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THE TREATMENT OF BOILERS

BY

MR. W. W. WILSON

(MEMBER OF COUNCIL),

READ AT

GRESHAM COLLEGE, E.C.,

ON

MONDAY, SEPTEMBER 12TH, 1892.

Adjourned Discussion, 58, Romford Road, Stratford,

Monday, September 26th, 1892.

PREFACE.

58, Romford Road,

Stratford, Essex.

September 12th, 1892.

A meeting of the Institute of Marine Engineers was held this evening in Gresham College, London, E.C., by kind permission of the Secretary and Committee of Management, to whom a hearty vote of thanks was accorded at the close of the meeting.

The chair was occupied by Mr. W. H. Northcote (Vice-President).

Mr. W. W. Wilson read a paper on "The Treatment of Marine Boilers," the discussion on which was warmly sustained and replied to in the course of the evening.

The discussion was adjourned till September 26th, on which evening it was arranged to continue the discussion in the Institute Premises.

JAS. ADAMSON,

Honorary Secretary.

THE

TREATMENT OF MARINE BOILERS.

BY

MR. W. W. WILSON.

Read at Gresham College, Monday, Sept. 12th, 1892.

INTRODUCTORY.

In laying before the Institute the following remarks, I am induced to do so for two reasons; first, owing to the very great importance of the subject both to the Marine Engineer and the Shipowner, and second; in that although we have been somewhat over three years in existence, and thirty-seven or so papers on various subjects have been laid before us for discussion, still, with one exception, viz., that on "The application of zinc to boilers," read by Mr. Green, in the first half of last session, nothing has been brought forward in connection with the marine boiler, which I look upon as being the most important portion of the machinery, and consequently that which ought to be the first care of the sea-going engineer.

The "Treatment of Marine Boilers" is a subject on which there certainly exists a very great diversity of opinion, and no doubt many members will be inclined to differ from me in certain points which I may bring forward to-night. It is for this reason, therefore, that I take the opportunity, and I only hope that in a free discussion, even although we do disagree, we shall get such information as may prove beneficial to all. I would further say that even though we do disagree, we shall be doing nothing more nor less than did our predecessors and older members of the sea-going fraternity, for if we refer to the evidence taken by the Boiler Commission in 1874, we can see many varied opinions that then existed amongst the superintendents, chief engineers and others interested in the preservation and successful working of marine boilers at that time.

We can also note, from the same source, that throughout the years which have elapsed since that evidence was taken,

there have been very considerable changes in the opinions of those "who go down to the sea in ships" as to the proper method of procedure, and I venture to say that, were the same gentlemen now called upon by a similar commission to express their opinions, the collection of evidence, now obtained, would be of a somewhat different character to that which was then adduced.

I would first draw your attention to the fact that the marine boiler of the present day is very much more durable than that of from 20 to 30 years ago, or even less, for up to the period ending with about ten to twelve years ago, the natural life of a boiler was looked upon as being only about eight to ten years, and generally in that time it was in such a state that it had already either undergone extensive repairs, or been reduced in pressure to such a degree that it was next to impossible to keep it at work with anything like economy.

What a difference there is in those of the present day from the boilers just mentioned. Many of them I could point out now, which from the careful treatment they have received during the last decade (and which treatment has been progressive during that period), are now in quite as good and safe—I might almost say better and safer—condition as they were on the day when steam was first raised in them, and I am perfectly sure they will be good boilers (provided the same care be exercised in future) when the ships are rendered obsolete by the advances made in naval architecture.

I am quite well aware, however, that we cannot claim for this enhanced longevity of the boiler the treatment it receives only, for there is no doubt that the construction has something to do with it. Designs are better, material is superior, as now manufactured for this class of work, and the workmanship is, as a rule, of a very high class indeed; still I hold, that even with all these, there still remains the fact that if it be not treated well and carefully nursed and tended, the structure will all the sooner show signs of failure and decay. As evidence of this latter point, I could mention a ship in which the boilers, when I last saw them, were about 13 to 14 years old, and which, about eight years previously, were in such a state that it was considered they could not last more than about a couple of years longer, yet with the system of treatment which they afterwards received they were at the time I saw them in almost as good, and certainly in a tighter condition, than they were eight years before, and I may say were quite as much, if not more, entitled to receive the two years' certificate than they were then.

TREATMENT OF BOILERS FROM 20 TO 10 YEARS AGO.

In introducing the subject proper, I would ask you to go back to the system of treatment which prevailed (in my knowledge) about twenty years ago. I would fain have asked you to go still further back, to the time when it was necessary to have brine pumps, for extracting the highly impregnated salt water from the boiler, and discharging it overboard so as to retain the minimum density as nearly as possible ; the time when the boilers carried so little steam pressure that it was impossible to blow the water out against the pressure due to the height of the water outside, and, when it was a common occurrence, to see the engines working (and I believe very satisfactory at that), with the gauge showing something less than 1lb. of steam. I am afraid, however, that I must allow some of our older members to give us the information regarding that time, and I will only deal with that which has come under my own personal notice.

At the time mentioned above, viz , about 20 years ago, the pressures on boilers varied from about 20lbs. in the older ships, with common condensing engines, to from 40 to 50 in the newer ones fitted with compound engines, then little more than in their infancy. Some of the former (older) vessels carrying about 20lbs. still retained the old jet condenser, and on one of the earliest, in which I was employed, and which was so fitted, I well remember looking in at the manhole doors, and seeing the thick heavy salt scale which was then prevalent in ships of that class. I have often heard engineers remark that they liked to see the interior of their boilers perfectly white, as that was a sign they were in good condition, and certainly, if that is the necessary criterion of good condition, the boilers mentioned were first class, but if I remember rightly (and I think I am not mistaken), the scale on the furnaces was at least a quarter of an inch thick, with, of course, a proportionate quantity on the other portions. It may be truly said that it was in these days that cleaning was required. When we look into it, is there any wonder that the cost of fuel was so great in those days with such a scale on the main heating surfaces? It never having been my fortune to sail with boilers such as I have described, I cannot make any definite statements as to the manner in which they were generally worked, so, as I have already said, I shall leave that to be dealt with by our older members, contenting myself with the courses that were pursued in vessels in which I have been at sea, or which have come more intimately under my notice person-

ally. All of these have been fitted with surface condensing engines, either common or compound.

On one of the earliest of these, the pressure to which the safety valves were loaded was 20lbs., and during a considerable portion of the time I was in her, we were subjected to very bad weather. Having dead weight safety valves, we thought ourselves very lucky if we were able to see more than 16lbs. showing on the steam gauge, for each roll the vessel made (owing to the inclination of weights from the centre of the pressure), up went the valves, and away rushed the steam. Every time this took place so much water was wasted, which had, of course, to be made up by the auxiliary feed or donkey, and, as a matter of fact, these boilers, with all the advantages which ought to have been derived from surface condensation, were in much the same condition as if there had only been jet condensing engines in the ship.

This treatment could, of course, scarcely have been avoided under the circumstances, with such boiler fittings, and it could only be lessened slightly by reducing the steam to the lowest limits compatable with the obtaining of a fair speed.

In the matter of getting up steam in these same boilers, it was customary for the fires to be lit from three to four hours before steam was required, and it can easily be imagined what temperatures the various portions of the boilers were at when the necessary pressure for getting under weigh was obtained ; in fact I can assert without the slightest hesitation that at the bottom, the water was practically as cold as when first run in.

As a consequence, there were strains put on the boiler that caused the bottoms, at least, to be in an almost constantly leaking condition, which, unfortunately, was for the most part hidden by the system of setting which was then adopted. This was done by placing the boilers on heavy baulks of timber running underneath the whole length (they being square in shape), and I well remember considerable trouble experienced by some boilermakers cutting away this saturated wood for the purpose of finding the source of a leak which had shown itself rather badly during the previous voyage.

This leak was discovered to be at one of the angle irons to which an upright stay was fastened, the heads of the rivets having been so much corroded that the stay had literally drawn them out through the little plate that remained. How it ever was possible for the rivets or plates to do other than corrode I cannot comprehend, for they were constantly damp with the salt water, and the combination of that with the heat when the boiler was at work, I have no doubt, you will coincide with me, was the best means that could have

been adopted, had it been desired to promote corrosion. Besides, it was so completely out of the sight of everyone that the mischief was, as it were, wholly accomplished ere it was observed.

While at sea no particular care was taken to preserve the condensed water, for the order was that each watch was to brine or blow some five to six inches out of one of the boilers, they being taken in succession. This was to maintain as nearly as possible a certain density, and, of course, to enable this to be done it was necessary to make up from the sea. There was, therefore, no need for the engineer to be in any way particularly careful with his feed water, any loss of which only meant perhaps a quarter to a half-hour's extra opening of the auxiliary feed valve to satisfy requirements. In consequence of this, also, the advantages gained from surface condensation were by no means obtained as they ought to have been, even in good weather.

When, on arrival at the terminal port, the order was passed that steam was no longer required, the first operation to be done was to draw all fires, and immediately thereafter, as soon as possible, blow off, cocks were opened, and *all* the water blown right out. The remaining steam was then let off through the safety valves, to the very great annoyance of all on board, or in the vicinity.

In other ships with higher pressure than the one mentioned, I know that when forced to take fresh water into the boilers (say from a fresh water harbour or dock) it was the custom, that at soon as they got to sea into clean salt water, the hot well overflow was opened, and the fresh water allowed to run into the bilge, the supplementary feed being opened full, and the feed suction valve so adjusted that only the required quantity was fed into the boiler ; but, of course, instead of this being pure distilled water, as it ought, it was really about half the density of the sea. This treatment was continued till the density of boilers reached about one and a third the sea density, when the two cocks were shut. Brining was then commenced as soon as two thirty seconds was reached, and continued till the termination of the voyage.

It may be said that this was the proper treatment for boilers at that time, but I am inclined to think from the experience of the last few years that it was not. However, it was done then, and I should not like to say that the boilers were not clean ; I believe they were very fairly so, but I contend that although they *looked* it, they were not nearly so clean as those of the present day.

Another system of treatment which was greatly pursued, and which was carried on, to my own knowledge, till

about ten years ago, was that of changing the water as much as possible at every port called at. If stopped for only two or three hours, the donkey pump was kept working all the time, and as each boiler got full, so it was brined again to the working level.

By this means, as a rule, the density of the boiler water was reduced, but I am afraid it was only the cause of the introduction into the boilers of the wherewithal to induce still further deposit. In like manner, if for any reason a ship was detained for a day or so in port, the boilers were blown out, and refilled with more salt water, too often long before they had anything like time to cool down, and by this action of itself there is not the slightest doubt that strains were put on both furnaces and shells, that it was really impossible to expect any structure to stand.

I have seen, in one of the ships already alluded to, a boiler blown down, and within an hour (I daresay considerably less) from the time when the fires were commenced to be drawn, a door was removed, and a hose played over the interior, to cool it down. Of course this was done under extraordinary circumstances, owing to an accident; but I am of opinion now that such proceedings only tended towards further accident. In those days it was expected that on no account ought engineers to allow the density of their boiler water to exceed the orthodox *limit* of the salinometer, and if he did do so, he ran the risk of being considered very negligent, and not capable of having charge of any kind of engine.

Fortunately this state of matters died away, gradually, no doubt, but surely, till about ten or twelve years ago it was realized that with good surface condensing engines, the density could be allowed to considerably increase, and it was soon observed that when ships arrived, after a voyage in which only the *waste* was made up by sea water, although the salinometer showed a density of 4 to 5 thirty seconds, there was really little difference in the extent of the scale, in fact it was generally found to be, if anything, lighter, although even then in the more inaccessible parts of the boiler, where cleaning was difficult, there still continued a gradual accumulation of scale. With the increasing pressures which were gradually being obtained in boilers, it was therefore easily seen that it would be almost impossible to continue working on in that way, without incurring vexatious delays, by leaky boilers, and possibly serious risks as well; and other courses had to be adopted.

This brings us close to the present time, and I now propose to lay before you a few thoughts as to my ideas of what is required in the working of the H.P. boilers now in use.

I am quite aware that in older ships, with compound engines constructed from 10 to 15 years back, the facilities given to engineers, for working their boilers successfully and efficiently, are not so good as those in the recent additions to the Mercantile Marine ; still I must give them credit for many successful means they have taken to adapt even their old jobs to the present system of working.

TREATMENT OF BOILERS DURING CONSTRUCTION.

Although this paper is not intended to deal with anything concerning the construction of boilers, still, I consider that there is a certain amount of care necessary during that time which has much to do with the successful subsequent treatment which they receive. It is therefore my opinion that, prior to any work being put on any of the *shell* plates, they should be "pickled" in a similar way to the plates for the hulls of vessels now constructed for the Royal Navy. This is done by exposing them to a bath of diluted sulphuric acid, so as to take off the bloom, and then thoroughly cleansing them with clean water, and allowing them to dry ; or in a manner of speaking, forming a slight rusty coating on them. As for the heating surface plates, I am not quite prepared to recommend such a course, still I believe that even with them this treatment would not be found amiss, provided that immediately after the pickling process, and after drying, they be thoroughly cleaned, so that no scale be allowed to gather on the surfaces. This latter cleaning is, of course, also necessary in the shell plates.

When the boiler is well on towards completion, but previous to the furnaces and combustion chambers being fixed in their place, the inside of the shell (cleaned as above mentioned) ought to be coated with white zinc paint mixed to a good stiff consistency with light kerosine oil. In recommending this pickling and painting to be done at this time, I am led to do so from observations of several new ships which have had two good coats of this same material put on *after* the boilers were built, but the plates not having been pickled the bloom was still on the surface. On the completion of a very short voyage, in fact ere the trial trip was much more than over, it was found on examination that only the slightest appearance of this painting was visible. After about 9 to 12 months running, however, when the boilers were thus coated, the paint seemed to stick hard, and white as a rule, although in places there gradually appeared signs of a corrosive action going on underneath, which, I contend, would in many cases be avoided were the treatment conducted during the construction as I have recommended.

On the completion of the boiler there is applied the

hydraulic test, and it is my opinion that in this operation the start is made in that corrosion and waste which is subsequently perhaps the cause of its condemnation. I do not for a moment say that this test is not necessary; still, I think, to give boilermakers of the present day their just dues, it certainly is of considerably less necessity than in former times. It is not the actual test I complain of—it is the subsequent treatment. When it is over, the water is usually run out by the most convenient means, and when it stops, as a rule, the outlet is closed, and any water which is left (and there is sure to be some at some part) is allowed to lie there in the bottom. Perhaps it may be a month or two ere the boiler is required, and during that time this water creates a certain amount of dampness inside which is a most active agent in setting up corrosion. Should it be warm weather this action is intensified by the heat causing more vapour. I think we may congratulate ourselves that the days when this dampness was required to make good the leaks occasioned by bad workmanship are now gone. What I contend ought to be done is, that immediately after the test it should be seen that all water is thoroughly drained out, and the boiler dried, and kept so.

When the boiler is placed on board, I presume there is little use saying that it should be in such a position that access can easily be obtained to all parts of the outside. This, I think, is generally the case now-a-days, still there are instances where the bearers are so low down in the bilge or on the tops of tanks that it is impossible to get underneath. This should be avoided, and I think, happily, it is of rare occurrence, and such operations as having to cut away wood chocks from underneath to get at leaky seams, as I have already mentioned, are now no longer necessary.

Previous to the boilers being filled with water for steaming purposes they ought to be fitted with all the necessary requirements for fixing zinc in some approved fashion, and not only the fittings but also the zinc should be in position. If zinc is of use as a preservative at all (and I think there is little doubt of that), I say that it is now at the very beginning of the life of the boiler, when no other preservative is upon it, that it ought to be most necessary.

