SESSION 1909-1910

Discussion on Mr. H. Ruck-Keene's Paper on "The Treatment of Boilers on Long Voyages."

January 10, 1910.

CHAIRMAN: MR. J. E. ELMSLIE (MEMBER OF COUNCIL).

CHAIRMAN: The matter before us to-night is the adjourned discussion on Mr. H. Ruck-Keene's paper on "The Treatment of Marine Boilers on Long Voyages," read at the Imperial International Exhibition in September last. Before proceeding with the discussion Mr. Ruck-Keene would like to make a few opening remarks, and I now have pleasure in calling upon him to do so.

Mr. RUCK-KEENE: There are one or two points which I wished to emphasize when the paper was read, but time did not admit of my doing so on that occasion. One of the chief things was the question of furnaces collapsing due to overheating, and I drew attention to the papers read by Professor Lewes before the Institution of Naval Architects in 1889 and 1891 on the subject of the evil effects of oil in conjunction with other substances being deposited on the furnace plating. I have here a sample of greasy matter taken out of the steam space of a boiler which had been running for more than six weeks, which if deposited on the furnace plating would naturally cause overheating. It is often very difficult to trace the cause of furnaces collapsing, even when it is due to the presence of oil, because there is often no trace of the oil left on the furnace afterwards. I should like, therefore, to show you the effect of heating this mixture of oil and calcic sulphate, and it will be found that when the mixture is overheated the oil will

distil off and nothing be left but what looks like a quite harmless white deposit. I shall heat it in these two glass tubes and you will then see how the oil is distilled off and becomes condensed in the cold parts of the tubes and the calcic sulphate is left as a white powder. This greasy matter sticks to the furnace crown, the plating gets overheated and the greasy deposit is blown up into a thicker spongy leathery mass, the oil in which evaporates, leaving the small powdery deposit.

Of course the cause of a furnace collapsing is sometimes apparent; for instance if there is a thick scale on the furnace there is no question that this would be the cause of the overheating of the plating, but if there is no cause apparent, even if there is no trace of oil to be found on the furnace while there is oil in other parts of the boiler I think it is reasonable to assume that oil has probably been the cause of the trouble, but that it has been distilled off through overheating of the plate. There are one or two other matters to which I should like to allude. One point I raised at the end of the paper, still on the subject of oil, was the absolute necessity of keeping oil out of the boilers as far as possible, and that we should be more careful to make sure that no oil is getting in with the feed water. With most engines nowadays, the only internal lubrication used is that of the piston and valve rods, but even then a certain amount gets through into the condenser and eventually into the boiler if precautions are not taken to prevent it. Another point was the question of salt getting into the boiler.

Of course salt can get into the boilers in many ways, but assuming that the boilers are filled with fresh water, and that fresh water make up feed is provided, salt will get into the boilers if the condenser is leaking, and I think the question of testing the feed water for saltness is too often overlooked.

The best test for determining whether there is any salt in the feed water is the nitrate of silver test, which is that used in the Royal Navy, and is a very simple and at the same time a most efficient test. I will now show you what this nitrate of silver test is. I have here a tube filled with distilled water, and I will place in it one drop of the nitrate of silver. You will see that there is no discoloration at all, but the presence of a very little salt will cause discoloration. Here are samples of feed water from three different ships. I will now put the nitrate of silver in each, and you can see that in the first sample there is practically no discoloration of the water and therefore no

salt ; in the second, the discoloration shows the slightest trace of salt, while in the third you will see the effects much more distinctly. The nitrate of silver will not only show salt but lime also. I have here a solution of lime water and on introducing the nitrate of silver you will see that a discoloration is shown quite clearly, but that it is a different colour from that caused by the salt water. The nitrate of silver test is absolutely certain and will show the smallest amount of salt, and when we think of the importance of keeping sea-water out of the boilers, and also of being able to tell whether the condenser is leaking, I am sure you will see the necessity of regularly testing the feed water by the nitrate of silver test in all vessels. Another test used by naval engineers and a very effective one is the test to discover alkalinity. I have here four samples of water into which I have put some soda, an alkali which is used in boilers, as you all know, for very good reasons. The first sample is equivalent to one taken from a solution of 8 lb. of soda in 16 tons of water, which is about the amount of water in a fair-sized boiler. The next tube is equivalent to 4 lb. per 16 tons, the next to 2 lb. and the next to 1 lb. and you will see what a very sensitive test this is, because even the alkalinity produced by 1 lb. of soda in 16 tons of water (or 1 oz. of soda in 1 ton of water will be distinctly seen. The solution used is phenol phthalein, and it is used in exactly the same manner as the nitrate of silver. Thus no matter how small the amount of alkalinity you can at once see whether the water is alkaline or not.

One other thing I would like to point out. I mentioned in my paper that I had surveyed boilers that had been running for many years in which there was no scale at all. The boilers were always filled with fresh water and the make-up feed was from evaporators ; the boilers were of good size and no forced draught was used. The vessels ran from England to China and Japan, a voyage of about fifty days out and fifty days back, and the boilers were filled up with fresh water at each end of every voyage, and they never had need of a scaling tool in the boilers. A tube was cut out of one of these ships the other day, and this sample was sent to me to show what a boiler tube looked like after being in use for seventeen years. As you see it is absolutely sound, showing that a boiler which is always filled with fresh water, and which is well kept, will last a great many years.

