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Description of a Safety Escape Pipe for Steam Boilers

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DESCRIPTION OF A SAFETY ESCAPE PIPE FOR STEAM BOILERS.

The object of the present paper is to describe an improved mode of applying the ordinary fusible plug to steam boilers, so as to secure the greater certainty of its action, and thus to remove one of the principal causes of boiler explosions, namely that arising from shortness of water. This plan is the invention of Mr. Routledge of Manchester, and it occurred to him that if the fusible plugs were inserted in a small flue or pipe, through which a current of the hottest gases, taken immediately from over the fire, was made to pass, this pipe being at the time at a higher level than the boiler surface over the fire, the fusible plugs would be melted out with greater certainty than in the ordinary arrangement, whilst at the same time the boiler not being overheated would be preserved from risk of injury.

The following is a description of the mode in which this idea has been carried into practice.

Fig. 1, Plate 132, represents a transverse section of an ordinary cylindrical boiler, 7 feet diameter by 14 feet long, set up with the fire underneath and with a wheel draught. An elbow pipe A, in this case 4 inches diameter, is made the means of carrying a portion of the heated gases from the furnace to the side or exit flue; and the upper part B of this pipe is perforated with conical holes $\frac{5}{8}$ inch diameter, as shown enlarged in Fig. 2, which are filled with fusible metal plugs simply driven in. In this arrangement, should the water fall below the upper surface of the pipe, the fusible plugs being constantly exposed to the current of heated gases passing through the pipe are melted, and thus preserve the boiler from injury, by immediately opening a large area for escape of the steam. A small tray or shield C is fixed upon the top of the pipe immediately over the fusible plugs, for the purpose of catching the sediment from the water and preventing the formation of a deposit upon the ends of the plugs.

Fig. 3 shows the application of the plan to a cylindrical boiler with internal fireplace. In this case, the pipe A as in Fig. 1 forms a connection between the furnace and side flue, and the fusible plugs B being exposed to the current of flame passing through the pipe are melted out as soon as the water falls below the proper level, and long before the plates of the main flue can possibly be injured.

The pipe A may be made of wrought or cast iron, brass, or copper, but it is preferred of wrought iron or malleable cast iron. Several experiments have been made by the inventor upon one of his own boilers, similar to that shown in Fig. 1, to test the efficiency of the plan, and very satisfactory results have been obtained. In one case, where the pressure of the steam ranged from 40 to 45 lbs. per square inch, and the water level from 3 to 4 inches above the covering or top of the side flues, the water was blown off, in order to facilitate the experiment, until its level was not more than $\frac{1}{4}$ inch above the top of the pipe A. The furnace was then fired up with the view of evaporating the water as quickly as possible, and reducing it below the proper level. Through a spy-hole made in the brickwork the action of the fire was distinctly observed playing upon the plugs until they melted out. It was subsequently found that three of the plugs had given way, thus relieving the boiler from steam pressure, and gradually putting out the fire, whilst a sufficient quantity of water was retained in the boiler to enable the stoker to recommence firing with but little delay for replacing the plugs.

Mr. Ramsbottom showed a specimen of the escape pipe with fusible plugs fixed in it, and separate specimens of the plugs; also one that had been burnt out. He said he had seen the plan at work in a boiler and thought it a good idea for extending the utility of the ordinary fusible plugs, by greatly increasing their efficiency in area for discharge of steam when melted, and by protecting them from being impeded in action through the accumulation of deposit upon their ends, by means of their position and the small tray placed over them to stop the deposit; the plugs were also placed at a higher level than any other heated portion of the boiler, and being exposed to a through current of the hottest gases were more certain to be melted out before injury was done to the boiler than any other plugs which he had seen.

The Chairman asked what composition was employed for the fusible plugs, and what was the temperature at which they melted.