TREATMENT UNDER STEAM.

In getting up steam the first consideration is to do so very slowly, and this ought to be more thoroughly attended to when the boilers are used for the first time. I am afraid that it is too often the case that when fires are first lit and steam raised by the builders that it is done too hastily.

In my opinion for the H.P. boilers of the present day,

nothing less than 12 hours should be allowed to raise steam, and I would even go so far as to say double that, if all else will allow it being done. Too often when steam is raised for the first time the necessary connections for the circulation of the water in the boiler are not completed, and, therefore, under the circumstances, longer time ought to be allowed for the purpose. We are all aware that one of the most important points necessary for the preservation of boilers in good and sound condition with a minimum of leaks is, that there should be a thorough circulation of the water, so that there may be maintained as nearly as possible an uniform temperature throughout.

No one, I think, doubts that bad circulation is the cause of many leaky seams, owing to unequal expansion, and we must only recall the appearance of the bottoms of shells as they existed some 12 to 15 years ago to mark the difference from those of the present day. The introduction of the Messrs. Weir's hydrokineter worked a decided change, and in recent years many contrivances have been brought forward for effecting this object. I would only mention that in my opinion the simplest, and I believe the most effective, of all circulating systems is that in which the donkey pump draws the water from one portion of the boiler and discharges it through the feed valves into another. Of course, this is used, as a rule, *only* in getting up steam, the custom of most engineers being to shut it off shortly after steam shows, although why it should not be continued until there is a fair pressure, I fail to see.

It is usually the case that boilers when new are filled with fresh water, which, I think, is a thing to be regretted. What, in my opinion, ought to be done is to fill them with good pure sea water, and during the period of all trials, testing of valves, &c., also, if a day or two's run is required, all waste should be made good by the same. In this way a fine preservative scale would be obtained on the interior surface, the value of which, I am sure, would in after years be realized. I have in my recollection now a steamer which, at the commencement of her career, encountered somewhat bad weather, and her air pump discharge valve being rather leaky, a considerable quantity of sea water got into the hot well, and consequently into the boilers, necessitating blowing out at intervals. This lasted for about three or four days', when an opportunity was afforded of rectifying the leak, and the boilers were then worked in the usual way. At the terminal port, on opening up, the chief engineer was surprised and very sorry to find that a rather heavy scale had formed on the furnaces and other heating surfaces. However, a chance was obtained there to have these thoroughly

cleaned, and from then up to the present time, now about eight years or so, during which they have been fed almost exclusively with fresh water, I am not aware that any corrosion has ever been seen in these boilers, nor have they given any trouble whatever, and I know that voyage after voyage all that is required is a fairly good scrape over the surfaces, the scale being little or nothing, and for the most part only a gray powder. In ships (one of them a sister ship) running on similar voyages, and now worked altogether in the same way, there is not nearly the same appearance in the inside, and in all there is more corrosion visible. This is not the only case I could cite, but it is one which makes one more satisfied that for a *short* time at the beginning of its career a marine boiler ought to have the benefit of pure sea water.

On completion of this baptism of salt water, as I might call it, the use of fresh water (and if it could only be got in good quantity distilled water) should be commenced and persevered with. Fresh water is the only water that can be relied upon for keeping efficient high pressure boilers of to-day, and I think I am saying right when I affirm it is almost the universal custom to use it now. The great increase in the construction of evaporators is testimony that our engineers are looking more and more to the provision of means for the supply of that commodity. A modern engine room is not considered complete unless there is at least one of these contrivances of some description on board.

With the introduction of fresh water, and the maintenance of the density of boiler water at *nil* throughout a long voyage, there is, however, an attendant element of danger, and that is the presence of oil, brought into the interior with the feed water. In former times the lubrication of all internal surfaces was effected by the use of vegetable or animal oils or greases, which, as a rule, either got carbonized in the cylinders and other heated passages, or if they did reach the boilers, it was generally only in small quantities, and these were absorbed by the saline and other materials in the water, and precipitated in the form of mud or dirt to the bottom, perhaps a slight percentage of it being found adhering firmly to the ends and sides at the water line in the form of a powdery deposit. The use of mineral oils for this purpose has made quite a change, and it is my experience that with the same consumption of oil, the fresher the boiler water is maintained the more oil is found deposited. It is quite obvious, I think, how this comes about. Mineral oils as manufactured for internal lubrication have all a high flashing point, and as, in consequence, they do not lose their lubricating property, even with the temperatures to which

they are now exposed at high pressures, it is natural they should pass through the various cylinders, valves, &c., in a fluid or at least frothy state, and be eventually carried with the feed water into the boilers in their original condition.

Of course, it must always be taken into account that the quantity found in boilers is proportionate to the quantity used in the engines.

At the Institution of Naval Architects in the Spring Session of 1891 a most valuable paper on "Boiler Deposits" was read by Professor Lewis, and for which the Gold Medal of the year was awarded. This related almost wholly to the presence of oils in the boilers of steam ships, and the writer showed very ably the effects of too much oil being allowed to get there, and for the purpose of obviating the damage likely to ensue from such, he proposed the following:—

"First. The filtration of condenser water through a coke column.

"Second. Free use of the scum cocks.

"Third. The use of water of considerable density rather than of fresh water.

"Fourth. The use of pure mineral oil lubricants of the highest attainable specific gravity and boiling point."

To these points I shall draw attention hereafter, and, in the meantime, will continue by saying that in the course of his paper he showed that with one-sixteenth of an inch of oily deposit such as had been found in a boiler coating the inside of an iron vessel, with which he experimented, the outside of the iron when exposed to a slow heat reached a temperature of about 392° F. when the water boiled, whereas when the vessel was clean, the water boiled when the outside reached about 239° F. When the same experiment was repeated, but with an intensified heat obtained by means of a common atmospheric blow-pipe, or forced draught as it were, the temperatures obtained, under the same circumstances, were about 239° F. as before with clean vessel, and with coated vessel about 793° F. From this we can see that there is indeed very great danger from the use of mineral oils and fresh water.

I shall also make a few quotations from an article published in the *Mechanical World*, January 18th, 1890, on the same subject. The quotations are extracts from the summary of results of some experiments made on the Continent, and are as follows:—

"*Mineral Oil*, when applied thinly, produces no appreciable "effect, but it causes overheating after being decomposed by "heat. A chip soaked in mineral oil and applied to a plate "causes overheating.

"*Linseed Oil*, even when very thinly applied, causes a rapid "overheating of the plate at a moderate evaporative ratio.

"*Rape Seed Oil* acts in the same manner as linseed oil, but "does not produce quite so rapid an effect.

"*Valvoline* does not cause overheating except at a high evapo- "rative rate.

"*Lard Oil* causes overheating even when mixed with a con- "siderable quantity of plumbago. If the plumbago is greatly in "excess, the metal does not become red-hot.

"*Tar*, applied to a tinned or polished surface, becomes de- "tached when the water boils. If applied to a rusty plate it "adheres better, but does not cause overheating."

From the experiments which had been made and of which the foregoing are some results, there were drawn certain conclusions, two of which are as follows :—

First. "That *any* grease or oil on the internal surfaces is a "serious obstacle to the transmission of heat."

Second. "That when oil or grease is decomposable by heat, "overheating is particularly to be feared. The organic oils, "linseed, rape seed, &c., appear to be more dangerous in this "respect than mineral oils."

In Professor Lewis' paper, already referred to, he really comes to the same conclusions, for in it he says that any "lubricant containing animal or vegetable oils to give it body should be unhesitatingly discarded" for internal lubrication.

It appears to me, therefore, from the foregoing extracts, that in the days when tallow or vegetable oils were used we ran greater risks than we do now—but of course we had not the same high pressure to contend with, and besides, as I have already mentioned, these oils or greases were as a rule decomposed in the cylinders and very rarely reached the boilers except in small quantities. However, that it was not always so, and considerable damage sometimes did take place, I have a case in point, in which some 10 or 12 years ago a large passenger steamer arrived at a Chinese Port while I was there, with no fewer than seven of the furnaces more or less collapsed out of about twenty-four. The boilers were of the dry bottomed low pressure type, and to enable her to reach port, the damaged furnaces were propped up from the bilge, the bars, &c., having been removed to allow this being done. By doing this, steam was maintained in the boilers by the undamaged furnaces, although great care had to be exercised. I heard afterwards that on examination, the damaged portions were found to be covered with a thin deposit, much of the consistency of common glue, and whose formation was attributed to a new oil that had that voyage been supplied, and which (so it was stated) was of vegetable origin.

Referring back to the means to be employed for preventing damage being done to boilers by the presence of this oil

internally, the first that presents itself to my mind is to stop all internal lubrication, or at least to reduce it to the least possible quantity. I am perfectly aware that in many ships, all *apparent* lubrication is stopped, still I am quite as well satisfied that there still remains some. The lubrication of the rods (which, by the way, should always be done with mineral oils) is, in my opinion, a not inconsiderable means of internal lubrication, so that even although there is none put in through the usual contrivances fixed for the purpose, still it gets in by these.

It is not my intention to go into the merits of whether or not this way is admissable for stopping the oil from reaching the boilers, or of its consequence to the engines, so will pass on to the next means which appears to be the most feasable and proper procedure. This is to fit some system of interceptor between the feed pumps and the boiler. Professor Lewis has mentioned this as one of his proposals, viz., to have a coke filter, but I think there are other and more practicable means upon that. In my opinion a feed heater (in which the heat is imparted to the water through heated surfaces and not by the admixture of live steam) is the best form. In my examination of boilers I have found that the parts where this oily material deposits itself most is on the coldest end of the tubes, and this causes me to conclude that an arrangement of feed heater, as mentioned, is what is required. This should be made in such a way as to be easily cleaned, and should be made in duplicate so that while one is at work the other may be cleaned, this being regularly done every second or third day or as often as in practice it would be found necessary.

I may here say that I have not had the opportunity of examining the inside of any heater of this description after a voyage, still I am convinced that it is of considerable value in the prevention of the oily deposit in the boiler.

Since this paper was written I observe there has been brought to the notice of Marine Engineers a contrivance somewhat on the principle which I have mentioned. I refer to Edmiston's feed water filter, mentioned in *Fairplay*, July 15th, 1892, from which I extract the following :

"The filter consists of two rectangular chambers, with a semicircular bottom, each chamber forms a separate and complete filter, and each has an inlet and delivery valves. The two inlet valves are united by means of a breech-pipe with the engine side of the main feed-pipe ; and the two outlet, or delivery, valves are similarly united and joined to the boiler side of the main feeding pipe. There is also a bye pass pipe, uniting the two branches of the feed-pipe ; thus the feed can pass through either, or both filters, or through the bye pass pipe to the boiler. To use the language of the electrical engineers, the filters and bye pass are

in "parellel arc" and placed "in circuit" with the feed. The filters are formed of perforated iron plates, between which are placed pieces of a specially manufactured cloth or flannel. The perforated plates and flannels are placed in alternate layers, and the whole set up and secured in place by set screws. On the chamber cover are placed the air chamber, safety-valve, pressure-gauge, and steam-valve. The engineer of the watch is thus enabled at all times to satisfy himself as to the internal condition of the filter. The feed-water is forced by the feed-pumps through the filtering media, with the result that all grease, metallic particles, etc., are mechanically averted, and nothing but pure water is forced into the boiler. When the filtering media become choked, the fact is indicated by a rise in the pressure, as shown by the gauge. In practice, when the gauge shows a pressure of about 2 to 3 lbs. above that required to lift the feed cheque valve, it is time to shut off that filter and clean it. Then the other one is used. The length of a time a filter will run without cleaning depends upon its capacity, the quantity of feed to be filtered, and the amount of oil used in the cylinders. A cargo steamer developing about 1,500 i.h.p., and evaporating about 240 tons of water, will require a couple of small size filters, which will run without cleaning for 12 or 14 days; while a full powered twin-screw mail-boat will require the largest size on each feed-pipe, and the filters will require cleaning about every three days. As, however, the operation of breaking the joints, taking out the saturated flannels, inserting fresh ones, setting up and making the joints, occupies from 20 to 30 minutes, there is not much time lost. The superior condition of boilers to which the filter is an adjunct is very apparent. There is no scale, and no patches of grease, and no deposit of dirty scum, but the interior surfaces are coated with a whitish powder, easily removed by the finger, exposing the bright metal beneath."

Again, in my opinion, there seems to be another means of neutralising the effect of the oil, and which I may say I have observed to be of considerable good in a number of boilers which I have seen. That is to use carbonate soda, or, if wished, a little caustic soda. I do not profess to be much acquainted with the chemistry of these materials, but by experience I am perfectly satisfied that their use is to be recommended. I have heard objections made to the use of caustic soda, but so far as I can see, a judicious use of this put in with the feed, tends to the same results as if carbonate were used only it must be used in smaller quantities. Although saying this, I would, however, recommend the common carbonate. The results of its use appeares to me to be that it neutralises the oily material, and instead of thick greasy deposit being found on the tubes, and other cooler portions of the boiler, a light greyish-brown powdery substance is formed, which, as a rule, is fairly easily brushed off. As to the quantity used, I think this can be overdone, but I may say that to the best of my judgment from observations of the results, about half a

pound for every ton of water put in when boilers are filled, and at sea about one-eighth of a lb. per day for every 10 tons of water is sufficient. These quantities were deduced from results in a ship using about one quart of mineral oil per day, for internal lubrication, with engines indicating about 2,500 h.p.

In one ship, in which rather more than this quantity of *caustic* soda was used, I must say I was always of opinion that too much was used, for when the cylinders or valves were examined all the wrought iron work had a silvery, scoured appearance, which I cannot say I ever observed when using common soda.

I may also mention that I have never observed any evil effects in any of the boilers caused by either caustic or common soda.

With regard to Professor Lewis' second proposal, viz., to make free use of the scum cocks, I am perfectly at one with him, and I think there may be members present to-night to whom I have recommended it. The only drawback is that when they are used it is at the expense of fresh water, and unless fresh water is at hand for refilling I do not consider it possible to take this course. I have on several occasions recommended the raising of these scum pipes to such a level that they were able to remove the scum, with a minimum of loss, and still leaving the water a few inches in the glass.

I am sure that we will all hail the time when it will be possible to so clear the sea water of all the low temperature scale-forming properties, in some such manner as that proposed by Professor Lewis, but I am afraid that in the meantime we shall require to have the use of fresh water, and fresh water alone, for the marine boiler, and with care on the part of the marine engineer, and a co-operation on the part of the shipowner and his representative, the captain of the ship, by giving the former every, and as much opportunity as possible, for cleaning purposes, I think that there ought to be very little fear of much damage accruing to the boiler.

I have already referred to the use of zinc as a preservative of the interior of the boiler, but as this was very well discussed in the paper read by Mr. Green last session, I scarcely think it is necessary to say much on the subject, still it must be mentioned, as its application forms one of the most important points of treatment, conducing to the durability of marine boilers of the present day.

In bringing it before you, however, in the present paper, I only wish to confirm the general conclusions which were arrived at at that time, and as Mr. Green, in his closing

remarks, said he would be happy to receive the results of experiments by any member, I shall now give one of those which I have been able to make since that paper was read, and which bears strongly on one of the points then placed before us, viz., the efficacy of good contact.