CHAIRMAN : You have all had an opportunity of reading and studying this paper. The matter is now open for discussion, and we shall be glad to hear the views of any member present, especially those who have had experience of marine boilers on long voyages.

Mr. JOHN MCLAREN : We are much indebted to Mr. Ruck-Keene for bringing such an important subject before us. Boilers call for more care and consideration at the present time than they did in the past, owing to the high pressure we work at and the economies which have to be effected by the modern engineer. Mr. Ruck-Keene speaks of the shortness of water as a cause of the failure of boilers. I do not think this need be considered in connexion with the treatment of boilers, as shortness of water seldom happens, and in nine cases out of ten is caused simply through carelessness. In reference to furnaces coming down through overheating, in my opinion the most frequent cause of this is the presence of the oil which has been used for lubricating, swabbing, etc. When the furnace gets so hot as to collapse, certain traces of the oil are removed or burnt away as Mr. Ruck-Keene has explained. I have seen a boiler black with oil ; the furnace came down, and upon examination the appearance of the deposit was found to be of a different character to that on the unaffected part, the oil having been decomposed by the heat. Some time ago I mentioned in this room that I thought our present system of filtering feed water is wrong. In my opinion feed water should be filtered on the suction side of the feed pump. It would thus give the filter a better chance of catching all oil and other foreign materials, whereas if the filter were placed on the discharge side of the feed pump some of the oil is bound to be forced through the cloths. Another disadvantage of having the filter on the discharge side is caused through the practice of engineers on board ship putting soda or boiler fluid in the boiler and through the feed pump. Whatever solution comes to the filter causes the deposit on the cloths to be carried through by the feed water. I have made practical experiments in connexion with this matter. I shifted the filter to the suction side, but I found it was not large enough for the purpose, the cloths requiring to be changed almost every watch, as they should never be allowed to get clogged or they are of no use. Mr. Ruck-Keene might have said more about the treatment of

new boilers, as it is generally the first few months of treatment that tell on the life of a boiler. Every engineer knows that new boilers, want special treatment and great care as the free oxide given out by the continual boiling is considerable. After this is got rid of the chief difficulty is over. Another matter which would be of interest to many engineers is the question of how to stop pitting or corrosion once it has started. Mr. Ruck-Keene mentions the use of zinc plates, also soda, and I dare-say these can be applied with successful results. With regard to the tests Mr. Ruck-Keene showed us, I remember once asking in my store list for four dozen pickle bottles. I was asked what they were for and said they were for boiler tests. I used to draw water off at 12 o'clock every day and put it through the test Mr. Ruck-Keene has given. I kept a " boiler book " and entered up all the results, and day by day we could see if the boilers were correct and if not alter the water according. It was my lot to take out six or seven new ships and by using this method we never had much trouble. This sample tube now before us is very interesting. I heard of a vessel the other day which was twenty-four years old, and I was told that the boiler tubes were as good as when originally put in. I am very interested in the subject of boilers and am pleased to have the opportunity of entering into the discussion. There is one question I would like to ask Mr. Ruck-Keene : has he ever known of the collapse of furnaces being traced to bad circulation in the boilers ?

Mr. F. M. Timpson : I agree with Mr. McLaren with regard to the filtering of the water, and I think when we consider the large plants used for this purpose on shore we will agree that the marine type of filter should have more attention paid to it. As he says the filter cloths fill up very quickly. With regard to pitting, zinc plates are used in a great number of cases, and they seem to have a good effect in preventing pitting, but these require careful fitting. There is another point regarding the collapsing of furnaces which has not been mentioned. In the boilers of some light draught steamers there is a large amount of buckling at the backs, which, I suppose, will be caused through the water being driven off by the extreme use of forced draught. With regard to oil I had some trouble at one time in this respect. Mr. McLaren spoke of soda going in through the hot well. In the

case I am speaking of the soda was put into the boilers and none put in the hot well, and on examining the boiler at the end of the voyage we found a considerable amount of oil in them, showing the danger of soda going through the cloths and cleaning out the dirt and oil, carrying it into the boiler. I think there have been several instances where there has been a collapse of furnaces and no trace of oil was found, but it was assumed that the oil had been burnt off. We are much indebted to Mr. Ruck-Keene for the paper and especially for showing these tests, which are not so widely known as they should be.

Mr. W. Veysey Lang : I was unable to be present when Mr. Ruck-Keene gave this paper, but I read it with the greatest interest. I must confess I could find no new or startling method of treatment advocated, or any secret process exposed for the benefit of " fellow man," but his paper is particularly valuable as summarizing concisely and in a practical way the recognized best efforts towards a safe treatment of boilers at sea. I noticed that no mention was made of the use of *soda*. I wrote to Mr. Ruck-Keene upon the subject (copy of which letter I did not retain) and received his reply as follows :

" Thanks for your letter of the 9th instant in which you give some very interesting data *re* the use of soda in boilers. I quite agree with you that the use of soda is a good preservative for boilers, not only on account of its affinity for oil, but also that, on account of its alkalinity, it is a preventive against corrosion. I purposely made no mention of the use of it or of lime in my paper, but I hope that you and others will put forward your views on this subject when the discussion on my paper takes place at the Institute on January 10."