Mr. Routledge said that the plugs he used were composed of 9 parts of bismuth, 22½ of lead, and 22½ of tin, an alloy which would melt not only from the action of the heat passing through the pipe, providing the pipe was not covered with water, but likewise when the steam attained an undue pressure and consequent high temperature; the plugs being so situated that little or no sediment could possibly settle upon them, as they were high up in the water space, and well protected by the shield or tray to catch the sediment when settling down to the bottom of the boiler.

Mr. R. Roberts thought it was objectionable to place fusible plugs in tubes, as the joint between the plate and tube retarded the conduction of heat from the plate to the plug; he considered they should be placed in a large extended surface. He remembered a case of a boiler explosion occurring at Stockport where it was supposed the boiler could not have been short of water, since the lead plug which was fixed in a brass tube had its centre only melted out; but on examination of the plug in the adjoining flue in the boiler it was found in precisely the same condition as the other plug, although from the appearance of the plates they had been red hot all round the plug.

Mr. Wm. Smith enquired how long the same plugs had continued in use in any case in the new apparatus.

Mr. Routledge replied they had been 9 months in continuous use, and he had seen the plugs melt after being that time in use; they had been found to answer completely, without any case of failure having yet occurred. The plugs were driven into the solid material of the flue or the large pipe leading out of it, so that he thought they could not fail to have the full action of the heat.

Mr. Wm. Smith considered that in the action of fusible safety plugs for boilers it was a question of the conducting power getting interrupted after oxidation of the surface had taken place, and the metal could not then be melted by even a much higher temperature than was enough to melt it ordinarily. He had known a number of experiments that were tried with plugs of tin and lead for the purpose of ascertaining the extent to which this action took place; and it was found that after 10 months' working in the boiler they failed of being melted out, though they were not placed in holes or ferrules, but were fairly exposed to the same current of heat as the rest of the boiler plate.

Mr. SIEMENS thought that when the flame was striking past the ends of the plugs the heat was not fully communicated laterally to them, even when they were flush with the plate; but some fusible plugs were very ineffective where fixed in little recesses, because they were then in a quiescent atmosphere which was a bad conductor of heat and prevented the action of the heat on the metal. In such cases he could quite believe that the water might have been low and uncovered the plug, yet this little dome of stagnant air would cut off the heat from the plug, and it might fail to melt in time to save the boiler. If metal plugs were desirable to be used, the plan now shown appeared certainly the best mode; if the plugs were not left in so long as to oxidise and become infusible they would be sure to act, and the large total area exposed would greatly increase the effect of safety obtained.

Mr. I. DODDS remarked that he had made use of a plan many years ago for fixing lead plugs, not in a tube, which he thought was certainly objectionable, but in the centre of a raised disc, 9 or 10 inches diameter, raised about 2 inches in the centre, and fixed in the top of the boiler flue or firebox; this plan was found very effective for the object intended, as it raised the level of the plug, so that it might be uncovered first and give way, and still allowed a free exposure of the plug to the heat. He had been led to the plan by finding that the ordinary plate was changed round the plug and became crystalline and brittle; but after 12 or 18 months' working he found the lead plug generally became very hard and difficult to melt, and it was requisite to change it about every 6 months to ensure keeping it always ready for action.

Mr. WM. SMITH said that in the experiments he had referred to the plugs were tried in all the different positions practicable in the boiler, over the furnace, in the internal tube, and in the side flues, to ascertain the difference of effect; but in every case, even over an intense fire, it was found to be only a question of time as to when the plugs would fail to act; after 18 months their ends became coated with oxide and the metal became oxidised and corroded through one third of its thickness; and if exposed longer than 18 months the entire mass of the lead plugs became changed and lost its fusibility. Lead plugs should certainly not be continued in use so long a time, as they became quite untrustworthy.