In the summer of last year it was reported to me, that in one of the ships coming under my observation the boilers were showing signs of corrosion, on the combustion chambers and furnaces. On a personal examination of this I discovered that the zinc plates were placed in rough hangers hooked over the main stays, &c. (a system which I may here say I never did approve of), and the boilers did not look what I should call particularly healthy. Knowing they would be directly under my notice at each time the boilers were opened up, I proposed to the Chief Engineer that we should try the following experiment :— At one of the worst looking places in the set of boilers a stud was screwed into the furnace side, as near the position of one of the hangers as possible; in fact when the zinc plates were in place, they were only separate an inch or two. On this stud a 6 by 6 by 1 *rolled* zinc plate was fixed, by a hole bored through the centre, and it was also screwed hard against a collar, in much the same manner as the studs used by Mr. Phillips, as mentioned in the paper referred to. The stud had also a slight taper on the body. Another plate of same material and dimensions was placed as usual in the hanger. Both plates were carefully weighed, both before and on completion of the voyage, with the result that the one on the stud had worn considerably more than the other. For the next voyage the plates were interchanged, the one previously on the stud being placed in the hanger, and the one on the hanger fixed on the stud.

The hole in the first one which was on the stud was carefully filled up with a piece of zinc of the same quality as the original, so that there might not be any more surface exposed than in the first experiment. At the end of the second voyage I found that the two plates had very nearly come to the same weights, having in the two voyages wasted nearly the same amount, that on the stud having wasted most on both occasions. I give actual data of weights :—

First Voyage. Time under Steam 787 hours.

Position of Zinc.	Weight at beginning of Voyage.	Weight at end.	Loss during Voyage.
On Stud.	8 lbs. 13 ozs.	5 lbs. 14 ozs.	2 lbs. 15 ozs.
In Hanger.	9 „ 0 „	8 „ 6 „	0 „ 10 „

There was thus a greater loss on stud zinc of 2lbs. 5ozs. for the voyage.

Second Voyage. Time under Steam 746 hours.

Position of Zinc.	Weight at beginning of Voyage.	Weight at end.	Loss during Voyage.
On Stud.	8 lbs. 3 ozs.	4 lbs. 13 ozs.	3 lbs. 6 ozs.
In Hanger.	6 „ 1 „	4 „ 8 „	1 „ 9 „

There was thus a greater loss on stud zinc of 1lb. 13ozs. for the voyage.

I think this is fairly conclusive that good contact is necessary and most effective, and I may also add that the adjacent portions of the boiler looked much better on completion of these experiments.

With this, therefore, I shall conclude the zinc question.

There is a custom which I fear is still very prevalent amongst seagoing engineers, and which ought to be discouraged at all times. This is the opening of smokebox doors for checking the draught. There is not the slightest doubt that it is very injurious to the tubes and tube plates, and though I believe most engineers are perfectly aware of this, still it is practiced to a very great extent yet. In my opinion it is more advisable to allow the safety valves to lift and blow the steam into the air than to open these doors. I do not think it is at all times the fault of the engineer that either case has to be resorted to, for I am of opinion that there should be more communication passed from the deck to the engine room as to the whereabouts of the ship, and *due* notice given as to the probable time she is likely to be brought to anchor. There is also, it seems to me, a prevailing opinion amongst captains and officers of steam ships, and particularly so when in intermediate ports, that as steam is on the boilers they can demand the engines to be moved at any moment. I think if these gentlemen could be brought to understand that a considerable amount of harm can be done by not giving due notice as to probable time of arrival in port or even departure from it, many defects would be avoided, both in engines and boilers. A case came under my own personal observation some years ago. The ship in which I was then serving was coming up Channel in the face of a strong easterly wind and a heavy sea running, on a pitch dark night in the middle of winter, when suddenly the telegraph rang slow and immediately thereafter stop. Fires were heavy, and, in consequence, up went the steam, roaring off at the safety valves. Smokebox doors were thrown open (it having been the custom in that ship to do so up till that time, but never afterwards), and in a minute or two thereafter from the back end of two of the furnaces in one of the boilers the water came pouring out in a stream, so much so that we had to draw fires and knock off that boiler almost immediately. I afterwards

found out that the ship had been brought to anchor in the Downs, as had been the pilot's intention from the first, though such intention had never been communicated to the chief engineer, for had such been done and due warning given on approaching the anchorage, the damage to the boiler would certainly have been prevented.

In a long run I daresay many will say that it is absolutely necessary that smokebox doors be opened for the purpose of cleaning tubes, but even this is not so much required as it often appears to be. If the bottoms of the smokeboxes, and especially the corners, be kept clean (and they can be fairly so by means of the small sliding doors now usually fitted) then there is not so much need for the frequent sweepings which formerly were required. Besides, when it is really necessary to sweep tubes, the fires can be reduced and furnace doors and ashpit dampers kept closely shut during the operation.

There is, however, an operation which is abosolutely necessary at sea, at least in the majority of steam vessels, and which there is no doubt is fraught with a considerable amount of danger to the furnaces and combustion chambers of boilers. I allude to cleaning of fires. How we are to cope with the inrush of cold air during the time this is being done, and prevent its impingment on the already intensely heated, and consequently, expanded plates, is somewhat difficult to solve, and until some really good mechanical means of stoking and cleaning fires, without the necessity of pulling the fire out by the furnace door is obtained, I fear that we shall still continue to hear of leaky seams or tubes. The only thing, therefore, for the engineer to do is to avoid as much as possible the exposure of these parts to such extremes of temperature. The cowlhead of the ventilator nearest the fire which is being cleaned, should be turned away from the wind during the time of cleaning, and till the new fire is well alight. I am afraid that these ventilators are the cause of many leaks, and I think my statement can be verified by some members here to night, that in many instances a cracked or leaky saddle-corner is first found in the furnace nearest the bottom of one of these ventilators. Of course I do not say this is always the case, but it is so very often.

Various methods have been proposed for protecting these furnace and firebox seams, by covering them with fire bricks and fire clay, and so prevent their exposure to the fierce heat in the one case, and the cold air in the other. Of these I wish to say but little, for I am inclined to think that what is gained in one way is lost in the other, and it will be found that in too many instances, even with this protection,

leaks will take place all the same. It is my opinion that if due care be exercised in preventing too great an inrush of cold air, and careful attention be paid to keeping these seams well cleaned on the inside, there will not be much trouble experienced with them, that is, of course, always assuming that the original construction is not at fault, which, I fear, is too often the case.

There is one more point in the working of boilers at sea to which I wish to draw your atten tion, and which refers more particularly to high powered vessels, having a number of boilers. Often in such ships it is not necessary to utilize the full power of the engines, and I find that under such circumstances it is a common practice to knock off one or more of the boilers, so as to economise fuel. Now, in my opinion, this is altogether a mistake and ought to be discouraged. In my own experience, I have found it what I believe to be the cause of much internal corrosion, and I may say that when I now hear of any apparently unaccountable corrosion being observed, the first thought that strikes me is that the Chief Engineer has been working only some of his boilers during the voyage, and I almost invariably find that such has been the case. If the boiler should have been kept full, so as to be ready to light up at any time, with the least possible delay, I think it is even in a worse plight than if it had been kept empty. In the latter case I do not think there is quite so much harm done, of course, always assuming that it is otherwise kept free from vapour and perfectly dry. No one can estimate the evil that is worked in a boiler through leaky stop valves and feed valves, especially if neighbouring boilers are kept at work all the time. Water ought *never* to be allowed to lie in the bottom of a boiler, on any account. In proof of the foregoing rema rks, I can only ask you to think of the state in which donkey boilers, after a few years' work, are found, viz., almost quite condemnable, while their sister main boilers of the same age are practically as good as ever, and I contend that the intermittent working of donkey boilers, one day with steam on, another with none, one day full of water, and another nominally empty, is the most prolific cause of the decay of these too often ill-used portions of the machinery of a steam vessel.

TREATMENT AT TERMINAL PORTS AND CONCLUSION.

On arrival in a terminal port there is really but little to be done that has not already been mentioned in some part of this paper. The use of scum cocks has already been referred to, and it is now when the boilers are of necessity

to be emptied that these should be utilized; but in my opinion this is, as a rule, left too long. If (as I have recommended) they are placed high enough to allow two or three inches still to show in the gauge glass when steam is blowing from them, then I say that the scumming ought to take place as soon as possible after the ship has been slowed down, and when, as it were, the water in the boiler is still "on the boil." The water in the glass ought to be sufficient to take the vessel into her berth. When everything is finished, and orders passed that engines are no longer required, a short blow from the bottom does, in my opinion, some little good by removing portions of the muddy deposit from the bottom, but care must be exercised that this blowing does not last long enough to bare any of the chamber crowns.

In the earlier part of this paper I have shown that it is necessary that steam should be slowly raised, and now I would say it ought to be as slowly lowered. Consequently I contend that upon no account should the old custom of completely blowing out the water and steam be adopted, all that is required in that line being what has been mentioned above. As to the necessary manipulation of the fires, there is nothing except to see that all doors and dampers are securely shut, the fires being allowed to die out, and so every facility given for the gradual cooling down. I shall further recommend that if at all possible at least twenty-four hours should be allowed to elapse before any water is let out of the boilers. When this latter has been done the engineer should see that the insides of the boilers are dried out thoroughly, as early as possible, light fires being kept in the furnaces for this purpose, if required, and I may here remark that a good large fire, carefully built in the centre of the stokehole during damp and cold weather, cannot, by any means, be looked upon as a useless waste of fuel, in fact, I rather consider it the reverse.

As to cleaning the boilers, I am sure you are all as cognisant of what is required as I am, but I have hopes that with the appliances which are gradually being placed at our disposal, and by careful attention to some of the methods of working boilers which are brought before your notice in this paper, that the time is fast approaching when a moderately hard brush will be sufficient to do all that is necessary in that line.

And now, gentlemen, in conclusion, I shall once more impress upon you the fact that the "Treatment of boilers" is a subject which is of vital importance to us all, and if in a free and open discussion of its several points, any hints can

be given which will tend to improve the system of working that is generally adopted at the present time, then I shall consider that the object for which this paper has been written will have been accomplished.

INSTITUTE OF MARINE ENGINEERS.

(INCORPORATED.)

SESSION 1892-3.

LORD KELVIN, PRESIDENT.

VOLUME IV.

DISCUSSION

ON THE

TREATMENT OF MARINE BOILERS

(THIRTY-EIGHTH PAPER),

READ AT

Gresham College, Basinghall Street, E.C.

ON

MONDAY, SEPTEMBER 12, 1893,

Discussed at 58, *Romford Road, Stratford, E., on Monday, September 26th*, 1893.

Continued on Mondays October 3rd and 10th.

PREFACE.

58, Romford Road,

Stratford, Essex,

October 10th, 1893.

A meeting of the Institute of Marine Engineers was held here this evening, presided over by Mr. A. W. Robertson (Vice-President), when the discussion on the paper, "Treatment of Marine Boilers," by Mr. W. W. Wilson, was concluded.

The paper was read at Gresham College, on Monday evening, September 12th; the discussion was adjourned till September 26th, and was further adjourned till October 3rd, and concluded this evening.

The discussions on September 26th, October 3rd and 10th were held at 58, Romford Road.

JAS. ADAMSON,

Honorary Secretary

SESSION 1892-3.

THE TREATMENT OF MARINE BOILERS

BY

MR. W. W. WILSON.

Discussion at Gresham College, Sept. 12th, 1893.

THE CHAIRMAN,

(MR. W. H. NORTHCOTT, *Vice-President.*)

We have all, doubtless, listened to the paper read by Mr. Wilson with very great interest and attention, and as the subject is one which affords ample room for discussion, I will at once call for some one to begin, what, I expect, will prove a valuable contribution to our transactions.

MR. R. BRUCE.

(*Member.*)

In regard to the paper read, one can with pleasure congratulate the author upon the clearly practical and useful nature of his work, and of the special points with which he deals, I think those bearing upon the treatment under steam the most interesting. The author's recommendation that the boilers should be subjected to a "baptism" of salt water, will generally be concurred in by the members, and I think also that the subject of the Filtration of Feed Water was worthy of the prominence he gives it. Engineers well know that however careful they may be respecting internal lubrication, oil does get into the boilers. Therefore given a reasonable method of preventing this, no doubt it should and will be adopted; from actual observation, I should say that the apparatus spoken of by the author, viz.: Edmiston's, is the most effectual at present before the shipowning public. There is, however, an equally important, if not all important matter, to be dealt with in working marine boilers, and that is the air supply to the furnaces. The experiences the

author mentions are now happily avoided, and in all properly equipped steamers the air supply to the fires is under as complete control as is the supply of the feed water to the boilers, so that combination and evaporation are quite at the command of those in charge, while the comfort of the firemen is assured. This occupation, at all times a very trying one, is reduced from its hitherto toilsomeness, and one might also say degrading influences, and further, the air supply being heated, a uniform temperature in the furnaces may be maintained during the operations of stoking and cleaning, from the fact that all cold air in-rushes are prevented by the adoption of Mr. Howden's methods. In respect to the question of corrosion, it will be gathered from the foregoing, that, given a properly designed boiler with good natural circulation, the evils of "mechanical" corrosion may be altogether overcome, but, that of "chemical" corrosion will, I fear, be always with us, from the very nature of the material with which we have to deal, in that the chemical homogenity is practically impossible. Such homogenity can only be approached in fused metals, such as cast steel, and many years ago (1859) locomotive boilers made of cast steel plates, worked for many years without signs of pitting, although under similar conditions iron plates had suffered severely in this way. Pitting may thus be defined as a form of corrosion localised in particular spots by voltaic action. Therefore, to resist that action known under the name of pitting, a maximum of electro-homogenity is required in all the component parts of the boiler.

MR. W. E. LILLY.

(*Associate.*)

I have listened with pleasure to Mr. Wilson's paper. As a record of practical experience, it is no doubt valuable, but it seems to be deficient in this respect, that although the methods advocated have stood the test of experience, the reasons on which these methods are based are not given, as for instance, the use of caustic soda passed in with the feed water and the use of zinc, and why so much difference of opinion should exist with respect to the method of fixing the same, and whether the waste of the zinc should be so much attributed to galvanic action as it often is. Another point which many engineers differ on is the density at which the water in the boiler should be worked, this bearing directly on the question of the precipitation of the scale, and this again on the temperature at which the salts are precipitated; these and many other points are of interest, especially as so much difference of opinion exists among engineers with regard to the working of boilers.

MR. D. GREER.

(*Member.*)

There is one part of the paper which I think requires further explanation by Mr. Wilson. I refer to that at which he says smoke-box doors ought not to be opened for checking the draught. My opinion is that the opening of these will do no harm, but the opening of fire doors may. If smoke-box doors are opened, the draught is stopped by the rush of the air from the stokehole up the funnel without passing through the tubes, therefore it cannot do harm to the back ends, whereas if the furnace doors are opened, cold air must get in and naturally cool the inner ends of the tubes. I cannot therefore understand why Mr. Wilson wishes the opening of smoke-box doors to be discontinued, and for my own part I should say it is the best thing to do if we wish to prevent the rising of the steam.

I am speaking thus from experience which I had some years ago in a steamer, whose back tube plates were so very bad that they leaked less or more every time the furnace doors were opened for stoking, and we found that the leakage was in a great measure obviated by first opening the tube doors and so preventing the cold air from passing through the tubes.

ADJOURNED DISCUSSION

ON THE

TREATMENT OF MARINE BOILERS.

HELD AT

58, ROMFORD ROAD, STRATFORD,

ON

MONDAY, SEPTEMBER 26TH, 1893.

THE CHAIRMAN

(MR. A. W. ROBERTSON.)

The subject for discussion this evening is the paper read by Mr. W. W. Wilson at the last meeting in Gresham College, on "The Treatment of Marine Boilers." I had the pleasure of reading the paper, and certainly must say, to begin with, that I admire the spirit in which Mr. Wilson has dealt with the subject, as I consider he has treated it in such a

manner that I am sure all present who have had any experience with boilers will cheerfully come forward and give their experiences and the results thereof. I may have a few remarks to make on the paper, but would wish to defer them until a subsequent period of the discussion. I would first ask Mr. Adamson to read any communications that have been received from members unable to be present, and I would then ask some of the gentlemen present to express their views.