I thought so much of this paper—as a general instruction—that I obtained a few copies and forwarded them to some of the chief engineers under my superintendence with the following accompanying letter :

" I enclose herewith a paper recently read by Mr. H. Ruck-Keene (Lloyd's Surveyor), which summarizes concisely the best general practice in regard to boilers at sea, and which you would do well to peruse carefully, and carry out as nearly as circumstances permit."

Mr. Keene makes no allusion to the use of common (washing) soda ; but its affinity for oil, as also its neutralizing properties

makes it a valuable preventive against corrosion. It is always desirable to put in some soda *at the time* the boilers are refilled, say, 5 to 7 lb. per ton of water, and feed in regularly, say, 7 lb. per week per boiler, to keep the water alkaline, or oftener if found necessary or advantageous."

It would be interesting to have the experiences of members regarding the use of soda in boilers; the quantities found best for (1) new boilers when first set away and (2) for maintenance, also what results might be expected from the excessive use of soda.

With regard to compositions, doubtless there are advocates of some one or another of the boiler compositions, but as their name is legion and each one is " better than the other," one is inclined to think that the *best* is to leave them alone. I was particularly led to this conclusion some time ago when, after many calls from a representative of a much advertised compound, he called again on a subsequent occasion and explained that he had left the former firm and was now on for another, and assured me most convincingly that the former stuff was " absolute rubbish." It would be invidious, at such a meeting as this, to name or advertise any firm, but I may say that I gave a trial some time ago to a composition that is well known, sending a quantity to three separate ships. After six months' trial the reports briefly, were :

(1) Did not see that it was any good nor any harm and, considering the expense, not worth using.

(2) Believed it softened the scale and made cleaning easier, and would like some more. (N. B. With the same report he mentioned that tube ends had started leaking badly, but had not connected the two facts together.)

(3) Started using the composition as directed, but began to have trouble with back tube ends, although these had never leaked before. Discontinued using the composition and the tubes took up again, The remainder of the composition was landed.

Regarding the use of zinc plates, I should like to have information upon their advantageous action (if any), as I have conversed with experienced men who considered them of no use, whilst the average man considers, or has been taught, that they *are* advantageous. My own view is that they are especially necessary in new boilers, but are probably of little effective value in boilers of age, whose inner surfaces have be-

come less subject to adverse actions and are more or less protected by scale. I should be glad to know the practical working of Navy boilers in this respect.

In the course of a conversation with an experienced engineer some time ago, he told me that his inquiries at surveys of collapsed or distorted furnaces almost invariably brought out the fact that the boilers had been under steam for a period of over forty days. He further stated that collapsed furnaces were more prevalent in the large diameters and recommended a maximum of 42 in.

The extracts from Professor Vivian Lewes' paper summarize most interestingly the action of oil globules and solid atoms, and so closely agree with experience that his conclusions carry conviction. This is particularly so when " banking down," at which time, after a long run, I have frequently found such furnace defects were first observed. In some boilers I had to do with I had the same experience as Mr. Ruck-Keene speaks of. When the furnaces came down the engineer reported that all that was found was this white fluffy deposit Mr. Ruck-Keene spoke of, so no doubt it must have been due to the oil. I have had two or three furnaces to deal with during the last three months, and found the shells of the boilers were thickly coated with grease, showing that an abnormal amount of oil had been used. The furnaces were deflected. I may say that with D valves it is practically a necessity to use oil, although my own opinion of D valves is that they are the best from an economical point of view ; I hear them condemned occasionally, but I have never had cause to. I have them in three ships working at 200 lb. pressure, and they are in splendid order.

On the question of density, is it safe, apart from any consideration of economy, to run a boiler up to, say, $\frac{7}{32}$? I knew a superintendent years ago, whose name I now forget, who would never permit " blowing down " and he averred that at no density would he blow down ! He had been to sea many years in compound jobs, and was a man of great experience ; his veracity was not in question.

Mr. A. E. Seaton states :

" The amount of scale or salt deposited on the surface of the boiler *does not depend on the density of the water*, but *only on the quantity of sea-water pumped into the boiler*. The boiler for a surface condensing engine may be worked with perfect safety and with economy when the water is four times the density

of sea-water $=\frac{40^\circ}{20}$ oz. per gallon. The Boiler Committee appointed by the Admiralty in 1873 recommend such boilers to be worked at $\frac{45^\circ}{4\frac{1}{2} \mid 32,}$ and those of the jet condenser at $\frac{35^\circ}{3\frac{1}{2} \mid 32}$. I may say that the salt brine at Nantwich when pumped up is about 22 oz. per gallon. Do we not tend, in modern sea-going practice, to keep the boilers *too fresh* with distilled (evaporated) water, and is not this *dead* liquid, when used over and over again and impregnated with grease and carbon particles, a very present cause of distorted furnaces and other attendant evils ?

