

Europe with Constantinople, as the capital of a Pan-Slavonic Empire, and the Black Sea transformed into a Russian lake. At Agram, the capital of Croatia, and at Belgrade in Serbia, are the headquarters of the Omladina, an association for bringing about a union among the Slavonians in Austria and Turkey, who seem to be incapable of absorption into the mass of European society, and constitute an element which must continue to create disturbance until united under one head, or the new era of nationalities shall have spent its force.—*Army and Navy Journal*.

### The Last Naval Disaster.

After an unusually protracted and a very careful inquiry, the inquest on the bodies of the unfortunate persons killed by the explosion of the *Thunderer's* boiler has resulted in a verdict of "Accidental death." The verdict, as is usual in such cases, is accompanied with recommendations from the jury, the object of which is to prevent the recurrence of such a lamentable catastrophe. The decision of the jury appears to be fully in accordance with the evidence given to the court; and sad as it is to find that so many unfortunate creatures may be hurried into eternity, without a moment's warning, by accidental causes, it is yet satisfactory to discover that the errors which led to such a fatality are easily preventible, and were in fact due to a coincidence of defects and omissions which, by the law of probabilities, is very unlikely to occur again. It would have been most painful to discover that such a disaster is among the contingencies to which steam navigation is constantly liable, and that the forces which we employ in the propulsion of our ships are so little under our control, that the persons whose lot it is to stoke boilers and drive engines are at any moment in danger of instant destruction, such as was dealt out in the stokehole of the *Thunderer* on the 14th of July last. That there are dangers in the stokehole and engine room as well as on the topmast cross trees or the flying jib boom, is undoubtedly true, and every man who employs the forces of nature to perform his bidding, is bound to realise the fact that they may some time or another get the upper hand of him. But the contingency is, happily, somewhat remote, and accidents from steam are very rare indeed in the Royal Navy, and in fact, anywhere if proper care is taken, and precautions observed.

The explosion of the *Thunderer's* boilers was caused by a coincidence of three circumstances, or, perhaps, we should say, mishaps, either two of which happening without the other would hardly have resulted in the catastrophe. Indeed, judging by the evidence given before the coroner's court, it seems certain that had either one of the defective conditions been absent, the care exercised by the engineers and stokers would have resulted in the discovery of the other two before the explosion could have occurred. To explain ourselves we should say that the boilers on each side of the stokehole were joined, by short pieces of pipe, to a large steam pipe which conveyed the steam to the engines. A stop-valve is placed in each of these short lengths of pipe, by closing which the boiler can be isolated from the others on the same side of the stokehole. When steam is being raised all the stop valves should be open, and all the boilers therefore in communication. By so doing a uniformity of pressure is maintained in all the boilers, and should one boiler evaporate more water than ano-

ther, the excess of steam is distributed among them all. Should, however, one boiler be defective, it can be separated from the others by the stop valve, and the engines can still be worked; only, of course, with a reduction of steam. The evidence shows that the stop-valve of the exploded boiler was shut, and hence the latter was separated from the other boilers in the stokehole. Steam was got up under these conditions, and every attempt made to get a pressure of 30lbs. per square inch by twelve o'clock when the trial run was to be made on the measured mile. It should be remarked that all the boilers had been previously tested by water pressure to 60lbs. per square inch.

Now, although the fatal boiler was separated from the others, and therefore doomed to contain all the steam it generated, there were two appliances attached to it which, if they had been in working order, would have disclosed the state of affairs before the boiler became subjected to a dangerous strain. These were the two safety valves and the pressure gauge. The former were loaded to 30lbs. per square inch, and if in good working order should have allowed the steam to escape in large quantities directly that pressure was exceeded. The latter should have indicated the pressure of steam in the boiler, and if that was seen to be different from the pressure indicated by the instruments on the other boilers, it would at once have shown either that the instrument was out of order or that the boilers were not in communication one with the other. It is here that the singularity of the deplorable coincidence displays itself. Not only was the stop-valve of the fatal boiler closed, but both its safety-valves were inoperative, and the pressure gauge, when referred to, had been put out of gear by the abnormal pressure which had already been acting upon it. Had the safety valves been in working condition the pressure-gauge would not have been damaged, nor would its registrations of pressure been so much needed. And had the pressure-gauge been so constructed as to register pressures up to 60lbs. per square inch, it would have disclosed the condition of the safety-valves, and, no doubt, of the stop valve, before the boiler had been subjected to any greater pressure than that to which it had already been tested by hydraulic power.