MR. R. BRUCE.

(*Member.*)

"I am sorry that previous engagements and distance from home, prevent my attendance at the meeting this evening to listen to the prolonged discussion on Mr. Wilson's paper. In respect to his remarks on the filtration of feed water, will you please inform him that where Edmiston's arrangement of filter is used, zinc, in any shape or form, need not be employed in the boilers. The use of common soda with the water filtered meets the case completely. The soda may be used in the proportion of 3lb. per 1,000 I.H.P. per twenty-four hours. Further, if impurities in the water have to be dealt with, this should be done while the water is outside the boiler, not after it has got inside, just as Mr. Weir, with his feed-heater endeavours to free the water of air by breaking it up into spray before passing it on to the pumps.

On the general questions raised in Mr. Wilson's paper I have little more to add to previous remarks. I might emphasize these, by adding that there is now no longer reason to dread injury to boilers from the effects of cold air. With an air supply heated, and under complete control at the furnace front, all ingress of cold air is prevented. Evaporation is under command by simply stopping or starting the fan. Heated air is just as advantageous in its way as heated feed water, and as no one at this date would for a moment dream of feeding with cold water, certainly no furnace should be supplied with cold air, especially as the air may be heated by waste gases, which is a direct source of economy in proportion as the funnel temperature is reduced."

MR. ALEXANDER JOHNSTONE.

(*Member.*)

"I had great pleasure in hearing Mr. Wilson's paper on the treatment of boilers, which all, I think, will agree to be a very interesting subject, and worthy of our best consideration, more particularly with regard to the design and construction of boilers.

I feel sure that were we all to give our experiences on the working of the Marine Boilers that have been under our charge, it would be very instructive, and form a very valuable source of information to all concerned.

So much could be said on the treatment and working of marine boilers, that any remarks I may have to make may be considered more in continuance of what Mr. Wilson has already given us.

In going back over twenty-two years, to about the time of my first experience in charge of the working of marine boilers, I remember having to do with two single-ended cylindrical and multitubular boilers, with two furnaces in each, and loaded with dead-weight safety valves to a pressure of 20 lbs. per square inch. The engines were jet-condensing, consequently the boilers had to be fed with the admixture of sea water and condensed steam, the temperature of the hot well being about 100° F. The boilers were usually filled with sea water, and the density was about one and five-eighth thirty-seconds on the Salinometer, equal to about seven and a-half ounces per gallon. The scum cocks were, with the ship under weigh, kept partly open, to maintain a uniform density of $1\frac{5}{8}$. I never remember seeing the thick heavy scale that Mr. Wilson speaks of; but in corroboration of his statement, I have heard that boilers have been in the state described, with scale and dirt. I have heard chief engineers say they like to see a light coating of salt and lime scale over the plates, and especially the heating surfaces, as it tended to prevent corrosion and pitting of the plates.

I quite agree with what Mr. Wilson says in the matter of getting up steam, as it was customary for the fires to be lit from three to four hours, and even less before steam was required; and with the system then adopted of seating boilers with the bearers so low down as to be almost on a level with the tops of the ship's frames—more especially in paddle steamers with flat bottoms—with a few inches of water in the bilges, the ship rolling, and the lower parts of boiler shells wet and damp, this rapidity in getting up steam was no doubt the sole cause of so many leaky seams, rivets, &c. And, as Mr. Wilson states, on the arrival of the ship at the terminal ports the boiler fires were drawn and boilers blown down sometimes in less than one hour after the fires had been drawn, the remaining steam being blown off through the safety valves; or in other cases the order has been given to keep everything shut, as the steam in condensing helped to soften the scale in the boilers. Regarding the treatment of boilers during construction I have had no experience of the process of pickling the plates that Mr. Wilson recommends, but I have experienced and noted very favourable results from the use of good white zinc paint both on the

shells and heating surfaces where corrosion and pitting of the plates had been going on, and that by the cleaning and scraping of the iron at pitted parts, and coating it with the zinc, this has arrested any further pitting of the part affected.

With regard to the treatment of boilers under steam, I would say that about eighteen, but never less than twelve hours should be allowed for raising steam. I will give my experience of the working of two single-ended boilers, with three furnaces in each, and loaded to 160 lbs. that were under my charge for nearly two years. The steamer was in the coasting trade (foreign service), and made short voyages of about seven days' steaming. It was my custom on arrival at terminal ports to let the fires burn down and keep all dampers closed. Then on the following day, but never less than twelve hours from the time firing ceased, I had all the clinker and ashes drawn, and the tubes, &c., cleaned. Being on short voyages, and always using fresh water both in the re-filling and feeding of boilers they were allowed to run about four months before being opened for inspection and cleaning. On one occasion they had been under steam continually for seven months, and during the intervals of the voyages, when the ship had several days at terminal ports, with no steam on the boilers, a part of the water was pumped overboard from the bottoms of the boilers (by a special pump so fitted for circulating the water when raising steam), and the boilers re-filled from fresh water tanks. The fire bars were also coaled and all covered very carefully with the four wing fires filled up in the fronts, close to the crown plate of the furnace, the ash-pit dampers shut, and when about to raise steam the centre fires were lighted about eighteen hours before steam was required, and allowed to burn until well alight. Then the funnel damper was kept shut, with the ash-pit dampers very little open, and about three hours before the engines were required, the wing fires were lighted with all the dampers a little open.

On opening the boilers on one occasion I found slight traces of pitting on the tops of the combustion chambers, and the top rows of tubes. The zinc slabs 12 in. by 6 in. by 1 in., had been in the boilers four months, some were fixed on studs, secured to the sides of the furnaces, while two zinc plates simply fixed in iron bands and hung from stays were suspended over the back of the combustion chamber. I had no new zinc plates in stock, and having received instructions that the ship was to run on a new itinerary, and would be under continuous steam, at the same time suspecting from the general appearance of the boilers that oil and grease was the cause of the pitting, I had the main and auxiliary condensers and fresh water tanks cleaned. I found a considerable amount of oil and grease in the tanks under the engines, their arrange-

ment being such that when the engines were working in and out of port all the surplus water or condensed steam that the feed pumps could not clear—on starting the engines—from the hotwell, passed into these fresh water tanks, as well as the drainage from the auxiliary condenser ; and on opening the boilers after being under steam about seven months I found the zinc slabs completely wasted. There was also a slight coating of lime scale on the bottoms of the corrugations on top of the furnaces. Otherwise the boilers were in a beautiful condition, there being no traces of pitting or signs of corrosion. I may say that during the period mentioned, it was customary every fortnight, when time permitted in terminal ports, to lower the steam to about 50 lbs. and pump a part of the water from the bottom of the boilers overboard, which kept the density of the water about $18\frac{1}{2}$ ounces on the salinometer, caused by the small leakage of sea water from the condenser, &c. I had a bracket made and fitted with a helical spring to the delivery valve on the ship's side, from the hotwell, and so loaded it that the valve would lift with the starting of the engines, which prevented any sea water from entering the hot-well, and during the two years of experience referred to, there were no boiler makers employed, or repairs needed on the boilers.

I would very strongly advocate the use of a good and sufficient means of filtering all feed water for H-P boilers, also the use of common soda, about a quarter-pound to every ton of coal consumed :—a proportion consumed in boilers under my charge for nearly eight years, which gave very good results in neutralising the effect of oil.

With regard to cleaning fires or smoke-boxes at sea, I approve of burning the fires well down and having the clinker raised from the bars so that in the act of cleaning the fires the door is open as short a time as possible. The bars should be well covered with the fresh coal before relighting, and the ash-pit damper kept partly shut until the fresh coal is well alight. In the cleaning of the tubes and smoke boxes, I would say that by clearing away the accumulation of soot in the smoke boxes about once every forty-eight hours or so, the tubes are kept comparatively clean. I have noticed that on a sudden stoppage at sea, with the fires heavy, a large flame came back under the fire bars on the sudden opening of smoke-box doors, which no doubt is caused by the inrush of cold air to smoke boxes, and through the tubes, although I believe it to be only momentary. I would say, open the smoke box doors in preference to fire doors, as being the least of the two evils, but with the modern boilers having a silent blow-off valve to the main condenser, with independent circulating pumps, there is no need to open the smoke-box doors, as by closing all dampers the

generation of steam is partly checked, and in corroboration of what Mr. Wilson says, very much good could be gained by a little wise consideration on the part of the captain regarding the chief engineer's department and his duties.

With reference to having a boiler when not in use, either kept full of water or empty, as a means of preservation, I would say that the least of the two evils would be to have it full of water as the most practicable on board a steamer.

In conclusion I would remark that much has been gained during the last ten years, both in the treatment and economy of the marine boiler by the introduction of feed-heaters and independent feed pumps.

MR. S. C. SAGE.

(*Member of Council.*)

The interesting paper on the treatment of Marine Boilers which is under discussion this evening has recalled to my mind recollections of different kinds of boilers, and the treatment that was considered proper for them, and looking at the different system which now prevails, I can well understand that marine engineers of the present day would shudder at the contemplation of such treatment. In the early days of my sea-going experiences we had to deal with a very different kind of boiler (and engines, too, for that matter), than are general at the present day, both in their construction and manner of working, and in the results obtained from them.

They were mostly then of a rectangular and box-like shape, with what was called a wet uptake, *i.e.*, covered with either steam or water spaces, the only parts not so enclosed being the smoke-box doors, which meant that the tubes were shorter than the furnaces by the depth of the smoke boxes. Pressures being then so much less than now, a great deal thinner plates were used in the shells, in some cases being even less than the furnaces—all arising from the large amount of flat surface exposed to pressure—thickly studded with stays of various kinds. It is now a well-known principle that steam should be raised slowly and gradually, but having during my engineering infancy had a great deal to do with steamers engaged in weekly trades, sailing generally late on Saturday nights or early Sunday mornings, it was the recognised rule that the firemen in turns took the "steam" (and two hours, sometimes less, was the time allowed), that is to say, they lit the fires and got ready for sea at the appointed time, the other members of the crew, including the engineers, coming on board just before the moorings were let go. I well remember calling on board one vessel, trading to Harlingen, as I was going home one Saturday night, about eleven o'clock, and going into the

engine-room, there I found the fires all roaring away furiously, and not a soul in the engine-room or stoke-hold. After being there some minutes a man came down, and I then remembered that I had passed him at the gangway talking to several others. He at once proceeded to heavily charge the already very heavy fires, and explained to me that it being his "steam" he had been late in getting aboard, and was afraid that when the second engineer came a few minutes before the advertised time of sailing he would not have the steam up at the working pressure (which on this ship was 15 lbs. per square inch), and would get scolded.

While we were thus talking, the safety valves suddenly opened and blew off furiously, and though the pressure was nothing to compare with present pressures, it made noise enough to scare us, and on going to the front of the engines and looking at the gauge there we found 16 or 17 lbs. registered, and the pointer vibrating somewhat. The gauge in the stokehold by which the man had been working was still at zero—in fact, stuck; an operation very frequently performed in those days, the mechanism being made with a rubber diaphragm, connected by a rack and pinion to the pointer instead of the Bourdon tube. The usual methods (orthodox in those days), were adopted to reduce the steam viz., all the furnace and smoke-box doors were thrown wide open, the safety valves were further eased by hand, and the donkey put on. What ashes there were in the pits were drawn, damped and thrown on the raging fires to check as far as possible the rapid generation of steam. I do not know that the boiler of this vessel suffered particularly from the events I have just related, and I do not suppose that they were unique in its existence.

I have myself been in vessels where there was a small atmospheric valve fitted, intended, I believe to prevent the collapse of the shell if the steam fell below the pressure of the atmosphere. The safety valves were set at 7lbs. per square inch, and the plates at the back of the combustion chambers and in the wet uptake were in many places less than $\frac{3}{16}$" thick; in some places indeed when we bought the vessel the plates had corroded completely away. On the voyage from Lisbon to Hull I have seen the steam gauge showing less than 1½lbs., and yet the engines rattling merrily away at 60 revolutions per minute, and it was a lucky watch indeed which obtained enough steam to keep the scum away.

The amount of water which had to be blown or scummed out of these boilers to keep the density down was enormous and the amount of scale deposited was, in spite of it, also enormous.

I must apologise for this digression from the subject of Mr. Wilson's paper which deals with the boilers of the pre-

sent day, but may remark that similar treatment to that I have just described prevailed to a large extent after the introduction of the compound engine, with boilers working at a pressure of 60 lbs. per inch, and generally I must say, with unsatisfactory, and frequently, with disastrous results. Mr. Wilson has so ably treated his subject that it leaves little room for discussion, save for members to give us their individual experiences, but before concluding my remarks I may say that to minimise the amount of the unpreventable waste of feed water and the quantity of oil used for internal lubrication, should be the first thought of those in charge. Where oil must be used in any quantity some filter or interceptor should be placed between the pumps and the boilers.

I was shown a patent for this purpose, by the inventor, after it had been fitted on a steamer, and also a large amount of grease, &c., which was stated to have been taken out of the filter in a very short time, and it was more than would fill a gallon measure, so that I should say there had been in this case a large quantity of oil used, or its quality for cylinder lubrication was not good.

The filtering medium in this filter was many thicknesses of flannel between perforated iron plates, and from the appearance of those flannels which were taken out of the filter for my inspection, and which were stated to have been in use a short time only. I should say that the difference of pressure at the inlet and outlet of the filter would be considerable.

For my part I should prefer the filtration of the feed water to be effected by some more porous material than the flannel above named, say, the coke mentioned by Professor Lewis, and quoted by the author, or pumice stone, or other suitable material, arranged in a receptacle that would not cause much extra pressure, and where the filtering media could be readily and rapidly cleaned or renewed.

Respecting the use of soda in marine boilers I fully believe that it is highly beneficial in correcting acidity which may be from any cause present in the water, and I had one young engineer under my notice some four or five years ago who used regularly to test the water in his boilers with litmus paper, and regulate the injection of soda solution by the quantity of acidity shown to exist. A friend of mine who has had charge of a fleet of steamers for twenty years, has very consistently and continually used soda in the boilers to the extent, I believe, of 4lbs. per day per boiler, and he has some vessels of 16 years old with their original boilers working now with the original pressure.

MR. P. SMITH.

(*Member.*)

In perusing Mr. Wilson's paper, I was pleased to find he had gone into the subject so extensively, and as he has had an opportunity of observing the results of various treatments, I consider his paper a valuable one, both for the information it contains, and the large field for discussion it opens up. The first part of the paper is merely a retrospect which it would be well for every marine engineer to be acquainted with, but as it would be waste of time to discuss that portion of the paper, I will pass on to the more modern marine boiler, and the improved treatment of the same.

On page 9, under the heading of "Treatment of Boilers during construction," Mr. Wilson's remarks are very practical as regards the painting with white zinc, mixed with kerosine oil, but more especially in having the zinc pans properly fitted and the zinc slabs in their places before steam is raised in the boilers. This I consider very important, as the sooner the zinc begins to act on the boilers the sooner any corrosive action will be checked. In my experience of new boilers this action commences early and goes on very rapidly especially on the iron tubes, for the first six months, when by proper attention to the zincs being kept clean as opportunity occurs, and renewed as required, the corrosive action will gradually cease, being a proof that one important step has been taken towards prolonging the life of the boiler.

On page 11, under the heading of "Treatment under Steam," I agree with Mr. Wilson about the importance of raising steam slowly, I should say as slowly as possible, and to circulate the water thoroughly by means of a good circulating donkey pump in the manner he describes. An ordinary pump will circulate water quite well until the steam reaches a pressure of 60lbs., by which time the temperature will be nearly uniform, and undue strain on the boiler prevented. The donkey pump is the best arrangement for circulating water in the boilers that I know of, and is very useful for other purposes, such as pumping the boiler water overboard, instead of blowing it out or running it into the bilge, as is often done.