As illustrating the cause and effect of galvanic action as found in boilers, etc., I might mention that some years ago a steamer was sunk off Lundy Island and lay there (submerged) for some months : She was loaded, outward bound, principally with coke. She was eventually salved and brought up Channel, and it was found and remarked upon that her holds were covered with red rust throughout of a most brilliant colour. I was at that time interested in electrical work and experimented as follows : I procured an old rusty iron plate cistern of about 600 gallons capacity, put in a wicker basket of coke (on wood bearers) with a bar of iron in the centre and a copper wire connexion from same and also to the tank side. I filled the tank half full of Usk River water, at high tide (which would be about $\frac{3}{4}$ salt) and was surprised to get, on a 4 voltmeter, $2\frac{1}{2}$ tenths of a volt of current. This was ample proof that the ship, when submerged off Lundy Island, was just a huge Leclanché battery. We may safely assume, I think, that a similar proportionate action takes place in a marine boiler wherever an atom of carbon attaches itself to an active surface of plating, so setting up pitting.

I should like to hear from Mr. Ruck-Keene what his idea is as to the treatment of boilers after a trial trip. An enormous amount of oil is used in the cylinders. The same thing applies to boilers under repair. When boiler repairing or scaling is going on I do not know how many candles are used, *but I know how many are charged for*, and if all the waste grease from those candles is in the boiler it is a bad thing, which *ought* to be removed by scraping, but never is because there is never time.

Mr. W. Earnshaw : We are all indebted to Mr. Ruck-Keene for his able paper, and I am sure there is very much valuable information in it. There is an old saying that " Cleanliness is next to godliness," and I think in boiler work especially it could be very well exemplified. The adjuncts we can best use to effect this are the extended use of the filter, evaporator, and surface condenser. I think it is very true that we must keep the boiler as fresh as possible after the initial scale is put on, and then careful use must be made of these three auxiliaries. Mr. Parker, late of Lloyd's Register, has experimented and shown that about a ton of sea-water is used per 24 hours per 1,000 H.P., and in this water there will be about 2 cwt. of salt, which shows very clearly that unless care is taken there would soon be a very large deposit in the boiler. I was very much interested in the experiments to-night and should be pleased to know the strength of the nitrate of silver and the phenol phthalein.

Mr. E. W. Ross : I must re-echo the statements which have been made to-night, that we are very much indebted to Mr. Ruck-Keene for bringing this subject before us. It is a thorough sea-going engineer's paper, and it is good to think that it will go all over the world to our members across the seas. I am at one with Mr. Ruck-Keene, where he says that he is in favour of the practice of lighting all the fires at once when commencing to raise steam. A very common practice is to light the centre fire first, and to my mind this is not by any means a good practice, as it causes unequal expansion in the boiler. There is, of course, circulation of the water in the boiler, but there would be more equal expansion in the boiler generally if the fires were all set away together slowly. The whole trend of the discussion this evening is in the direction of emphasizing the necessity of keeping the boilers clean by every means in our power. Some time ago we had a paper which gave the impression that marine engineering was going to be revolutionized by the re-introduction of superheated steam. Would not that be a source of still further trouble by reason of more oil being required for the cylinders, which oil would find its way into the boilers through imperfect feed filters and in other ways ? There are, apparently, some doubts as to the beneficial action of zinc in boilers, but I think it has been proved over and over again that the use of zinc is an undoubted advantage to

the boiler. I should be pleased if Mr. Ruck-Keene would give his opinion as to the respective values of rolled and cast zinc for this purpose. I have known men have the zinc removed from the boiler altogether if it lasts for any length of time, as they say it is not doing its work properly. Cast zinc does not last long, and it is a question whether or not it does the work more efficiently. Mr. Ruck-Keene does not mention in his paper anything about the manufacture of the boiler, but it would be interesting to know whether he thinks it likely that in the future the practice will be to have solid rolled shell plates, either in one plate or in two, with circumferential seams. A short while ago I saw a pictorial representation of work done by rolls, showing work rolled solid up to 12 ft. in diameter and about $1\frac{1}{2}$ in. thick. If it is possible to do that is it not possible to have boiler shells manufactured in a somewhat similar manner ?

Mr. C. M. B. DYER : I quite endorse all Mr. McLaren said with regard to testing the water and the use of sampling bottles. In addition, we always took the precaution, when at sea, of suspending a bright piece of iron in the water, partly in and partly out, and could tell from it what the action of the water would be upon the clean plates. With regard to boiler fluid, referred to by Mr Lang, I do not think we can altogether condemn the use of it. The cause of the leakage may be that the boiler has been dirty to begin with and the fluid has cleaned the joints. The deposit of scale is sometimes very useful in stopping up leaks.

Mr. R. BALFOUR : Mr. Ruck-Keene's paper is brimful of information and cannot fail to benefit the members, especially as regards the tests he has demonstrated. The nitrate of silver test is easily applied and should be frequently used throughout the voyage in connexion with the main and refrigerating engine suface condensers.

Given a vessel fitted with all the modern appliances, such as evaporators, automatic feed pumps, feed water heaters and air extractors and filters, there is no excuse for dirty boilers. Reference has already been made to feed water filters. I am of opinion that the position of some filters is on the wrong side of the feed pump, viz. the pressure side, as any soda or other solution which may be used for mixing with the feed water is

likely to carry the oily deposit through the filter pads, into the boilers.

