are welding. Let us thrash out the troubles that are being had.

Mr. Johnson: Is Mr. Vogel of the Rock Island here?

Mr. Christopherson: I would like to ask Mr. Godwin if he found a better electrode. I think last year you were on that committee and you had done research on a better electrode.

Mr. Godwin: No, we have not completed that test yet, Mr. Christopherson.

V. B. Vogel (Chicago, Rock Island & Pacific Railroad): We have been going strong for diesel power, and the welding of staybolts on the Rock Island is at a minimum at present, but all of our seal welding has been done under the procedure that I outlined to Mr. Seeley.

We have extended this procedure to various combinations. This includes Nickle Clad sheets and Monel Metal staybolts. Otis sheets and steel bolts. Nickle Clad sheets, iron on one side, steel bolts on the other. Mayara steel side sheets and steel bolts this on our 4-8-4 locomotives, and 4-8-2.

Our experience has been entirely satisfactory, some better than others. Best results obtained were from Nickle Clad sheets, and Monel metal staybolts welded with Monel metal electrodes. Welded in 3-3-45 and still in good condition.

Our procedure is to weld the staybolts with water out of boiler. We make no particular preparation other than to get sheet clean and free of oil. We have used an oil solvent for this purpose. Now we use a tool to champhor the end and remove threads, and cleans sheet 3/16" around the bolt. Oakite No. 33 cut 1 to 8 of water is good for removing oil.

While good results have been obtained using E-6010 electrodes, E-7010 electrodes gives a more uniform deposit, and better results are obtained.

A lot depends on the procedure of applying and getting a proper fit to the staybolts to be seal welded, and when welded you will experience no difficulties.

As far as the procedure is concerned it is not so difficult, just good workmanship. With the proper fit the man doing the welding is responsible for the seal welding. Experienced welding operators are selected for this welding, and if bolts are properly fit there will be no difficulty experienced in obtaining tight seal welded staybolts.

Mr. Barrett: Mr. Chairman, we have had but little experience in the welding of staybolts and side sheets and so far we are not altogether sold on the idea, but there is one part of the report on which I would like to just raise a little criticism and that is the method of driving. I don't care whether it is iron bolts or steel bolts, if you hold with a 60-lb. dolly and drive on the outside there is a tendency for the helpers on the dolly to get tired and you drive your bolt like a drum on an open plate.

We drive our staybolts with the double-gun method, both for conventional application, and also, for those to be seal welded. When driving seal welded staybolts we hold on with a tit, straight staybolt set, and then on the outside with a double gun so that both sides of the bolt are driven simultaneously. If you do that you are holding on the bolt all the time, you are driving on the bolt and not on the sheet. I think if you will follow that method you will find it is not only more economical but also that you will get a far better result and less danger of forming these hair checks which was mentioned.

There is just one other aspect of this subject if we have time. Some years ago in a paper of a similar nature in connection with staybolts we made a test as to the value of button heads, taper bolts and ordinary staybolts, and we found the pulling test of the taper bolt was almost the same as the ordinary straight bolt. We found that, of course, on crown sheets. At that time when we were discussing the value of button heads a lot of objection was taken to the application of button heads as they increased the holding strength of the crown sheet so that in the event of low water the crown would resist to the point when you would have a terrific explosion. That was the objection to the button heads. Now you are going to the seal welding of your taper bolts, you are going to increase the holding strength of your crown sheet, and when you get low water you are going to have the resultant terrific explosion.

We have been the advocates and are using on our Railroad the strong and weak zone method. We have four rows of button heads and four rows of straight parallel bolts, and we have not had a case yet of low water but where the engineers have stepped off the cab. The only bad explosion was on an engine that was loaned from another Railroad in which all the crown bolts were taper bolts. So I think we have to be careful when we start now advocating the welding of taper bolts. If you are going to continue your taper bolts I would say weld a section and leave a straight section, that is, four rows of welded crown bolts, four rows of not welded, so that you set up a weak and strong zone and in event of a low water condition you will find that the weak zone will give out, put the fire out, while the strong zone will hold the crown sheet and prevent a major explosion.

Thank you. (Applause)

Secretary Stiglmeier: I believe we have Mr. Milligan in the room. I don't know if he would care to get up and give his Railroad's method on these taper crown bolts. I believe in the Canadian territory they put in button head crown bolts, seal weld them without any thread. I would like to hear Mr. Milligan say something on that.

Mr. Milligan: Yes, we have applied button head crown bolts and button head staybolts without threads in the fire box end, seal welding the button head. On one locomotive, 275 lbs. of boiler pressure, we applied 42 button head staybolts without thread in the side sheet below the arch tubes in the centre of the sheet. On this class of power we were troubled with cracks developing from the staybolt holes in this section. The application was made in February 1948 and since then, the locomotive has accumulated about 180,000 miles. We have not had any trouble with them nor have any leaks developed. I expected there might be some burning of the button head, but they are just the same as the day they were applied. We have applied button head crown bolts without threads in the crown sheet, seal welding the button head in what we call the Safety Zone of two locomotives, 190 lbs. boiler pressure. There are two safety zones in each crown sheet containing 32 button head bolts. The application was made in August 1949 and has accu-

mulated approximately 160,000 miles, and one in May 1950, and so far we have had no trouble with these and no leaks have developed.