I now come to a part of the paper where I entirely disagree with Mr. Wilson, viz., his suggestion to fill new boilers with sea water, and to make good the waste for the first few days from the same source. I consider this a very dangerous practice, especially with high pressure boilers having corrugated furnaces. We have heard of a good many furnaces of new boilers coming to grief during the last ten years, due to want of precaution, and error of judgment, in putting

too much faith in sea water not being dangerous. My experience has been that to make good the waste with sea water in high pressure boilers is undoubtedly a source of danger, and I would advise every engineer whose duty it may be to take charge of a set of new boilers, to first satisfy himself that they are thoroughly clean, to fill them with fresh water, and endeavour to keep them fresh as long as he possibly can. Now that the use of zinc in boilers has been proved to be such an excellent antidote for corrosion, why do we want any protective scale? That in my opinion belongs to the period Mr. Wilson refers to in the introduction of his paper. I tried one voyage to get a scale on a set of boilers (where the tubes were corroding considerably), by filling with sea water and making good all waste from the same, but to my great disappointment I found a heavy scale on all the vital parts of the boilers, but none where I wanted it. This scale took the next twelve months to get off. Since then I have tried to keep boilers entirely fresh, with excellent results.

I have no doubt that the fresher the water is kept in the boilers the more effective will be the action of the zinc.

On page 12 I am pleased to notice that Mr. Wilson admits that fresh water is the only water that can be relied upon to keep boilers as they ought to be kept, but he introduces another element of danger which must not be overlooked, viz., the greasy deposit due to internal lubricants in the engines. Owing to the inferior quality of cylinder oils the market is flooded with, this is, indeed, a source of danger which we have to guard against, and to do this, I believe in scumming the boilers in a systematic manner. I have known some engineers who advocate the scum being blanked off, but I would sooner dispense with the blow-down connection than the scum pipe. To scum a boiler requires a good deal of fresh water, but, as Mr. Wilson says, a modern engine-room is not complete without an evaporator, and I am sure any sea-going engineer could design an evaporator, simpler, and more useful than one-half of the so-called patent evaporators, so that the shipowner if he chooses has not far to seek for ample means of providing his boilers with fresh water. I will now conclude my remarks by stating that I am inclined to think that sea-going engineers, as a rule, pay too little attention to the management of their boilers, the system of firing, &c. Economy must begin in the stokehole, and a little neglect in that compartment means a waste of tons of fuel per day.

MR. G. B. SHEPHERD

(Member.)

On page 11 of this very able paper read by Mr. Wilson I

observe he speaks of good circulation as being a very important point. I consider it *most* important, and in view of this discussion I thought it might be of interest to this Institute if I brought to your notice a system of circulation which I expect to be put into the market within the next few weeks. In furtherance of this object I have obtained a few particulars from my friends, Messrs. Ashlin & Co., whose permission I have to lay them before you this evening.

I am not in a position to give full particulars at present, but I hope that, with the permission of the Council, this system will shortly form the subject of a paper, in which all particulars will be given, and which will at the same time be practically illustrated by a working model.

The invention secures a perfect system of circulation almost instantaneous in its action within the boilers.

It commences its circulating action automatically, as soon as the fires are well alight, and continues without interruption while steam is being raised, whilst working under steam, whilst under banked fires, and even after the engines are finished with, in fact so long as there remains an atom of steam in the boiler.

It requires no alteration in the design of the ordinary marine boiler, and it is applicable to any existing boiler, of the usual type.

It can be fitted at the cost of but a few pounds, and can be taken to pieces in about half an hour, the putting of it together again occupying but little more time. It dispenses with all cocks, pipes, and outside connections, and as it is not under the control of any one it cannot be tampered with. It does not require any attention, as it is automatic.

It is now working in a most satisfactory manner, and when raising steam the bottom of the boiler simultaneously with the top is practically at the same temperature, consequently doing away with all unequal expansion.

The principle on which it works consists in utilising the action created in making steam, to create circulation at the same time.

This is accomplished by closing in the spaces between the combustion chambers, so as to form a trough or tube, having two sides formed by the sides of the combustion chambers, with an outlet, or opening below, near the bottom of the boiler, and an outlet also at the top.

The action is as follows :—As the water evaporated by the heating surface of the sides of combustion chambers, passes off as steam at the top outlet, it can only be, and is actually replaced by water from the bottom of the boiler, through the bottom of the inlet of the trough or tube, thus

causing perfect circulation at all times whilst there is any steam being produced.

Mr. J. J. GRAHAM.

(*Member.*)

I have listened with very great interest to the reading of this paper, which I consider of great importance. Still there are one or two points on which I do not quite agree with Mr. Wilson. We are told that it is advisable to use salt water in boilers for a time when new. Now I do not approve of this, and personally I do not use anything but clean fresh water, if it is at all possible to be had, and I am of opinion that the same good results in new boilers can be obtained by using only fresh water, and having a few extra zincs.

Mr. Wilson has given good reasons for using salt water in new boilers, but I have seen such evil effects from salt water scale, I would not use it when extra zincs would give as good results. With regard to the use of brine cocks, which has been recommended, my opinion is the day has come when they ought to be done away with ; the fewer cocks we have the better, and with distillers, evaporators, and filters, they are not required in ordinary working.

Should a leak at any time occur in the condenser, the blow-down cock is quite sufficient. There are three reasons for using the blow-down cock in preference to the scum. When we blow down we get rid of not only the densest water but also the coldest, and in a boiler that contains oily matter, that which is most objectionable is found towards the bottom ; for these reasons I consider the blow-down cocks most efficient. I am also of opinion that the size of these cocks ought to be still further reduced, and so prevent any vibration should they at any time be opened full when steam is up in boilers.

Regarding the use of feed-heaters and evaporators, why should we use live steam from the boilers or the casings ? I question if we have done all in the utilization of the heat which ascends the funnel ; my opinion is that a really good feed-heater should be placed at the base of the funnel where it would intercept the hot gases on their upward passage, and I do not think the mechanical difficulties connected therewith very great. There is nothing whatever to prevent a heater of such a character to be constructed strong enough to withstand the necessary pressure, and provision could be made to prevent any accident by having an escape valve fitted on the feed-pipe outside of the funnel, and non-return valves between escape valves and pumps.

Provision should also be made to circulate water through the heater and overboard when raising steam, or at any time when under steam and the feed heater is not at work; it ought also to be arranged that in the event of any damage being done to it, it could be shut off, and the feed water sent to the several boilers. The obstruction caused, and the heat taken away would tend to lessen the draught, but this is entirely overcome by forced draught.

I believe feed-heaters have been constructed and placed in the funnel, but their construction and the cause of their being discontinued, I have never learned.

Mr. W. E. LILLY.

(*Associate.*)

I had the pleasure of hearing the paper which is to-night under discussion, read at the Gresham College, and cannot but admit that it appears to be a valuable compilation of what practical experience has shown to be necessary for the treatment of marine boilers ; still it seems to me that the opinions which the author has put forward, to be made generally useful, require to have a more theoretical basis, or that the why and wherefore ought to be more fully explained.

The results of the experiences of Mr. Wilson, together with those of other members who have joined in the discussion up to the present, are no doubt valuable, still to be of real value to younger members, as well as to others interested, I think it would be advisable to have them tabulated, so that an opinion can be formed from those put forward by the majority. If these tend to confirm the theoretical side of the subject under consideration, engineers will then feel more confidence in applying them.

Reference has been made by Mr. Wilson to Professor Lewis' paper on "Boiler Deposits," and the means he recommended for preventing the formation of the organic and oily deposits. This was partly to be accomplished by the utilization of water of a higher density than fresh water (cleared of the principal scale-forming properties), so that the oily material would be kept afloat, and not be allowed to settle down on the lower portions of the boiler. Altogether the paper dealt with the subject in a most masterly way, and what made it doubly valuable was that so many practical engineers agreed with the results there stated, which were so little in accord with the notions which prevailed amongst engineers some time ago.

There is another remark I should like to make, viz., regarding zinc in boilers. Marine engineers seem to be

almost practically unanimous in their opinion as to the use of this material, but differ very much regarding the method of fixing it, and the results obtained.

The waste of the zinc is vaguely attributed to the electrical action, and where the water circulates most is the part where the zinc is usually found to waste most.

Considering the solvent action of water with its different compounds, and with air in solution, it seems probable that a large proportion of the loss of zinc can be accounted for in this way, quite independent of the waste due to electrical action. I have not yet been able to find any satisfactory explanation of the supposed action, and should like some further explanation on the point.

Mr. JAS. ADAMSON.

(*Honorary Secretary.*)

The treatment of boilers is a subject which arouses a good deal of varied experience and latent opinion into expression, and were these expressions all placed on record in our transactions they would form a bulky volume of interesting and useful matter.

My earliest recollection of the treatment of boilers dates back to 1868, when I assisted to overhaul and patch a boiler the combustion chamber of which was buckled and bulged, like the Paps of Jura. The inside of the boiler was coated with salt scale an inch and a half thick. The engines were high-pressure, direct-acting, and the vessel was employed in the coasting service. The details of the treatment I am not in a position to give ; the results were, however, very far from satisfactory. To me it seemed extraordinary that steam was got in the boiler at all. The man in charge of the machinery was a decent handy man, who evidently did not appreciate the dangers and responsibilities of the position he occupied, much less did the man he had relieved, and herein lay the original cause of the trouble, a cause which still rules, but to a very much less extent—that of placing machinery and boilers in the care of an unqualified man.

A Commander who has been introduced to a steamer direct from a sailing vessel forgets, or is ignorant, that steam is a power which requires to be controlled and guided with some degree of care and attention, and in this we have an element of possible damage to the boilers, when without warning the telegraph is changed from full speed ahead to stop. If this condition of things ruled only in the case cited, there would be ground for excuse, but as it seems to be of occasional occurrence with others than

Commanders recently changed from wind to steam, the protest against sudden calls without preliminary notice should, in the interests of the boilers and their treatment, be emphasised, as it has previously been in the interests of shafting in a previous discussion.

A large number of boilers, of from ten to fifteen years old, have within the last five or six years been deposed, and their skeletons given over to the tender mercies of the antiquary or the student of anatomy, or relegated to the limbo of forgetfulness, and this not because of their old age and bad condition, but chiefly because the rage for higher pressures has made them obsolete.

There are many boilers still at work, although 20 to 22 years old, carrying the same steam pressure for which they were originally intended. I refer of course to main boilers; the donkey boiler runs only half his years as a rule, due to causes which are all more or less obvious. Referring to the age and condition of main boilers, one frequent cause of deterioration was lamination, especially in the furnaces, but the introduction of steel has removed this entirely, or almost so. Boilers are working now with furnaces patched and stiffened owing to pieces having been cut out where the plates were laminated. Occasionally these defects have been visible on the fire side of the plate, and when probed have been found to go within an eighth of an inch or so of the water side.

In place of laminations now being the cause of trouble, when steel was adopted as a material for the construction of boilers, cracks became the events to look out for, and some strange experiences were gained. Without any apparent cause a plate would become rent, it might be inches or it might be feet, and it is a matter of history, into the details of which no doubt many have searched in the pages of the technical press—that at one period steel was looked upon as a very treacherous material. Why the tube plates of a boiler should be rent after a voyage or two, while the cleaners were at work upon them, or why another boiler should give way at a lower, after having been subjected to a higher, test pressure, are questions which were fully discussed some years ago; they are of interest yet, and some fresh experiences of a similar kind may be forthcoming in the course of the discussion on the subject when introduced in a future paper by one of our members.

Tube-box doors and furnace doors should never be opened unless absolutely necessary, and with the present usual system of stokehold ventilators, every care should be taken to trim the cowl-heads, so that the down rush of cold air may not do even worse damage than the opening of a

furnace door. I did have some painful experience showing the evil results following upon the systematic opening of doors on the slightest provocation. The practice surprised me more than the results ; results which culminated on our arrival in port at the end of a voyage with ash-pits streaming to such an extent that it was with difficulty water sufficient to avoid further disaster was kept in the boilers until the ship was moored at the jetty. There were, no doubt, other elements at work contributing to the results referred to, as very bad weather had been encountered, in the course of which seas were shipped, and the water accumulated till it washed into the furnaces, with stokehold plates lifted and bilge pipes choked.

It is impossible to avoid opening the furnace doors when cleaning fires. With a mechanical stoker and a system of rotary furnaces, this to a large extent could be obviated, and as there are indications to show the want of such, it is possible that some appliance may be brought to light to fulfil the necessary conditions.

The use of zinc was introduced into many boilers—which are running now with the original pressure—some eighteen years ago, in order to arrest the deterioration which was threatening to cut their lives short, and although I have heard of boilers running without zinc for many years, doing well, and showing no signs of pitting or deterioration, I cannot say more, not having seen them. I have examined boilers where no zinc was used, and where it was generally supposed there was no pitting, but my examination did not bear out the supposition.

The density at which boilers were frequently worked some ten or twelve years ago, was as high as from 24 to 30 ounces without any detriment. The blow-off cocks were never used in these instances, and as a rule were entirely discarded for use at sea in ordinary circumstances. After working the jet condenser to clean the grease, &c. off the tubes about the end of the voyage, the surface cocks are useful to take off any scum which may have been left in the steam side of the condenser, and which would therefore be drawn into the feed pumps, thence to the boilers.

The electric light engines are frequently the cause of the oily deposit found in the boilers, especially those of the rotary type. Many steamers run a voyage of from three to four months without using any oil for internal lubrication, except what is used in the swabbing of rods, this of course being a mineral oil.

There are several filters or dirt arresters in the market and in use, and these doubtless are of great service in preserving the boilers from deposits of one kind and another.

The feed heater acts to a certain extent as a refiner and purifier, but still leaves some refuse for another tool to catch.

I would deprecate the use of caustic soda, on the ground that unless the measure be taken exactly and the caustic soda well dissolved, it is apt to eat into the metal it comes in contact with. There is one thing further I would urge upon your attention, and that is to reduce to a minimum the losses of fresh water due to preventible causes. These are, in large passenger steamers, mainly in connection with the auxiliary engines and the bath rooms and pantry. For the former there should be a complete auxiliary condenser fitted in the engine room, from which all the water can be drawn for the boilers, either donkey or main.

For the bath-rooms the circulating discharge water may be used for hot baths in place of steam. This has many advantages, the chief one as regards the boilers being the prevention of the loss of fresh water.

It is of very great importance that ample time should be employed in getting up steam ; in summer 24 hours at least should be allowed, and double that in winter, if possible.

Mr. J. T. SMITH.

(*Member.*)

(Read by the Honorary Secretary.)

I agree with Mr. Wilson that the best means of circulating boiler water while raising steam, is, by pumping from the bottom and discharging through the feed valves, and I know no reason why either that method, or hydrokineters, should not be used until the pressure of the boiler in use, and in the boilers in which steam is being raised, becomes equal. I would be sorry to use hydrokineters anything like full open ; with valves more than one-eighth off the face, I would expect to find leaky pipe joints.

It is a common practice to run boiler water in the bilges, at terminal ports. I think that where fitted with hydrokineters, if the main steam pipe for same had a connection to a donkey suction, the boiler water might then be pumped overboard direct from the hydrokineters, and so save damage to bilges and boiler lagging, from the vapour rising from hot water in the bilges, and this connection might also be used for circulating the boiler water when raising steam, if preferred.