When filters were first introduced only the single type was fitted and when this had to be cleaned the bye pass was used. This was certainly objectionable, as a considerable amount of the deposit lodged in the bye pass pipe was forced into the boiler when the valve was opened. With the introduction of the duplicate filter this trouble has been overcome, and like one of the previous speakers I am in favour of the filters being fitted on the inlet or suction side of the feed pumps, as in the cases where the gravitation system is adopted.

As regards the distortion of furnaces, the author lays great stress upon oil deposit as being the chief cause of many failures, and probably he is correct. Still, there are other causes, one of which, I think, is forced draught conditions, in conjunction with a limited amount of boiler power, faulty water circulation and inferior quality of coal. It is well known that some companies design their boilers for natural draught conditions, although fitted with forced draught appliances. In these circumstances little or no trouble is experienced with furnaces or combustion chambers, but other companies, whose vessels are fitted with limited boiler power, handicap the engineer, however careful he may be. The captain is expected to keep his ship to her scheduled time with all these adverse conditions and most likely a foul bottom. In such circumstances there is little wonder at furnaces and combustion chamber plates becoming distorted.

The importance of keeping the boilers free from oil cannot be overestimated. In these days of keen competition it is feared that in many cases an inferior quality of oil is supplied and a careful analysis of the same should be made, especially of that intended for internal lubrication. A clean boiler is bound to give far better results than one flooded with oil, which finds its way in in spite of all efforts to keep it out. In addition, the oil, especially mineral oil, is very often mixed with organic matter, which is a further source of trouble.

Mr. TIMPSON : Would the author state whether there is any definite proportion of evaporator power to the number of boilers or engine power, as I have been in some ships where there was ample evaporator power, and we kept the boilers

fresh with ease, while in others, with smaller evaporators, we were very often troubled with priming. It is a very common mistake to put too little evaporator power into a ship.

Mr. JAS. ADAMSON: An interesting paper is just to hand, read by Mr. C. C. Nelson, one of our members at Hong-Kong, in May, and as there are one or two points in it which are worthy of note in furtherance of our discussion to-night I would propose to quote them as follows :—

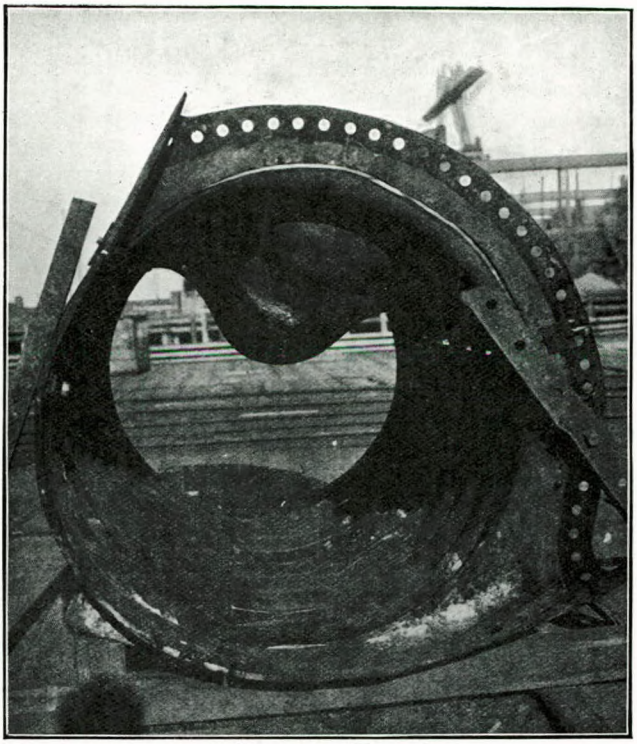
"The excessive difference of temperature at the line of fire bars tends to set up thermo-galvanic action, to which is assigned the pitting found here, but some authorities state that this pitting is caused by small air bubbles, which cling to the sides of vertical heating surfaces. The period that these small bubbles rest on a plate is long enough for the oxygen they contain to act on the iron or steel and cause small irregularities, on which subsequent bubbles find a still better lodgment and speedily effect the formation of pitting. The straining of the plates, as at the line of fire bars, loosens the rust, and the pitting gradually gets deeper: Mr. Macfarlane Gray's idea of pitting was that it was caused by minute particles of copper, but this was questioned by another authority, who stated that he had found pitting in land boilers in which there could be no question of copper at all. . . . Copper salts seem to be a constituent of nearly all feed water; its effects may be seen as green scale on or near the zinc plates. For some unaccountable reason it does not deposit itself uniformly over the boiler, but only in spots—chiefly non-heating surfaces. The origin of copper salts in boiler water is supposed to be from particles carried in with the feed water and also that the distilled water acts on copper as a solvent. . . . Zinc salts act as a preservative in boilers, and the painting of the whole of the interior of a boiler with zinc oxide, and the addition of some zinc salts (the chlorides excepted) to the boiler water, has been proved to be beneficial." . . . Whenever there is any doubt as to the harmlessness of fluids or salts intended to be put into a boiler, it is better to test them as follows : Boil them and then put a clean knife blade into the liquid : should rust be formed, should the water be discoloured, or should copper deposit itself on the blade, then the substance should not be used. If certain free acids are present the above test will give no warning, but a few drops of prussiate of potash should be added, when, if steel is being

dissolved, a light bluish precipitate is at once formed which slowly turns dark blue, or if tannic acid be added a substance like ink will be formed. . . . *Impurities in the metal.*—The composition of boiler plates often has a great deal to do with corrosion in boilers. In a ship built in the north of England her boilers lasted only months, when, notwithstanding that all preventives and preservatives were tried, the boilers were condemned by the Board of Trade and new ones had to be put in. I should think that is a case where there were some injurious impurities in the steel. The steel used for boiler plates is generally that produced by the acid Siemens Martin regenerative furnace process, as its composition can be regulated better than by any other method for the same cost."