Professor RANKINE had had an opportunity of examining a locomotive boiler in which the firebox was blown in at the crown, and found there that the lead plug had remained sound in the crown of the firebox and was not at all melted, although the temperature must have been very high, as it was found that a pressure of 470 lbs. per square inch was required to make a similar boiler give way in a corresponding manner. He considered lead was not trustworthy for the purpose.

Mr. Ramsbottom said that the fact of the lead plug not always melting showed that its action was interfered with by some non-conducting coating, and the ordinary plugs were liable to the formation of a protecting coating of oxide and deposit upon their surface after being long at work, which required the periodical renewal of the plugs to ensure their action. In the new arrangement of the plugs this could also be readily done as often as might be requisite; and there was then the advantage that the total area of discharge given by the number of plugs was so large as to be really efficient in discharging the accumulating steam when required.

The Chairman observed that the question appeared to be how long lead plugs could be relied upon as efficient and trustworthy; they could then be rendered practically safe by renewal regularly within the requisite time.

Mr. Tomlinson said that after about 6 months' work they could not be considered safe; he had found as the general result of his experience that in locomotive boilers it was advisable to renew the plugs regularly after being about that time at work, and had adopted that as a rule; and he considered that the plugs could then be safely relied on.

Mr. Craig said he had met with two or three cases where locomotive fireboxes had failed from overheating, without the lead plug having melted; and had adopted a standing rule for no lead plugs to be left in beyond six months, which he found sufficient to ensure their continuing in an efficient state.

The Chairman proposed a vote of thanks to Mr. Ramsbottom and Mr. Routledge, which was passed.

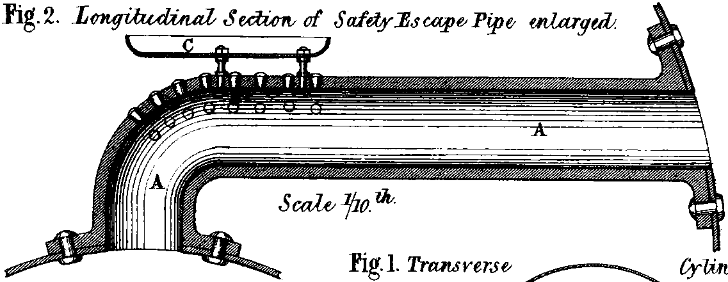
The Chair was then taken by James E. McConnell, Esq., Vice-President.

The following Paper, by Mr. David Joy, of Leeds, was then read:—

SAFETY ESCAPE PIPE.

Plate 132.

Fig. 2. *Longitudinal Section of Safety Escape Pipe enlarged.*



Scale 1/10th.

Fig. 3. *Cylindrical Boiler with internal fireplace.*

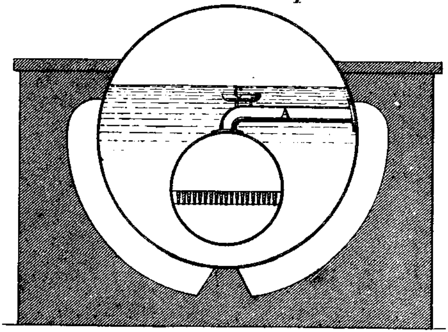
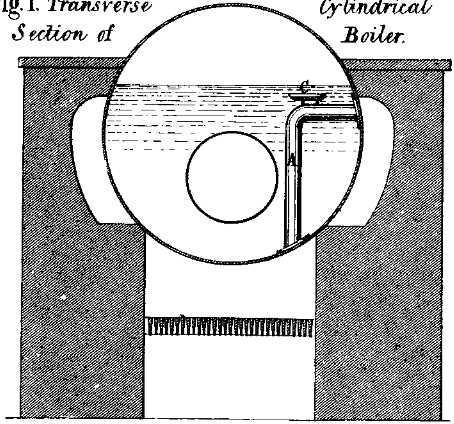


Fig. 1. *Transverse Section of Cylindrical Boiler.*



Scale 1/60th. 0 1 2 3 4 5 6 7 8 9 10 Feet.