Many modern ships are fitted with a tank to receive exhaust steam, &c., from auxiliary engines, such as electric machines, donkey engines, winches, &c., and I believe this tank is in many cases a trap for considerable quantities of

oil, found inside the main boilers. My reason for saying so is, that in a ship I sailed in lately the exhaust tank had an overflow pipe carried to the bilges; steam escaped down this pipe, and damaged bilge plates and boiler lagging, so we had an internal pipe fitted to the overflow, with a small hole at the top to prevent siphoning, and this stopped the steam going to the bilges, for the end of the internal pipe was always covered with water. The result was that we found much more oil in the boilers than formerly. Now to prevent steam going to the bilges or oil to the boilers, I would suggest that tanks fitted like the above, should have the internal pipe for overflow carried back to the surface in the form of a U. The bend would stop the escape of steam, and the end being open to the surface of the water would carry off oil, &c.

A filter such as Mr. Wilson mentions would be a good thing, but unless fitted to donkey feeds as well as to the main, it would not meet a case such as I have stated, and I am convinced that in a modern big ship the auxiliary engines use more internal lubricant than the main engines.

Besides raising the scum pans as Mr. Wilson suggests, I would strongly advise the removal of the gratings that usually cover those pans. A chief engineer with whom I sailed some years ago had them taken off, and I have since done likewise on my own account, and never knew a brine pipe to be choked yet.

Every one must agree with Mr. Wilson about the use of the scum as soon as possible after arrival at a terminal port, and where fresh water can be obtained I think the scum should be used, even if time did not permit of opening all the boilers for cleaning.

A boiler that has been run out from the bottom should never be filled again without having been at least washed down from the top, for most of the surface powder that has been left after brining must have settled on the heating surfaces.

I have found a paint mixture of kerosene oil and red lead stand well on the outside shell of boilers under the bottom where not lagged, but I have never known any kind of paint to stand long on the front of a boiler, say from the bottom of the smoke-box doors, and would be glad to hear the opinion of any interested in this part of the subject.

Mr. R. DUNCAN.

(Member.)

On looking over this paper, on page 9, I find that Mr. Wilson recommends that the plates should be pickled: I

cannot see why this should be done, as I have seen furnace scale or bloom, as it is sometimes called, on the inside of a boiler in the steam space when the boilers were nine years old, so there could be no corrosion going on there, and as acids are used in the pickling process there is a danger of some acid being left in the plates and so cause pitting to go on under the paint.

On page 11 Mr. Wilson recommends the use of sea water for starting new boilers with, and goes on to say that a fine protective scale would thus be obtained on the inside surface of the boilers, which in after years proves of great value. I quite agree with him that a light scale is of great value on the inside of a boiler; but one formed by the use of sea water contains a certain amount of salt. We all know that a house built with mortar mixed with sea sand is always damp in wet weather, and so also with a boiler covered with salt scale, when exposed to the atmosphere. It will, when opened in port, always get dry or wet in a similar way, according to the state of the atmosphere; these frequent changes are eminently conducive to rust; in fact Mr. Phillips, in a paper read before this Institute proved by his experiments that wetting and letting dry was a process under which iron or steel corroded very fast; I therefore think that it is owing to this cause that there is often as much deterioration in boilers when a steamer is laying in port as when she is under way. The scale I should prefer to see on the inside of a boiler is a thin, hard lime scale without any salt in it, as it is not affected by the changes in the atmosphere, and at the same time forms a good protective scale. It has been remarked that scale formed by sea water does not always show a tendency to become damp; but this may be accounted for by the subsequent use of fresh water, which in time may take the salt out of the scale, and thereby change the nature of it.

With regard to that part of the paper where Mr. Wilson urges the use of studs for fixing the zinc plates to the various parts of the boilers, I think it is the proper thing to do. I have used this system for some years now, the studs being screwed with a taper, and the zinc plates tapped and screwed hard on to them, and I can confidently testify from experience that it is a most satisfactory system for the prevention of pitting. I have also found as Mr. Wilson has done, that the zinc plate fixed in this way wastes faster than those on hangers, the reason of this being that they are in a better contact with the boiler plates.

THE TREATMENT OF BOILERS.

DISCUSSION CONTINUED

AT

58, ROMFORD ROAD, STRATFORD,

ON

OCTOBER 3RD, 1892.

Chairman—

MR. A. W. ROBERTSON, (*Vice-President.*)

MR. W. W. WILSON.

Our Chairman, Mr. Robertson, has said that I have prepared a supplementary paper to lay before you, but I cannot say it deserves that name. It is merely a few notes I have made with reference to the discussion which has already taken place, and it is intended more for the purpose of putting before you some of the points which have already been referred to, and which I think deserve still further discussion, or to draw to your notice some points on which I should have liked to have heard more opinions expressed.

It appears to me that the principal proposals of treatment which I have suggested are generally approved, although there are some which have been almost passed over, more particularly that in which I have recommended that no one boiler of a nest should be kept unused while its fellows are at work. It has been mentioned that the best means of preserving a boiler is by keeping it full of water, but to do this in a proper manner it is advisable to maintain a pressure in it, and means must be supplied for letting out the air at the very top of the structure. It is further advisable to use a quantity of lime or carbonate of soda (preferably the latter) in solution with the water. This is no doubt the manner that may be recommended in the event of a single boiler, or even a number requiring to be preserved, provided they are all in the same condition, viz.: out of use, but it is not under these conditions that I wished attention to be drawn in the paper. What I should like to have is the experience of some of our members as to whether they had found any corrosion going on in a boiler which may occasionally be knocked off whilst its fellows (connected to work together if required) are at work.

At the discussion last week a point was brought up by one of the speakers to which I should like to refer, as I think it is of great importance. This is the custom which prevailed somewhat extensively (and may do so now for all I know) since the introduction of three-furnaced boilers, viz., that of lighting the centre fire and getting steam into the boiler by its means before lighting the others. This is a system of working which, in my opinion, should upon no account be countenanced, for there are strains set up in doing so that are very injurious to the boiler.

With regard to the system of brining which I have proposed at terminal ports (and which I may further state I should also approve being carried out at intermediate ports or at intervals at sea if on a long run, provided there was a possibility of replacing the water blown out with good fresh water), it has been suggested to do away with brine cocks, and our honorary secretary has even told us that blow down cocks ought to be done away with, and really had been abolished in many recently built ships. Now I don't approve of either being done away with, but should like to hear the opinion of others on the subject. I would again, therefore, recommend their use, as I have indicated in the paper. It was in this manner that I worked when at sea, but to show that on occasions the juniors in the engine room are inclined not to obey their orders so implicity as desired, and also for the purpose of impressing on such of our young members the necessity of strictly obeying orders, I may, I hope, be allowed to give a little episode in my own experience. As mentioned in the paper, it was my custom to have the brine cocks opened as early as possible after arrival, so as to remove the scum, brining being continued until it was certain that only steam was blowing, when the cocks were shut and the blow downs opened thereafter for a very short time. On one occasion whilst these operations were being gone through, I had some suspicions that all was not right, so I visited the stokehole, to find the boiler maker (who was supposed to be in charge of the work) absent. After sending for him I asked if it was not yet time to stop the brining and start the blowing from the bottom, as it appeared to me the brines had been blowing steam for some time. He then told me he had already done so at the beginning, before opening the brines, and he meant to let the latter blow away for some time, till the steam was sufficiently reduced in pressure. Having explained to him that by such action the real intention of the work was practically rendered useless, all the answer I got was that he did not think it mattered much, and his way of doing it allowed him to get out of the way

of the firemen doing their work. As a matter of fact, the boilers were never brined at all, for by the time the little was blown from the bottom, there was really nothing but steam to come out of the brines.

Another speaker at last week's discussion suggested, with regard to the brine pipes, that the perforated covers usually fitted over the pans in the boilers should always be removed. This I certainly think a most proper thing to do, and I may say that it was what I did myself.

The scums are fitted for the purpose of removing the frothy material, which floats on the surface, as well as the water. Why, therefore, should we place these gratings to strain the water, and so prevent the egress of the very material we wish to get rid of?

It was further suggested at last meeting that the opinions of all those engineers who had spoken might be tabulated, so that the results of their experience might be judged from the opinions of the majority. With that purpose in view I would, therefore, before concluding these remarks, take the liberty of submitting the following points as being those which, in the paper, are considered necessary for the successful treatment of the marine boilers of the present day.

1st.—It is advisable to have boiler plates (more particularly shell plates) pickled; as by doing so the paint, which has been found to be a considerable improvement in preserving the interior of the boiler, especially the steam spaces, will adhere more firmly from the beginning of the life of the boiler.

2nd.—It is advisable to raise steam on the boiler very gradually, and more especially when it is done for the first time.

3rd.—It is advisable when first filling the boilers for steam raising to use only pure salt water, and to continue such use during all trials and for a short time thereafter, such as for a few days' run, but that on completion of that, when the boilers can be cleaned out, the use of fresh water, and if possible, even distilled water, should be commenced and persevered in.

4th.—It is advisable to prevent, as far as possible, the oil used for internal lubrication from reaching the boiler. As it will be impossible to prevent this by stopping the lubrication altogether, for oil must get in by the various glands, even although it be stopped through oil cups, and as it also gets into the main condenser from the auxiliary engines, whose exhausts are usually led there, the only other way of prevention is by mechanical means, such as feed-heaters or filters placed on the pipes between the pumps and the boilers.

5th. —The use of carbonate of soda, or even caustic soda, introduced into the boiler, is a very good preventative of the damaging effect of any oil which might find its way there.

6th.—That it is necessary to have zinc fixed in boilers on some approved system, and further it should be introduced before the boilers are first filled with water.

7th.—It is not advisable to knock off any one of a nest of boilers, as such action is conducive to corrosion.

8th.—That brining and blowing is to be recommended at intervals, providing there are opportunities of making good the loss with good fresh or distilled water.

9th.—It is advisable never to check the draught by opening either furnace or smokebox doors for the purpose of checking the raising of steam, it being preferable to allow the steam to blow off into the air if the dampers in funnel and ashpits cannot prevent it so rising.

10th.—That every care should be exercised in cleaning fires to prevent the inrush of cold air, by turning the cowls of ventilators, nearest the fires being cleaned, from the wind during the process, and for a little time thereafter.

11th.—It is advisable to allow the steam to be as slowly lowered as raised, and the water should never be completely blown out of the boiler by the pressure of the steam.

Mr. W. BIRKETT.

(*Member.*)

I listened with much interest to Mr. Wilson's paper, and while agreeing with him on most points cited, I find, on carefully reading the paper, that my experience is slightly at variance with some of his expressed opinions. As I was quite unprepared to speak on the evening when the paper was read, I thought it might be of interest, and possibly benefit, to some of the members if I wrote out some of my opinions and experiences on the "Treatment of Boilers." more particularly "Working Boilers."

I agree with the paper that pure sea water ought to be used for a short period at the start, so as to form a fine preservative scale.

I think the filtration of the feed is necessary with high pressure when fresh water is used, and consider it would be more economical and safer than the free use of the scum cock.

I think the use of carbonate of soda is to be preferred to using the scum cocks, and if necessary blow out from the bottoms, as a very little oily deposit has proved in too many cases to be the cause of overheating and collapsed furnaces.

My experience of carbonate of soda is the same as mentioned in the paper by Mr. Wilson. I agree with Mr. Wilson regarding the reducing of the quantity of oil used for internal lubrication, but to stop internal lubrication with pressures over 90lbs. per square inch, is somewhat a dangerous proceeding.

Regarding the use of zinc in the boilers, I consider Mr. Wilson's experiment is proof that good contact is most effective, and I hope soon to see the rough hangers and pans dispensed with, and proper studs fitted for the zinc blocks (Mr. Phillip's system).

Engineers do not open the smokebox or firedoors to check steam so much as they used to do; still, I think there is yet much to be done to prevent cold air from reaching the back ends.

Having had a little experience with rocking firebars, I can confidently recommend them for ordinary draught, as useful and economical. The fires do not require so much cleaning and are easier cleaned, as the clinker does not adhere to the bars, as is the case when ordinary bars are used, and there is considerable saving in fire bars as well.

If the ventilator cowl-heads are fitted so as to be easily worked from the firing platform, the turning of the cowl-heads from the wind when cleaning fires could be easily managed, but in many steamers they are not so fitted, although it is very necessary. As regards leaky saddle plates, they are most troublesome nearest the bottom of the ventilators.

As regards the treatment of auxiliary boilers when not in use, I find that if they are perfectly dried and kept so, with a current of dry air through them, very little corrosion takes place. If the boiler has to be kept full of water the plan I find best is to boil the water and leave the boiler quite full, as water has scarcely any action on iron if deprived of air; it is the moist air and water containing air that act so detrimentally on boilers.

Regarding the painting of boiler shells internally, I have used white zinc paint mixed with oakbank and mineral sperm oils on the boilers of several steamers that I have had charge of, and in all cases where the plates (iron or steel) have been well cleaned previous to painting, there has been very slight corrosion seen since, even when the plates had been corroding previously.

Mr. Wilson has said very little about the external corrosion of shells of boilers. This is quite as serious a matter now-a-days as the internal corrosion, but does not always get the same attention. I have recently painted the bottom shell plates externally with white zinc paint mixed with

oakbank oil, and find it much better than tar or red oxide paint, as it does not "blister off," but forms quite hard on the plates,

As regards the cleaning of boilers, I find that using carbonate of soda softens the deposits considerably, and an old tube brush (brass wire) with some light scraper is all that is necessary for cleaning the vertical sides of the combustion chambers, as the deposit comes off easily.

I often regret that want of space, and the awkward placing of stays, makes it very tiresome work cleaning boilers, and feel confident that with care in construction, the work could be lessened, and that with very little extra expense the awkward stays could be made to unship, and thus facilitate the work of cleaning.

Most engineers will agree as to the necessity for the careful treatment of boilers in raising and lowering steam. Messrs. Weir's hydrokineter is effective in causing a good circulation, but I think it ought to be kept at work till there is a fair pressure of steam on the boilers; the temperature of the boiler bottoms is the best test as to when they should be stopped.

I congratulate Mr. Wilson on his paper, and trust the free and open discussion thereon may be of benefit to us all.

Mr. T. W. FISH.

(*Vice-President.*)

(Read by the Honorary Secretary.)

The method of treating modern marine boilers, with a view to their lengthy preservation, advocated in the paper, will in the main be approved by the majority of sea-going engineers—many of whom will probably have tested its efficacy by practical application. It will be readily admitted that one of the most important duties of the engineer aboard ship, is to do his utmost to maintain the boilers committed to his care tight and free from corrosion in all parts, as well as study rigid economy in consumption of fuel, and as Mr. Wilson doubtless had all this in view when he prepared his paper, he is deserving of the thanks of this Institute for his laudable effort to aid those members whose knowledge of the results of proper and improper boiler treatment is less ripe, and less trustworthy—because less practical than his own. It is recommended that the shell plates of a boiler under construction should have the fine mill scale—which adheres to their surfaces for a very considerable time after leaving the rolls at the steel works—removed by some process such as he describes, before being built into the boiler. Were these plates treated in this way

their surfaces—particularly in the steam space about the water level, where pitting or corrosion is not infrequently seen in the earliest life of a new boiler—would perhaps be in a condition more likely to benefit from the zinc, at the very outset of its application. The coating of the plate surfaces in the steam-space with white zinc mixed with kerosene oil to the consistency of ordinary paint, has a beneficial and preservative effect, as many engineers can testify from experience.

Marine engineers are somewhat divided respecting the merits of soda and zinc; when employed, each is a means to accomplish the same end. My experience has been almost wholly with zinc slabs, and the benefits accruing from their proper disposal in a boiler have been very apparent to me. From observation, I should say, when starting with a new boiler, the weight of rolled zinc to be placed within should run about 18 lbs. per ton of water. A very convenient size of slab is 6 in. × 6 in. × 1 in.