The question of galvanic and of electrolytic action, referred to by Mr. Lang, has also been dealt with by Mr. Nelson in his paper, which is well worthy of study conjointly with Mr. Ruck-Keene's. There have been cases where the collapsing of furnaces was due to the rigidity with which the furnaces were fixed between the boiler shell and the tubeplate. I have seen furnaces out of shape attributable to this cause. In these cases the rigid stays were eased a little at the joints to give the furnaces " breathing " space, and after that no further trouble was experienced. I noted a case recently where it was considered that the main condenser was leaking, as the boilers were being over fed. This occurred shortly before coming into port. On arrival the leakage was found to be from the auxiliary condenser.

With regard to boiler tubes, it seems strange that we should hear of cases where they give out after a voyage or two and of others where they last for twenty years. I know of sets of boilers, including the donkey, where most of the original tubes are still in, after twenty years' steady work; zinc has been consistently used in these boilers in close contact with the plates. In one set of new boilers I found a good deal of rust on the shell plates in the steam space. The mill scale was very heavy, and on removing this some of the " pits " were found to be $\frac{3}{16}$ in. deep, with an area of 1 to 3 in. This was probably due to electrolytic action. The mill scale was chipped off, and the plates, after being thoroughly cleaned, were coated with a bitumastic solution; since then the pitting has entirely stopped. I had never previously seen a boiler with so much mill scale upon it;

usually it is removed through the working of the plates into shape. Some years ago pickling was advocated to remedy this. One objection was that it hardened the plate, but could be overcome by annealing the plates afterwards. There is another question in connexion with boilers which I have been very much interested in, and which brings up a question of impurities in the



A Collapsed Furnace.

metal even of tested plates. We certainly do find some very extraordinary cases. There was the disastrous one which happened about eighteen months ago, where the boiler burst with steam on it and did serious havoc, while the sister ship was just caught in time or a similar disaster might have occurred to her boiler. There is no reason to think that these boilers were ill treated. The effect of different kinds of water on boilers finds illustration in a photograph on the wall, which shows

a collapsed furnace attributed to a peculiarity of the water with which the boiler was filled. I have been informed that some waters in South America are particularly detrimental to boilers, and it appears desirable to obtain more information on the subject.

Mr. DYER : All the water round the West India islands San Dominique and others, is very bad for boilers, being of a very acid nature. That is a peculiarity of the sea-water in close proximity to the volcanic islands.

Mr. ADAMSON : I saw a paragraph in a paper, quite recently, to the effect that the boilers of turbine steamers are pitting much more than those in ships where reciprocating engines are used. I have never heard personally of such being the case and cannot agree with the statement. Rolled zinc has been advocated because it lasts longer than the cast, but if it lasts very long it shows that it is not doing the work properly, being rolled too hard, and the cast zinc is therefore better—at least, for new boilers or where corrosion threatens.

Mr. JN. MCLAREN : I should like to ask Mr. Ruck-Keene if he knows anything about a practice they have in Liverpool of setting up furnaces every voyage. They have hydraulic lifts, and nearly every voyage have to set up the furnaces 3 in. or 4in. Could Mr. Ruck-Keene say what is the reason for this. I know of one ship in which this was done for about twelve months. At last they took the furnace out and put a new one in, and since then have had no trouble. With reference to boiler fluids, three months ago I had to go through a boiler in which pitting had set in very badly. The owner told me he used a powder which was put into the feed water, and I was surprised when he told me that it assisted circulation. I thought I had found out a great secret. He could not explain it, but he said it assisted in circulating the water. It proved to me that it assisted "pitting" also. With regard to the use of knives to test the action of the water upon bright steel, I may say that we used this test very often. Mr. Lang spoke of the trouble from the candle grease ; may I suggest that he is not quite up to date or he would use electric light.

Mr. J. T. MILTON : I might add a word with reference to the use of cast zinc or rolled. The reason why cast zinc does not

last so long is not that it does its work better, but that the corrosion which takes place seems to penetrate among the crystals and makes the cast zinc crumble up so that it falls away. I think rolled zinc is far preferable, because it does not crumble away. I think we are much indebted to Mr. Ruck-Keene for this paper ; I do not think there is a single point in it to which objection has been taken. It is full of information from beginning to end. Only one point was omitted, and that was the phenol phthalein test for alkalinity, which, of course, Mr. Ruck-Keene has given us this evening.

