



its relative position to the firebox crown plate. We are very careful in enforcing a rule that these plugs shall be screwed into the plate to the prescribed dimension. In the case of stationary vertical boilers, steam crane boilers, etc., in use on the L.B. and S.C. Railway, the same type of plug is used, the only difference being that in these cases the plug is inverted, is countersunk on the square end, and filled with lead throughout its depth.

Some very extraordinary things happen at times with the use and abuse of the fusible lead plug. One case that came before my notice will suffice for an illustration. Not very long ago, a certain locomotive type boiler belonging and attached to a steam road roller, and carrying 125lbs. of steam, was discovered to have its fusible plug filled up with a screw bolt in the place of the lead. This might have been done by the driver of the roller as an expedient in a case of emergency, but he failed to report the matter, and, of course, all sorts of conjectures naturally arose from the occurrence.

I had an occasion recently to examine another steam road roller, whose boiler had failed on the road through the fusing of the lead plug owing to shortage of water; but although in this case no damage was done to the firebox, who shall say what might not have happened if there had been no plug in the firebox crown? In this particular case, upon investigation, the feed pump and injector were found out of order, neither working properly, but the one redeeming feature about the whole thing was the indisputable immediate functional response of the fusible plug.

I am alluding specially to this case, because a communication which recently appeared in one of the Institute's Journals says that fusible plugs (in the opinion of the writer) might well be omitted in locomotive engine boilers, although for stationary boilers the Insurance Companies insist on their use.

Fusible plugs in the firebox crowns of locomotive engine boilers drop their lead generally owing to the baring of the crown by water shortage. This may be due sometimes to a false water level in the gauge glasses, to defective feed apparatus, or to running short of water before a journey has been completed. A sudden stoppage, and the consequent wash of water off the crown, will also bring about a failure in this way. There are, however, at times, some unaccountable causes that bring about the fusing of the plugs. Fortunately such occurrences are rare, and when they do happen, a searching investigation is at once made by the authorities.

Fireboxes fitted with a back plug in addition to a front one give more trouble with failures than a firebox fitted with a front plug only; a sudden stoppage of the engine, and the wash of the water off the back end of the crown will cause the back plug to fuse.

With all the apparent disadvantages, however, that are experienced with the use of fusible plugs from time to time, principally in causing engine failures, and sometimes serious delays to trains, their value as a safety device for the boiler remains unchallenged, and for anyone to maintain that no plug is necessary at all for locomotive engine boilers, well!—such an assertion will, I feel sure, be met by pronounced disapproval by the great majority of Locomotive Engineers in this country.

Fusible plugs, as I have stated in previous discussions at these meetings, will not prevent some damage being done to the firebox when they fuse, but their fusing by shortage of water will certainly have the immediate and desirable effect of putting the engine “hors de service” for the time being.

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Being requested to explain why the lead was not carried to the bottom of the plug, Mr. Mannering continued:—

The idea is that when the lead is originally filled to the full depth of the plug, the very first journey that an engine makes with a new plug the lead begins to run out immediately; when it once starts, one never knows when it is going to stop; the effect of the lead starting to run out may be that it will continue to creep up, and so cause failure.

The greatest trouble with fusible plugs is, as I suggested just now, unaccountable failures. They are generally put down to mismanagement of the driver in being short of water, but it is not always that. I know a case happened only a week ago, and there was an inspector riding on the footplate at the time who testified that there was plenty of water in the glass, yet both the plugs went off; a searching inquiry is being made into the whole thing. Whether failure is due to pulverisation of the lead set up by electrolysis, I am not prepared to say, but it seems to me there is something in it, and yet I cannot altogether understand it, because the plugs are in such a short time—they are taken out every two months—and in some cases we never put back the same plug, but always put in a new plug, one that has been refilled.

The samples before you are not special plugs; they were

simply picked out from a batch in the shop, and cut in two, and I think you will agree they are a first-class job, to judge by the appearance, at any rate.

### DISCUSSION.

**Mr. Turner:** I think that tapered fusible plugs are wrong—they should be parallel. You will notice on the blue print that Mr. Mannering has passed round that it states “This dimension is not to be exceeded,” referring, I believe, to the dimension from the inside of the crown plate to the lower limit of the plug. This does not seem to be consistent with having a tapered plug, because the tendency in all tapered plugs is to expand the hole, and if the same plug is to be used in the same hole, it will go in a little further each time; the dimension mentioned will then be a variable one.