An overdose of soda in a boiler may cause some mischief in certain internal parts of the engine, but I have never heard of any ill effects on an engine or a boiler resulting from an injudicious or wasteful use of zinc.

I gather from a cutting from a scientific journal that, where the effect of some virulent acid is shewn in the pitting form of corrosion in plates, the addition of alkali to the feed water, in the shape of soda ash, will neutralize the effect of the acid. The soda ash should be dissolved and mixed with the feed water, and its amount may be regulated so as to meet the requirements, by testing the water drawn from the boiler, with litmus paper. The water should be maintained just sufficiently alkaline to turn red litmus paper slightly blue. It is stated that this proof will ensure the freedom of the water from acid and from its tendency to pit or corrode the plates.

I have never been shipmates with any of the patented methods of applying zinc for the internal preservation of boilers, therefore I am not disposed to speak too positively of the effects produced by them; though I may say, I have observed in boilers fitted with some of these, that their use too often appears to be attended with results infinitesimally small, and generally much less satisfactory than those accruing from a sufficiency of zinc slabs properly disposed in a boiler.

*A boiler fitted with the electrogen—an appliance doubtless known to the majority of members—shewed an increasing amount of very serious pitting and corrosion in the corrugated furnaces about the line of firebars, while

* See paper on "The Application of Zinc," by Mr. Green, also Discussion—Vol. III.

gusset stays in the steam space were similarly affected. This patent appliance had been in use for several years and appeared to be powerless for good. Zinc slabs were recently attached to the corroded stays, and after 6 months use seemed of no appreciable benefit; but their failure in this instance is not to be wondered at, seeing they were placed in the steam space and not immersed in water.

Appliances of the electrogen type fitted to a boiler entail trouble and inconvenience, on account of their wires, to those engaged in cleaning them, and their effect, in cases where they are said to have proved of real service, is usually of a local character, and their value not nearly so generally apparent, as in the case of a boiler in which the requisite number of zinc slabs is judiciously distributed.

Another patent, a fluid, consisting—I have been informed—of a combination or mixture of zinc, soda and water, has come under my notice in some boilers of a considerable age, in which it had been tried, and the effects were evident and not altogether pleasing. These boilers—like the majority of those in cargo ships which have run for some years—had had the usual accumulated scale round the tubes and stays next the plates. This fluid acted on the scale in a determined manner, and under its potent influence it disappeared from the necks of the tubes and stays, where leaks were set up and caused trouble. The cylinders, valves and internal parts of the engines also bore testimony to its potency. With new boilers the effects of the use of this fluid would of course be less appreciable. In the case just quoted, an indiscreet use of it may have occasioned the result named. With zinc slabs properly fitted in a boiler no such startling effects as the foregoing may be expected.

Many curious practices, as Mr Wilson has pointed out, obtained in the past amongst marine engineers, who unhesitatingly applied them, honestly believing in the beneficial and remedial effect they had on the innumerable ills the boilers of these earlier periods appear to have been heir to.

The practice of giving a thin coat of cement wash to the furnaces I have recently seen indulged in by some, who, I understand, hoped to hinder or arrest pitting or corrosion in places so treated.

Mr. F. W. SHOREY.

(Member of Council.)

Since last meeting I have had the pleasure of reading the paper which we have again met to discuss, and I must say I agree with many of the opinions therein expressed. I also agree with Mr. Wilson regarding one point as to which

a number of the speakers have expressed a contrary view. I refer to that part of the paper which recommends the filling of new boilers with salt water, and in support of this opinion I will give you a little experience of mine regarding two new boilers which I had at one time under my charge.

I thought I would try working each of them in a different manner, so I filled the port one with fresh water taken from the main at the port of departure, whilst the starboard boiler was filled with sea water. Throughout the voyage we endeavoured to keep both in this condition, all the water for starboard boiler being made up from the sea, while the other was kept as fresh as possible. The ship was on a voyage to Buenos Ayres, and on arrival there we opened up both boilers for examination. On the boiler which had been filled with salt water we found a thin scale on its internal surfaces, and it was white all over. On the other boiler in which we had used fresh water we found nothing but red rust throughout, and there was not the slightest sign of scale on it. I therefore agree with Mr. Wilson on this point. The object of using salt water is not to get a salt scale but a lime scale, salt water being strongly impregnated with lime. I may say that the pressure at which we worked the boilers was sixty pounds.

On the return voyage we reversed the treatment of the two boilers, but after about two years we found that the boiler which had been started with fresh water had pitted very much all along the level of the furnace bars, while the other, which was originally started with salt water, showed no signs whatever of anything of the sort.

Mr. J. NICOLL.

(*Member.*)

In connection with the same point on which Mr. Shorey has spoken, I take the liberty of quoting an extract from a paper which was read four years ago in Australia in connection with the Australasian Institute of Marine Engineers.

"Scaling and cleaning of the boilers should be commenced as soon as they have cooled down sufficiently for men to enter. When the scale is yet damp it can be removed much more readily than after it has become quite dry. So long as the scale does not exceed in thickness that of an egg shell, it should not be disturbed, for one of the most efficient methods of protecting a boiler against internal corrosion consists in covering its surfaces with a thin adhesive layer of ordinary boiler scale. The scale should be formed as soon as possible after a new boiler is put into commission, and before any oxidation can have commenced on the iron surfaces. To facilitate this formation of thin scale, boilers should be first filled with salt water and run for some length of time with water at least

three times the density of sea water. This plan has often been proved most effectively to produce this protective layer of thin and uniform scale, after which the boilers may be run with water of less density, but it requires no little attention to keep the scale thin all over the direct heating surfaces, and thin it must be, otherwise it will crack with the expansion and contraction of the plates, and the moisture entering and retained between the iron and the scale will but aggravate the evil of corrosion which it is supposed to minimise."

Mr. C. SLATER.

(*Member.*)

Though agreeing with Mr. Wilson in his remarks about giving as much time as possible to the getting up of steam, I do not agree with him that, in a three-furnace boiler the lighting of the low fires some time before the wing ones, is injurious to the saddle corners, at least, not according to my experience, for it is a practice I have carried out for years and without detriment. I may say that not having a hydrokineter or other means of circulating water whilst getting up steam, I have generally lighted the low fires some five or six hours before the wing ones, and believe by that means I get a more gradual rise of temperature and circulation of the water. I may also state my experience only takes me to 80 lbs. pressure.

With reference to the opening of furnace doors or tube doors for the purpose of checking the draft, I can say—without entering into their relative merits or demerits, for both practices are bad—I have experienced that the opening of tube doors is injurious to the tubes, for in one steamer it was customary, up to the time of my joining her, to open the tube doors, in order to check the draft, the consequence being they were troubled with leaky tubes; when I took charge I discontinued the practice, the result being no more leaky tubes. I later on had a damper fitted to the funnel, which I consider is a most essential thing for the proper working of boilers.

With regard to the treatment of boilers in terminal ports, I prefer keeping them dry, and the method I have adopted for years past, is that of lighting bogie fires in the stokeholds (say one to each boiler), and placing them in front of the boilers. These bogies have portable iron tops, on which sits an elbowed stove pipe which is led into the furnaces on the fire bars. By this means a great quantity of heat passes into the back ends, through the tubes and into the uptakes and funnel, also the radiated heat from the bogie heats the surrounding atmosphere, which in its turn passes through the bottom and breast manholes, and out through the top manhole, thereby drying all parts of the boilers. On more than one occasion I have carried out this

system throughout the entire winter months, and when, owing to a continuance of wet or foggy weather, the engines have sweated to such an extent that both painted and bright work have been perfectly wet, the boilers have been kept quite dry.

THE HONORARY SECRETARY.

I have here a communication received from Mr. C. W. Folkard, a non-member, whom I invited to attend the meeting, but apparently he has not been able to come. Mr. Folkard's contribution is entitled, "A Possible Revolution in Steam Boiler Practice," and although it does not seem to have been forwarded in view of the discussion on Mr. Wilson's paper, it really has reference to the subject of the paper, and it may probably be the desire of the meeting that it should be read. I leave the matter in the hands of the Chairman and the meeting:—

As the desire of members is that it should be read, I will now read the communication.

"The adoption of gaseous fuel for steam boilers opens so wide a field for ingenuity and experiment that it seems somewhat remarkable that so little notice has been taken of it. Hitherto boiler makers have been trammelled by such considerations as the maximum length of grate which a stoker can keep uniformly covered, a maximum and minimum diameter of furnace, on well known grounds, the necessity for the furnaces to be close to the ship's bottom (or rather to the bottom of the bunkers), so making two tiers of boilers impracticable, &c. Now it is, of course, impossible to ignore these considerations when using solid fuel, whether it be coal, coke, or wood; and as there appear to be no general laws of nature (like those of gravitation for instance) which render a 6-foot grate compulsory, it is evident that the chances are considerably in favour of boilers designed on other lines being found more economical as regards duty, first cost, and weight of iron and water per horse-power.

"That there is a wide margin for improvement as between the marine and the locomotive is well known. Even one pound extra duty on board ship means a great deal, not only as regards the cost of the coal saved, but also because of the smaller bunker capacity required, especially in long voyages or at high speeds.

"With quadruple expansion engines, and 300 or 400 lbs. steam, possibly another 10 or 15 per cent. reduction of fuel might be attained (judging from the results of replacing compounds by triple expansions), but the disadvantages would doubtless be very serious; and in any case it would appear that the limit, as regards steam pressure would then have been reached. We seem, therefore, to be driven to the conclusion that all or nearly all of the economy to be effected in the future will be due to the boiler, and not to the engine.

"With forced draught, what is to prevent the construction of a marine boiler which shall be as economical in water evaporated per pound of coal as an ordinary locomotive? Of course, this cannot be done in a day, and many problems will at once occur to practical men which it will be necessary to work out by the method of methods, that of trial and error.

"To take but one of these as an example: Required the size and number of tubes most effective for cooling the white hot products of combustion leaving the furnace or combustion chamber of a 1,000 horse-power marine boiler on their way to the smoke box, it being understood that the sole function of the tubes is to abstract the heat from the mixture of carbonic acid, steam, oxygen, and nitrogen, resulting from the combination of the gases of the coal, with atmospheric oxygen in the furnace or combustion chamber. Now we know that the 3½-in. diam. by 7-ft. marine tube gives a duty of about 8 lbs., whereas the 1½ diam. by the 10 ft. 6 in. locomotive tube gives a duty of 10 or 11 lbs. of water evaporated by 1 lb. of coal.

"This, of course, by no means proves that the 3½ in. tubes could be replaced advantageously by smaller ones, but general considerations would seem to lead to that conclusion, and it is evidently a matter which can only be decided by careful experiments. The general considerations just alluded to are these: In the case of a 1,000 horse-power boiler furnace, giving about 500 cubic feet per second of white hot products of combustion, what will be the best diameter, length, and number of tubes to reduce the temperature of the gases to 600° F? Now it is self-evident that when a particle of gas has been cooled by contact with the tubes to the smoke box temperature, it should be conducted at once to the smoke box and not allowed to mix with other particles of white hot or even red hot gases (that is to say, uncooled or only partly cooled). In a 3½ in. marine tube the mass of hot gas in the centre bears a far greater proportion to the cooled or partly cooled peripheral portion in contact with the water-backed iron forming the sides of the tube, than it does in the case of a locomotive tube. The cooled gas being denser falls towards the centre of the tube and so mixes with the hot central portion instead of being at once conveyed to the smoke box.

"It would therefore seem that a very short annulus would be a better form than a large and long tube, though it is just possible that reducing the diameter of the tubes sufficiently would be as effective practically as an annulus. Released from the 6-foot grate and furnaces necessarily close to the ship's bottom, and with forced draft, there would be no serious difficulty in designing a boiler with say 5,000 short tubes or annuli instead of 500 3½ in. tubes, and with possibly an approximation to the locomotive duty of 10 or 11 lbs. per lb. of coal. Is it not probable that the great advantage (as reported) of the "serve" tube may be due, at all events in part, to the action of the internal ribs in cooling the central portion of the gases simultaneously with the sides cooling the peripheral portion, thereby lessening the evil of allowing the cooled portion to mix with the uncooled?

"This question of the best length and diameter and number of tubes for a 1,000 horse-power boiler is, as before remarked, only one of the points which will present themselves to the mind of a practical thinking man, as requiring to be worked out under the freer conditions rendered possible by the adoption of gaseous firing, and which are, of course, additional to and independent of the intrinsic advantages of the use of gaseous fuel, viz.: uniformity of combustion from minute to minute and hour to hour, reduction of the excess of air necessary to ensure complete combustion (with its many attendant advantages), the possibility of heating the air for combustion in a recuperative arrangement of some kind, reduction of the labour of stoking and clinkering, &c.

"Of course, these things cannot be worked out in a day, or without money, any more than a substitute can be found for that relic of

barbarism, the combustion chamber tube plate: which has so strongly objected, if one may judge from its behaviour, to the employment of forced draught; but so far as one can see the necessary experiments should not be very costly, as modern experiments go. When we reflect that without cheap coal Great Britain would inevitably sink to a second, if not a third-rate power, we shall not be surprised at the assertion that no Englishman, Scotchman, Welshman, or Irishman (however exalted his position may be) can possibly have a more patriotic object than that of helping by every means in his power to postpone the exhaustion of our coal-fields; and marine engineers, by raising the duty of the engines and boilers in their charge, can exert a very appreciable influence in this direction. Of course, it is the fashion to look down upon the boiler and concentrate all, or nearly all, the attention upon the engine, but in the writer's opinion the day is not far distant when this idea will be greatly modified, if not reversed; and skilled, well-educated men found to be at the very least as necessary in the stokehold to superintend the complicated chemical and physical actions taking place in the furnaces, combustion chambers and tubes, as in the engine room to look after bearings, joints, stuffing boxes, pistons, and valves."

Mr. JOHN TAIT.

(*Vice-President.*)

Reference has been made in the paper now before us to the detrimental effect of oil in boilers, and in the course of the discussion several members have been very hard on it. Now I am inclined to take quite a different view of it, I think it is rather a good thing, I was at one time on a ship which was on the Indian coasting trade, and a good deal of oil used to get into the boilers, gathering round the tops of the tubes and also round the shells of the boilers at the water line. We had been troubled with priming in the boilers at first, and always when this oil was cleaned off; so when I thought a little more about it, I considered that perhaps this oil might prove a very good thing, and decided to let it remain, with the result that we never had any priming thereafter.

In a sister ship running on the same trade, whose chief engineer was always most anxious to get this oily deposit cleared out of the boilers at every available opportunity the priming of the boilers was a constant complaint by all on board. I suggested to this chief engineer that he ought to allow the oil to remain as I was doing, but he would not do it. It therefore seems to me that if oil does harm in one way it does good in another.

With regard to the use of zinc in boilers, my opinion is that we cannot do without it. It is an absolute necessity if we wish to keep our boilers free from corrosion.

As to the filling of boilers with salt water, with a view to getting a scale, I must say that my experience is that we have great difficulty in keeping the salt out of the boilers.

MR. H. BARRINGER.

(*Member.*)

I am afraid I cannot agree with Mr. Tait in his recommendation that the oil should be allowed to enter and remain in the boilers, for I consider that every effort should be made to keep it out. Unfortunately I have not been present during the whole of the discussion to-night, so am not aware if anything has yet been said relative to the use of soda in boilers.

I may say I have had some experience with "zynkara," which is, I believe, a compound of zinc and caustic soda, and with very good results, but it is my opinion that it is principally from the soda portion and not the zinc of the combination that these are derived.

I think that caustic soda, if used in small quantities is a good thing, but there is no doubt that common soda, has a very beneficial effect in getting rid of the oil. It combines with it and really deposits not only the oil, but also the insoluble portions of the water, and it is only necessary that the greatest care should be taken that these insoluble portions are not allowed to be deposited on the heating surfaces.