The order in which the defective conditions manifested themselves, although unhappily unobserved, was as follows:—Firstly, the stop-valve was never opened, as it should have been, before steam was raised. No evidence seems to have been offered to the jury to enable them to determine who was responsible for this unhappy and, as we think, careless omission of duty. Secondly, steam was raised and the ship was propelled, slowly, by her engines to the measured mile, thereby consuming steam from all the boilers except the fatal one. The working pressure of 30lbs. was soon exceeded in the isolated boiler, and the safety valve appears to have lifted slightly and allowed some steam to escape. The heat of the escaping steam caused the brass composing the valves to expand; but the brass-seatings of the valves could not expand so much, being firmly secured to the iron of the boiler, which does not expand so rapidly as brass at that temperature. The unequal expansion of the valves and their seatings caused the former to stick in the latter, and thus prevent any further escape of steam. Up to this time no one seems to have noticed the pressure gauge on this boiler; but it appears that very

shortly after the safety valves were jammed the pressure in the boiler became greater than the gauge was constructed to indicate, and so the latter was put out of gear. About this time the gauge attracted the notice of one of the deceased engineers, who, after breaking his glass face, and moving the index with his finger, came to the natural conclusion that there was something gone wrong with it; but in the full confidence that the boiler was in communication with the others, he did not concern himself much about it, as he concluded the other pressure gauges upon the other boilers were indicating the pressure in that one. Very shortly after this the explosion occurred, and our readers need hardly be informed with what result. Never before had a boiler explosion in the Royal Navy been attended with such disastrous consequences, and we trust such a fatality will never be experienced again. Even did not the law of chances render its repetition improbable, we consider that the lessons taught by this disaster are so simple and clear, and may be so easily acted upon, that its recurrence should be not only beyond the bounds of probability, but of possibility also.

It does not appear that anything relating to the construction of the boilers of the *Thunderer* is contrary to the terms of the specification and contract. The boilers withstood the stipulated hydraulic test, and all the valves, gauges, &c., were in accordance with the Admiralty requirements. The pressure at which the boiler exploded seems to have been about 100lb. per square inch, which shows a factor of safety of about  $\frac{3}{2}$ . If this factor represents the Admiralty idea of what is safe for a marine boiler—and it appears the boiler is exactly similar to those in the *Monarch*, *Sultan*, and some other vessels—then we cannot say we agree with them, nor do we think they will find the scientific opinion of the country on their side. At all events, the Board of Trade requires a factor of 5; and that figure represents the bursting strength of locomotive boilers and that of many high-pressure boilers in the mercantile marine. However, even had the factor been five, or a higher value still, the boiler would yet have burst, unless the stop-valve had been observed in the brief space required to raise the steam in a sealed boiler from 100 to 150 lb. to the square inch.

The sticking of the safety valve appears to have been, in great part, due to exceedingly close and accurate workmanship; but the principle of the valve was evidently defective, and it has been discontinued in the greater number of our mercantile steam navigation companies for a considerable period. It is to be hoped that one of the results of this deplorable affair will be that the Admiralty will give up their Chinese like exclusiveness, and show more disposition to observe what is being done outside the Admiralty, and to move with the times. There is a very dangerous tendency in the Admiralty at present to adhere to practices which are as old as the marine engine itself, while marine engineers generally are realising all the advantages of safety and economy which result from the collective engineering experience of the country. Among other things it is to be hoped that the safety valves will not in future be put out of sight in iron boxes on the top of the boiler, where the escaping steam is not visible; or, if they are, that in addition to them, very small check valves will be put in some position where they may be seen by the stokers and engineers. The suggestion of the jury that the pressure gauges should be