On the locomotives with which I have to deal, I found when I took them over that the standard fusible plug had a parallel thread, 8 threads per inch. It struck me as very unusual, and I inquired very carefully why it was and found that they had had this trouble with the taper thread; that the plug did not always position in the same place—that is to say, the top of the fuse did not always project by the same amount above the crown of the box. Further, it had been found that a better joint was got by depending upon a face joint than on the fit of a taper thread in the plate. I think that it is as a general thing much better practice to depend on a face joint than on the fit of a taper thread.

We find it desirable also to be very careful in finishing off the top of the fuse. After the fusible metal is put in, it is very carefully smoothed over with fine emery cloth, so that the surface is as smooth as possible. The idea is that the scale will not adhere to a smooth surface so readily as to a rough one.

**Mr. Smith Mannering:** In reply to Mr. Turner's remarks in which he alluded to the direction on the print as to the “figure not being exceeded,” and suggested that in screwing the plug into the hole again it might be screwed a little farther up, that makes no difference at all. The idea of “this figure not to be exceeded” is that the plug shall always stand up well on the waterside of the plate, so that the lead goes before the water gets down to the crown. It does not matter how much it comes inside the figure as long as it is not exceeded the other way. We found that, before these instructions were issued, sometimes the plugs were not screwed in far enough, and the consequence was they

did not project sufficiently on the water side. By this direction a minimum height from the inside of the crown to the top of the plug is ensured, so that if there is any tendency of the plug to go, it will go before the water actually reaches the plate and the crown is damaged.

**Mr. Sanderson:** Mr. Mannering has stated himself that the filling of fusible plugs could not be relied upon to be always a truthful indication of the cause why a plug has blown out; in other words, they give way sometimes and one cannot satisfactorily account for it. I know it is so. I have had it happen, and assured myself that there was nothing the matter with the water at the time. I concluded from investigation that the lead filling which had been used had changed its nature. It would blow out without there being any question of low water at all.

I want to call attention to a form of fusible plug that was in use some years ago. I cannot recall the detail of it now, but many of you would know it. Instead of the fusible metal being poured or hammered into the plug, it was in the form of a little cartridge, or flat plug, and by unscrewing the central portion of the brass plug, one could remove this little wad—like a thick gun wad—of fusible metal, put a fresh one in, and screw up again. In that way one could replenish the metal without having to take the plug itself out of the sheet, without having to take it to the foundry or anywhere else, to have the soft metal put in, because the boiler washers could carry these little wads around in their pockets, and make it their job, each time of washing out the boiler, to screw the centre piece of the plug out, put in a new wad, and screw up again. Thus the metal was always fresh. It seems to me this was a very good device, and got over the difficulty which Mr. Mannering has mentioned, viz., the metal going wrong and the man getting into trouble when there was really nothing the matter.

**Mr. Head:** I can bear out what Mr. Mannering has said with regard to the action of the fire where the plug is not protected by the water. It becomes apparent that it is waste to fill the plug down to the head full of lead. With regard to the composition of the metal, I use nothing else but lead, with very good results. While these plugs (referring to those which Mr. Mannering placed before the meeting) are countersunk at the top, I generally put a cap of lead so that it stands projecting well into the waterway. This acts as a valve on the top, with the pressure from the inside of the boiler, which is sufficient to hold it tight;

although it may leak a little, it keeps the engine going so as to get it to the shed and not get a direct failure. Since I adopted this some years ago, I find we have nothing like the number of failures that we had before.

Another point is the importance of seeing that the plug is well tinned before the metal is put into it. Hammering the lead in does away with the utility of the tinning as it breaks away from the tinning while the metal is cold, and will not adhere again.

The channels in the plugs I use are parallel but screwed.