On all our other locomotives the crown sheet is stayed in the same manner as Mr. Barrett told you; that is, we have a section of parallel bolts and then a section of button head bolts. The button head bolts are applied in this manner, 6 or 4 bolts in the transverse row right and left of the center line, depending on the length of the crown sheet, and 4 rows in the longitudinal row, making a bank of 48 or 32 bolts, with 4 rows of parallel bolts between each bank. This method of staying a crown sheet is a success and has proven its worth to us, as I regret to say we have had a couple of crown sheets drop due to low water and there was no violent explosion, just the pulling of a section of the crown sheet from some of the parallel bolts, and the button head bolts have held.

We found out by various tests that we made on button head bolts that by leaving the square on, we increased the strength of the bolt considerably. I am sorry I haven't got the figures here but it was quite a bit. It is now our standard practice to leave the squares on after button head bolts are applied.

Secretary Stiglmeier: Gentlemen, that is something for you to think about. That brings me back to some four years ago. A machinist entered the contest of the Lincoln Electric Company on procedures of welding staybolts and for this contest he submitted a paper on seal welding staybolts without threading the bolts, and that fellow was a better man than the Master Boiler Makers because he won first prize for his paper.

Mr. Heidel: Mr. Chairman, the Miller-Grant staybolt with the all-welded head in the firebox has been brought up and discussed at this meeting many times. Mr. Edlund has inspected this engine recently and can give us some interesting information as to the condition of these bolts.

Mr. Edlund (Chi., Mil., St. Paul & Pacific R.R.): The bolt application that Mr. Heidel has reference to has been inspected on a number of occasions. This bolt to begin with is a little bit different in its design and application than the one under discussion at the present time. This staybolt is applied from the fire side. Its head resembles that of a patch bolt with a slot through the center which permits it being run into the outer casing sheet. The head of the bolt is contoured and when run into its final setting the edge of the bolt head around its circumference is about 3/32" below the surface of the sheet. The bolt is threaded for the outer casing sheet but employs no threads for the firebox sheet. This end of the bolt as was indicated is similar to a patch bolt head with a seat having a bevel of approximately 45°. We have had a number of welded staybolt applications on our railroad and this is the first time to my knowledge that we have had the welded application of staybolts to a 285 lb. pressure boiler that had been in service for 11 months accumulating between 90,000 and 100,000 miles in heavy freight service that have given no trouble by leakage.

Now this was not a complete firebox application of welded bolts. For test purpose a patch was applied to the center of left side sheet in the hottest zone which involved the application of about 70 welded bolts. This was compared with a new application of a like number of threaded and driven bolts in the center of right side sheet. During the several inspections made of these bolt applications in the 11 months that they have been in service it has been found that the threaded and driven head bolts surrounding the patch containing the welded bolts have given considerable trouble by leakage, and have had to be hammered or bobbed up repeatedly. This was also true of the bolts applied to the center of right side sheet which were of the conventional threaded and riveted head type whereas the welded bolts have shown no evidence of leakage. The apparent reason for the success of this

type of welded bolt to date appears to be due to it having no threads at firebox end, and its greater holding power due to a head diameter of approximately 1-5/16" which also gives a greater number of lineal inches of seal welding.

As was stated earlier, we have made many side sheet applications of partially threaded and welded staybolts to boilers carrying 300 lbs. of steam pressure and we have not found any of these applications to stand up very well. All of these applications were made with the approval of the Bureau of Locomotive Inspection, I.C.C., and the applications were observed by their representatives, only bolts of proper tightness were permitted to remain in sheets, particular care was taken to see that all oil and dirt was removed from bolts and sheet surface prior to welding and only qualified welders were entrusted with the welding. These staybolt applications under the most exacting care that we were able to give in their application, after a period of from 2 to 3 months would give appreciable trouble by leaking and be in need of some form of repair.

I don't know fully what Mr. Heidel's opinions are in this respect but personally in our several applications of welded bolts to 300 lb. pressure boilers which were of the partially threaded and welded type it cannot be said that they have been successful. The Miller and Grant type of bolt applied for test purpose with the approval of the Bureau of Locomotive Inspection which has no thread at the firebox end but secured by a tapered bit and welding appears after 11 months service in a 285 lb. pressure boiler as far as we know today to be the answer to the welded bolt problem.

President Gilley: Is there anyone else who has a question? If not, we will close this topic and we will have a recess of 15 minutes. The Locomotive Maintenance Officers' Association are joining us at eleven o'clock.

. . . Recess for 15 minutes . . .

President Gilley: Please come to order again.

Gentlemen, we have with us this morning one of our new Advisory Board members, Mr. Hill, General Superintendent of Motive Power & Rolling Equipment of the Reading Company, Reading, Penna. I would like to have Mr. Hill get up and take a bow and to come up and say a few words. (Applause)

Mr. H. Hill: Mr. President and Gentlemen: It is certainly a pleasure to be here this morning. This is my first trip to Chicago on any of these meetings. I told our Vice-President before I left Philadelphia that with the big programs that are being carried on here in Chicago I don't know how it is possible for any one person to try to get around and visit all and get all the knowledge that is given out at these various meetings. It is certainly a pleasure to be here with you gentlemen this morning on my first visit.

Thank you. (Applause)

President Gilley: Gentlemen, we will now have the report on Topic No. 1, "Treating of Feed Water for Locomotive Steam Heat Boilers." Mr. T. W. Hislop, Chairman, New York Central System.

. . . Chairman Hislop read the Report on Topic No. 1, page 9, Official Program . . .