Mr. RUCK-KEENE : Mr. McLaren raised the question of feed water filters. I quite agree with him that it is better not to have these on the side where the water is forced through, because a certain amount of grease or other impurities are forced through the cloth with it, whereas if the filter is on the suction side there is not the high pressure, the water is drawn through, and there is not the same tendency for the impurities to be forced through the cloth. With regard to the use of soda I did not mention it in my paper, but I think it is a very good thing to use. There is one thing to be observed, however, if a filter is used the soda should not be put in on the engine side of the filter, because if it is on the engine side the soda is forced on to the pad of the filter and assists in driving the oil through. Soda, as we know, if it meets with organic oil, will combine with it and saponify. It will not do so with mineral oil, not chemically, at least. Mr. McLaren also asked whether I knew of any case of furnaces collapsing through bad circulation. I do not know of any particular case, but it assists in causing collapse because bad circulation retards the heat passing through the plate. If there is a good circulation over the heating surface the heat will pass through the plating much easier than when the water is lying dead on the top. Mr. McLaren said he always used to make these tests for density and alkalinity and entered the results in a log, which I think is an excellent thing. Towards the end of my paper I said :

" In view of the great importance of frequently ascertaining these densities, it is considered that every vessel proceeding on a long voyage should be supplied with a set of similar hydrometers, as well as the appliances for carrying out the nitrate of silver test," and I should have added the phenol phthalein test, " and the engineer in charge should be instructed to carry

out these tests regularly, and to log the results . . . ." And I should again like to strongly emphasize this, and point out that as stated in my paper for testing the density of the water in the boilers the hydrometer used in conjunction with a sensitive thermometer is considered to be sufficiently accurate, but for testing the FEED water the nitrate of silver test is the most satisfactory, but in both cases care must be taken that the instruments employed are *absolutely* clean, otherwise an inaccurate result may be obtained, and in the nitrate of silver test even sweaty fingers contaminating the water or test tube may give inaccurate results. And I might here suggest that even if all the test tubes on board are broken, a clean gauge glass with the end plugged with a clean cork may still be used instead.

For testing the alkalinity of the water in the boilers the phenol phthalein test is much more efficient than the ordinary litmus paper test.

If these tests were carried out regularly a record would be kept of the condition of the water in the boilers as regards its density and alkalinity, and any leak in the condenser would be at once discovered.

I have known of several cases where the condensers have been leaking and the fact was not noticed until serious damage to the boilers had occurred. If sea-water is used as feed for the boilers a tremendous quantity of deposit is being put in, because in every gallon of sea-water there are 93·1 grains of calcic sulphate, which together with the magnesic hydrate must become solid and be deposited even before the feed water has attained the temperature of evaporation."

A question was put by Mr. McLaren as to the treatment of new boilers and Mr. Lang also referred to the effect of trial trips. Most of us know that on trial trips an extraordinary amount of oil is sometimes used, and there is only one remedy that I know of, and that is to clean the boilers out thoroughly afterwards. I cannot advocate any special means for new boilers or after trial trips except to urge that the water should be changed as soon as possible afterwards and the boilers be thoroughly cleaned.

Mr. Timpson said that great attention was paid to the filter on land and better results would be obtained if it received more attention at sea. I think he is quite right. Of course some filters are better than others, but there is a great deal of

room for improvement in filters used on board ship, and care should be taken to see that they are supplied in duplicate, so that when one is cut off for cleaning purposes, the other one can be used. I do not think I need go into the question of boiler fluids, as Mr. Lang has dealt with that very ably ; besides I am afraid I have had very little experience with it. Mr. Lang brought up the subject of zinc plates. To my mind zinc plates are essential as a safe-guard, because if there is any acid in the water the zinc is the first thing it will attack. I think rolled zinc is better than cast for the reason stated by Mr. Milton. The zinc plates should be properly attached to the furnace plating especially, and to any other parts of the boilers that may show signs of corrosion. They should be fastened with proper studs, so as to ensure a good metallic connexion. Zinc plates have over and over again stopped corrosion when placed in good metallic contact near the spot where the signs of corrosion have appeared. The question of the amount of soda required depends a good deal on the size of the boiler, and the quality of the water used; the quantity mentioned by Mr. Lang is probably a suitable one, that is 5 to 7 lb. per ton. Mr. Lang mentioned about furnaces not generally collapsing except after forty days steaming. I have known furnaces come down after a much shorter period than forty days. There are some ships which do not run for forty days continuously and yet the furnaces collapse. I should say that it is not entirely due to the length of the voyage but rather to the treatment of the boiler. Of course, if some impurity is being admitted into the boilers which will lie on the furnaces, either oil, salt, calcic sulphate, or other impurities, the longer the run the more deposit there will be, and consequently there will be greater danger, but in this case again it is not so much the length of time as the amount of deposit that causes the trouble. I have known cases of furnaces having come down on a trial trip I do not think I need say more about banked fires, because as I said in my paper, the quiescence of the water allows the mixture of oil and other impurities to deposit much more readily than when the quick circulation washes the impurities away from the heated surface of the plate. Mr. Lang asked whether a boiler should be worked at a density of $\frac{7}{32}$. I do not think any boiler should be worked at that density, because that is the density at which sodium chloride will begin to deposit. Sodium chloride forms the greater part of the salts in

solution in sea-water, and above that density it will separate out and will deposit. That was illustrated in the case I mentioned in the paper where the density of the water was $\frac{7}{32}$, and the furnace crowns collapsed until they touched the firebars. All round each furnace was a solid ring of salt ; on the top of the furnace it was $1\frac{3}{4}$ in. thick, and on the shell of the boiler the salt was 1 in. thick. With regard to another question asked by Mr. Lang, I do not think we can have the water too fresh. For the make-up feed, there is nothing better, in my opinion, than the water from the evaporators. Of course, it is " dead " water, as Mr. Lang says, it is very flat, but still it should be flat, we do not want it aerated, we want to keep air out, and if we can keep the air out by boiling the water so much the better.