**Mr. Barnett:** I am very much surprised to see in this plug of Mr. Mannering's such a large hole. I may say that the boiler Insurance Companies, from their point of view, object very strongly to this type. One feature I object to myself is that the sort of thing Mr. Mannering found, a locomotive type boiler with a bolt screwed up into the plug, is possible. We make a practice of having the plugs taken out—certainly not at any regular period, but at least every time the boiler comes in to have anything done to the tubes, etc., perhaps not a longer period than three months. I have introduced a type of plug which we have not previously used on locomotives, although we have done so on the Lancashire boilers. This has a gunmetal pendant inside with a ball at the bottom and a very small hole, not more than three-sixteenths of an inch diameter at the top. The pendant does not come down to the bottom of the plug, but is some distance up inside it. When the fusible metal itself round the inner pendant fuses, it allows the gunmetal pendant to drop out in the fire. This means a more expensive plug, but one objection to a big hole is that such a large volume of steam and water blowing into the firebox is a danger to the attendants.

As to the question of alloy, it would be interesting to know what is used in this plug of Mr. Mannering's. With regard to the unfilled portion of the hole in the plug, if the plugs are left in for any length of time they appear to get this part of the hole filled up with hard flinty matter, and it seems to be almost impossible for the fusible lead itself to melt and run through.

Again, regarding the height of the fusible plug in the drawing, I should like to know if Mr. Mannering can give us any idea as to the amount of water showing in the glass with the plug  $\frac{3}{4}$  in. or  $\frac{5}{8}$  in. above the top of the firebox crown plate. It seems to me rather an important matter to know how much water the driver has on his box after the water in the glass has disappeared.

**Mr. Holcroft:** The usual type of fusible plug has a square head which projects downwards from the crown of the firebox. If the plate were bared of water, the plug would become red hot in a few seconds. Therefore the heat has to be dissipated from it rapidly, and the only means of getting the heat away is by conduction at the point of contact with the plate, and by the water covering the upper end. A small coating of grease, or of scale, will very appreciably increase the temperature, and if the plug were greased before being screwed in, or had scale on it, its temperature would be a good deal higher than that of the plate, and it would take very little more to melt the lead out. Under these circumstances, if the water on the top of the crown were not solid—being as much steam as water—there would not be sufficient means to conduct the heat away, and this may explain why the plug melts when there is really plenty of water in the glass.

**Mr. Smith Mannering:** As regards the diameter of the hole in the plug, I have no remarks to make, except that these plugs have been used to my knowledge for almost 40 years, and I cannot tell for how long before that. I think that sufficiently answers the question.

**Mr. Turner:** There is another point which has not been mentioned—the desirability of turning off the tops of the thread which come above the crown plate on the inside. If they are not turned off they get filled up with scale, and when the plug is taken out there is a tendency to tear the thread out of the copper crown plate.

We had trouble with the fusible plugs being “dropped,” and when it was laid down that two days’ suspension followed the dropping of a plug, the number of cases decreased very materially.

**Mr. Wheeler:** The drivers are not always to blame for all this. I have been a driver myself, and once, when working a very important boat train, I had to shut off steam going into Sandling Junction on a down grade, with a heavy load on, and had to apply the brake fully. The water, I suppose, temporarily left the crown of the box, but there was no actual shortage of water, but evidently something happened. I never thought that the lead plug was going to give out, but went on to Folkestone, then took another trip to Dover, and stood there half an hour, when bang went the lead plug—the back one. They gave me the credit of being short of water, but it was not so. The front plug was taken out afterwards, and when hit with a hammer, it smashed all to

powder! The two lead plugs were new and had only been put in two days previously!

**Mr. Smith Mannering:** I think the number of failures that we get on locomotives is as a rule small compared with the mileage run during the year. I know, in my official position as Chief Boiler Inspector on the Brighton Railway, that if there is a failure I am always called to examine the firebox, to see the extent of the damage, and I do not think I have been called out to a case in the last six months. Whatever trouble we have with lead plugs, it is very small compared with the miles run by the engines.

I presume most of you are aware that collapses occur from time to time in fireboxes. We have not experienced such a thing on the L.B. and S.C. Railway to my knowledge, but I have known some very serious collapses.

This strengthens my argument that a lead plug is really necessary, because in the absence of a plug a driver might be tempted to go on after he has burnt his crown through shortage of water, whereas with an engine which is fitted with a plug, he is done "absolutely" and has to come off his train. The delay caused is a secondary matter. The plug is a safety device, and I think it is a very good one.

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