Mr. Earnshaw advocates, as we all do, cleanliness. He asks what is the strength of the nitrate of silver solution. It is just the standard nitrate of silver solution, 2 per cent. is the amount, I think.

Mr. Ross agrees with me that the best practice is to light all three fires at once, instead of the centre one only as is frequently done. By lighting all the fires at once all the furnaces are heated to the same extent, and this enables the boilers to expand more equally. With regard to the manufacture of shell plates, these are frequently rolled 11 or 12 ft. in width, so that there need be no centre circumferential seams in large single ended boilers. I have not heard of any shell plates having been manufactured with no longitudinal joint. But this can be done, though the expense would probably prohibit their use in ordinary marine boilers.

The plates referred to by Mr. Ross were made by Messrs. John Brown & Co. for turbine rotor drums and were rolled from steel ingots into solid rings 12 ft. $2\frac{1}{2}$ in. diameter, 7 ft. 8 in. long and $4\frac{9}{16}$ in. thick. Particulars of the same were fully described in *The Engineer*, November 12, 1909.

I quite agree with Mr. Balfour that oil is not the only cause of collapse ; I stated that there were many other causes, but that in my opinion it was the chief cause. There is no doubt that forced draught, if improperly used, intensifies the evil effects of a deposit on the furnaces, as if the fires are uneven the heat may be concentrated in particular spots, which would then become overheated.

Mr. Timpson touched upon the subject of evaporators and

priming. I am unable to give the figures as to the comparative sizes, but certainly the evaporator should be made amply large enough to supply a sufficient quantity of fresh water without priming, because if the evaporators prime you are doing away with their efficiency. Mr. Nelson, as quoted by Mr. Adamson, spoke of air causing corrosion. There is no question that air certainly has that effect. The question as to what are the causes of corrosion is not absolutely determined, but one thing we do know, that, given the presence of air or oxygen in the boiler water, rusting or corrosion is immediately set up, and that is the reason why we should keep as much air out of the boilers as possible. Mr. Adamson raised the question of impurities in the steel causing boiler plates to crack. This is a matter which has been under investigation by scientists and others for some time past, but up to the present no very definite conclusion has been arrived at, as in most, if not in all, of the cases investigated, including the specific instance referred to, little or no fault could be found with the mechanical tests or analysis of the material.

I agree with him that furnaces are sometimes too rigidly attached, the stays being too close and there is not room for the furnaces to breathe, with the result that trouble ensues. Mr. Adamson also referred to the auxiliary condenser. That is also a very important point, because no matter how well the main engines may be looked after, if oil or other impurities are allowed to pass into the boilers through the auxiliaries, they will cause the same trouble as they would if coming from the main engines. Mr. Adamson referred to boiler tubes twenty-two years old. The one I have shown to-night is seventeen years old. I have seen others in good condition which were stated to have been twenty-six years old, and I believe the age was correct. It is very strange that sometimes, almost on the first voyage, some few of the tubes will give way ; but why only two or three should give way and all the rest stand I cannot explain. With regard to the question of some waters being injurious, that must depend upon whether the water contains acid or other impurities which will cause injury to the boiler, and it is important to see, therefore, when taking water from ports where the quality of the water is not known, that an analysis of the water is taken. With reference to the question of the boilers of turbine steamers suffering more from pitting than those of reciprocating engines I do not see any reason why this should be so, in fact, I

should have thought they would have stood better, as there should be no trouble with oil from internal lubrication. I did not see the article referred to, but the conclusion arrived at does not correspond with my experience. Mr. McLaren spoke of furnaces being set up after every voyage. There is no doubt that when furnaces have once been set up they always have a tendency to come down again slightly, as the metal has been stretched to a certain extent, and they cannot be made perfectly circular; but I have never heard of a case where it was necessary to set up furnaces every voyage, and can only suggest that the furnaces were overheated on each voyage. I must thank you all for the very kind way in which you have received this paper.

A hearty vote of thanks was accorded to Mr. Ruck-Keene on the proposal of Mr. E. W. Ross, seconded by Mr. J. T. Milton.

The meeting closed with a vote of thanks to the Chairman.

The following members were elected at the meeting of Council held on Thursday, February 10th, 1910:—

As Members:

Henry Gilby, Southampton.
Alex. J. Henderson, Liverpool.
Gerald M. Jones, Cricklewood.
Jas. B. Maclean, Madeira.
Vernon J. Reed, Bombay.
Archibald Robertson, Calcutta.
G. E. Seal, London, N.

Transferred from Assoc. Member to Member.

R. S. R. Barrow, Valparaiso.