MR. JOHN GREEN.

(*Honorary Member.*)

The report of the reading of the paper by Mr. Wilson, at Gresham College, gave me very great pleasure, so much so that I resolved to come up to town to be present at this discussion, but with the intention of being a listener rather than a speaker. However, as the Chairman has been kind enough to call on me, I shall endeavour to briefly put before you some of the thoughts which have been suggested to me on this very interesting and important subject.

The idea of pickling the boiler plates is, I consider, worthy of very serious attention, for the removal of the iron scale will prevent some pitting, make the electrical condition of the plate more uniform, and tend to add to the durability of the boiler. Pitting is often found beneath the iron scale, and an action is sometimes set up between a scaly and a non-scaly portion of an iron plate. Care, however, must be used in the selection of a pickling medium. The sulphuric acid used by galvanizers for pickling would be injurious, as part of the sulphur would combine with the iron and form sulphate of iron, while part of the hydrogen would enter into the mass of the iron and be incorporated with it to the

detriment of the iron. No subsequent water washing would remove this hydrogen. That hydrogen does enter the iron under such conditions, was proved many years ago by Professor Gladstone, who actually pumped it out again.

Galvanizing the iron plates might be a failure no doubt, as the high temperature of the zinc bath (nearly 800° F.) would injure the iron, but it strikes me that it is possible a deposit of zinc on the plates by electrolysis might advantageously take the place of the zinc paint advocated by Mr. Wilson. I shall endeavour to make some experiments to test the effect of electrical deposit on boiler plates, and hope I shall be able to lay the results before the Institute in the course of a few months hence.

With regard to oleic acid and other saponaceous matter found in boilers, I think it must not be assumed that the oil used outside the boiler is alone to be blamed. It is quite possible to create soap inside the boiler; for instance, soap of a low quality may be formed from lime, and I am inclined to think that soda may be a factor in the formation of some of this objectionable saponaceous matter; but on this subject I hope to have an opportunity of speaking more fully on another occasion. Of course I quite agree with the warning from several members as to the necessity of using as little oil as possible, and the taking of every possible care to prevent any of it being carried into the boiler.

It appears to me that we have made some progress in our knowledge of the use of zinc since the discussion on that subject last year. Besides being almost, if not quite, unanimous in advocating the use of zinc, we are now almost agreed on the importance of close contact between the zinc and the iron. In other words the benefit of the zinc has been proved by experience to be due to an electrical action rather than a chemical one.

Mr. J. H. THOMSON.

(*Member of Council.*)

I have been very much interested in the matter before us to-night, and I think that Mr. Wilson and the previous speakers have pretty well exhausted the subject, so far as internal treatment is concerned.

There are, however, generally two sides to a question, and in this one we are not singular. Besides the inside we have also the outside to look after. We have heard how scale has been kept on the iron in the insides of boilers for eight or nine years, but scale is not the proper

term for it. It is the "bloom" of the iron, and not a corrosive scale which is meant.

In a case which came under my notice some years ago there was a set of eight boilers, and when they were six years old, on the roof of the four wing ones the "bloom" was still to be seen, whereas, in the centre ones round about the base of the funnel, the fronts and roofs corroded considerably, forming a scale which had to be scraped off voyage after voyage, in spite of all applications of paint and even of white lead and tallow. The question therefore arose: Why should the four inside boilers lose their "bloom" while the four wing ones retain it? When the Boiler Commission was taking evidence, their attention was drawn to this matter, and after considerable debate it was concluded that it was owing to external causes that this corrosion was going on.

A great deal of damage is often done to boilers I believe, by bad setting. Proper consideration is not given to the distribution of the strains, and many leaky seams and bad joints are caused by this omission. Where the weight is borne on cast-iron blocks in three or four different places, I think that often some of these places take more than their fair share of the weight.

In olden times engineers were frequently troubled with bad seams at the bottoms of their boilers, and the boiler-maker was blamed for them, but the probability is that the man who rivetted up the shell did not know which was to be the top or which the bottom of the boiler (they being usually square at that time), and I do not believe that the fault could always be attributed to bad workmanship. In many cases I think the fault was due to the want of a proper adjustment of the supports.

I think there is still room for considerable discussion on this subject, and a great deal of information can yet be gained with regard to the treatment of the outsides as well as the insides of boilers.

I hope therefore that the discussion will not be allowed to conclude with the present meeting, but will be adjourned till another evening.

THE TREATMENT OF BOILERS.

ADJOURNED DISCUSSION

AT

58, ROMFORD ROAD, STRATFORD,

ON

OCTOBER 10TH, 1892.

Chairman—

MR. A. W. ROBERTSON (*Vice-President.*)

MR. J. J. TYLER.

(*Member.*)

In this discussion there is one point as to which I think Mr. Wilson has not been quite understood. He recommends the use of salt water for new boilers, as I understand it, not for the sake of getting a salt scale, but for the purpose of getting a lime scale on the plates. Now, I have known a boiler which has been used for two years with salt water come home with the plates covered with red rust.

My opinion is that it is not necessary to use salt water at all, for if a boiler were filled with good fresh water and a bucket full or two of lime thrown into it for a voyage, I do not think the boiler would give much trouble afterwards, and such treatment would serve the purpose quite as well as the use of sea water.

MR. JAS. ADAMSON.

(*Honorary Secretary.*)

The scales and deposits found in boilers are of a very varied character, as may be seen from the samples which have been placed in the Museum of the Institute from time to time.

It has been remarked that a salt scale is very injurious to the plates, especially while the boilers are empty. This was met by the reply that the scale found inside boilers is not salt. I would, however, point out that salt is sometimes present in the form of scale. In superheaters for instance, after the boilers have been priming from one cause or another, and here its ravages are frequently visible, resulting in the pitting and corrosion of stays and shell

plates, due in a great measure to the alternate heat and moisture, largely attributable to the presence of salt. No doubt other causes, such as leaking valves, &c. also lead to moisture forming on the plates, when all the boilers are not in use, thus causing more rapid deterioration.

There are advocates for superheaters, and there are those who discredit them. A discussion of their merits as regards economy and efficiency hardly comes within the scope of our present subject, although their condition after some years of service does. Suffice it to say, I am inclined to agree with the advocates up to 80 or 90 lbs. steam pressure, but at the same time, the amount of deterioration to which superheaters are frequently subject leads to considerable expense in their up-keep.

Some superheaters run for 15 or 16 years or so without any extensive repairs, beyond the renewal of a few stays, others again for a few years longer, while many are in almost as good condition at the end of 10 or 11 years, with the exception of a few stays, as when new. The alternative heat and moisture is no doubt the cause of most of the deterioration, but by care and attention this can be reduced to a minimum.

As with superheaters so with boilers in respect to the repairs and general conditions.

With reference to the date of modern practice, so called, I am inclined to think that it dates much further back than seems to be shown in the paper.

Were it not so, we would not know of so many boilers 20 to 22 years old, or more, running still with the original pressure.

The introduction of evaporators, eed heaters, auxiliary condensers, all drains and exhausts, whether from saloon department or engine room, being led back to the condenser, the use of the circulating discharge for hot baths in place of the antiquated system of heating them by steam, are all great improvements, and they are more or less developments from the change of practice, which has gradually come into general use since the introduction of the compound engine and surface condenser.

Mr. David Phillips did much to spread information as to the treatment of boilers, and conjointly with others —the late Malcolm Campbell amongst them—was the means of doing away with what was improper, and establishing a better order of things in connection with the general conditions of working boilers.

It seems invidious to give one name to the exclusion of others; I, however, mention that one as having a more intimate knowledge of him, and as having discussed ways

and means with him as to improvements and economies. For another reason also I mention Mr. Campbell's name, in that we have a memorial of him in our premises, and I take advantage of this opportunity of placing a memorial of him in our transactions, by associating his name with the early introduction of an improved and intelligent method of dealing with marine boilers.

The desire to get the boilers low down in the ship has led to them, in some cases, being placed almost resting on the kelsons, very much to the disadvantage of the boilers themselves, and making them difficult of access when the shell seams or rivets leaked. This difficulty of access has led to severe corrosion in the immediate vicinity of the kelsons, a corrosion which the difficulty referred to renders them almost beyond the reach of thorough repair.

The question of zinc and its application, was well discussed last session, when reference was also made to the use of zinkara and electrogens; the opinions then given were pretty conclusive, and those who had been in the habit of using zinc for 15 or 16 years in direct contact with the plates, on the system advocated by Mr. David Phillips, gave a very good testimony as to the efficiency of the means referred to. It has been, I think, generally admitted for many years that direct contact is preferable to the now almost obsolete pans for holding the zinc suspended from the stays.

Mr. R. LESLIE.
(Hon. Treasurer.)

I consider that the construction and treatment of marine boilers is a most important matter to us marine engineers, and also to ship owners, and therefore deserves our most careful consideration. I must endorse that portion of the paper in which it is stated that too often the boiler is somewhat ill-used at the beginning of its life.

It has been my lot to take charge of the engines and boilers of two new steamers, and I must say that, from experience, I do not think the boilers get much chance at a start under the tender mercies of the builders. In the first place the builder begins by putting any kind of water into the boilers for the trial trip, and then his engineers, during the time the engines are running, keep pouring oil about, both externally and internally as though it cost nothing; this oil, or part of it, of course enters the boilers, and along with the dirty water leaves a deposit highly detrimental to the life of the boiler or boilers into which it may enter.

Now, what I should like to see is, the boilers to be first thoroughly cleaned out, and then started with good

fresh water, and afterwards great care being taken to see that nothing but good clear water be fed into same. I think a good filter of charcoal, or some such material, is just what is wanted; for, if we wish to keep our boilers perfectly clean, we must certainly adopt some method of keeping out the impurities.

In the second place, before putting the water into the boilers, I should like to see that the boilers are properly fitted with zinc plates, in which I must say I am a great believer. With regard to this matter of zinc plates, I believe there is as much difference between results obtained by contact, between the zinc and iron, and those by non-contact, as there is between night and day. I maintain that between the zinc and iron there is a certain action that goes on. As the heat is generated in the boilers, there is a galvanic current passed between the zinc and iron, and in one case I have proved this very decisively by having seen the particles of zinc adhering to the iron. On the side of a furnace, a little below the fire bar level, severe pitting was noticed to be going on, and on examination as to its cause, it was found that this was the only part of the boiler where the zinc had been missed. I obtained a piece of zinc and fixed it at that part, and, from that time the plate never wasted to any perceptible extent. I have always made it a point, in any boilers of which I have been in charge, to see that the zinc plates are screwed hard up against the boiler plates, as I am convinced that, by so doing, a beneficial action does takes place; consequently there is no use in putting zinc plates into boilers unless they are placed properly in contact with the boiler plates.

With good clean water in the boilers to start with, good zinc plates properly fitted, and good careful engineers to look after the boilers, there is no reason why they should not last, at least, twenty years or more.

In the third place. I do not believe in drawing fires in a hurry, as is often done; they should be allowed to die out; for then no undue strain would take place between the different parts of the boiler, as would otherwise be the case if the furnace doors were opened and a large amount of cold air allowed to rush in as the fires were being rushed out. I agree with almost everything which is advocated in the paper, with the exception of putting salt water into the boilers, which I do not think ought to be done. I believe that salt water is at all times detrimental to boilers, and, therefore, nothing but good, clean fresh water ought to be used. I am also of opinion that, on the arrival of a steamer at a terminal port, it

would be well, if possible, just after the steam pressure had been reduced to say about 20 lbs., to use the scum-cock for at least half an hour, so as to get rid of all dirty matter floating on the surface of the water; as I know from experience, that such matter often settles on the top of the tubes as the water is being run out, and it is sometimes a hard job to get the tubes cleaned after once the dirt has settled on them.

I would also add that it is absolutely necessary to have the boilers coated with some good non-conducting material, such as Keenan's composition, as heat lost—let it be ever so small—is coals wasted, and money lost, consequently it is of great importance to have boilers well insulated.

MR. J. G. LATTA.
(*Member.*)

I should like to call attention to a very important portion of this subject which has been almost entirely ignored during the discussion. This is the action that the corrosive gases, which in solution are conveyed by the feed water into the boiler, have upon that structure. I should have liked to hear Mr. Wilson's views on this point, as I think he could give us some valuable information on it. My own opinion is that we ought to get rid of the gases, and to do so there appear to me to be only two ways. The first is to liberate them by boiling the feed water, and thereafter feed the boilers with practically non-aerated water, and I don't think a feed heater placed between the boilers and the pumps would accomplish this. The other plan is to dissolve zinc inside the boiler as is the usual custom, and so change the carbonic acid gas, &c, that would otherwise attack the iron, into a harmless gas which cannot injure either boilers or engines.

I cannot agree with Mr. Wilson with regard to the coating of the boiler shell when new, before water has been put into the boiler, with a mixture of white zinc and kerosene. I cannot think that this would be of any use, as I do not believe it could stick on to the plates until they are cleared of oxide of iron. All new boilers that I have seen have given off a quantity of this oxide of iron for some time after being first set to work, and until this is all off, I cannot see the paint will remain on. I do not think the pickling proposed would remedy this.

THE CHAIRMAN.
(MR. A. W. ROBERTSON.)

I am prompted to reply to the remarks made by Mr Latta regarding the extraction of air from the feed water

seeing that I at one time gave a great deal of attention to the subject.

I daresay a number of the members present to-night are aware that about ten to eleven years ago. I took out a patent for an apparatus which I called "Robertson's Air Extractor."

In it I did away with the Air Pump altogether, and after a very long and tedious trial, during which I was told by several of my friends that what I was attempting to do was impossible, I succeeded in obtaining a vacuum of 26 inches when the engines were running, but like a great many more new ideas, I found the experimenting very expensive, and owing to this and other circumstances, I decided to put it aside for a time, and stick more to the business that I had in hand, although I don't say but that I may some day return to it.

However, I brought it to a practical issue in a pair of engines specially built and fitted in a launch. I also fitted it into the s.s. "Cyclops," in which it made two voyages to China and back.

My idea was to prevent the air getting into the boiler, just as Mr Latta has mentioned, and as I looked upon it as a natural enemy, I drew it entirely away, allowing none to get into engines or boilers, unless what passes through with the auxiliary feed or leaky glands.

I thought if I could succeed in keeping the air out of the boilers I would stop the corrosive action due to its presence.

I may say there were eight or ten engines fitted on my principle.

Although, however, the invention was made successful in theory and practice, I must be candid and say we had considerable difficulty with the feed pipes, but this no doubt could have been surmounted had I persevered with it, or even then, had a feed pump something of the nature of Weir's been introduced; for with the high speed feed pump, the water being deprived of the air caused a very heavy jar on the feed pipes, which caused them to give way and leak, and gave a great amount of trouble during the two voyages it was fitted on the "Cyclops." It was owing to this that it was taken out.

Mr. LATTA.

I cannot see, from the description given, how Mr. Robertson's invention was to take the gases out of the feed water. The gases I referred to are held in solution in the feed water, and to extract them it is necessary that the water should be heated.

THE CHAIRMAN.

That was exactly the case. The feed water was at a very high temperature when I extracted the air, as it was drawn off about the level of the top of the condenser. There was no air-pump, and the feed pump drew the water direct from the condenser.

MR. LATTA.

I can quite understand why the feed pump pipes carried away in the case of the "Cyclops."

MR. J. H. THOMSON.

(*Member of Council.*)

At last meeting I thought I had said about as much as I intended to say on this subject when I called attention to the importance of looking after the outsides as well as the insides of our boilers. Since then, however, it has occurred to me that now we have practically got over the difficulty of leaky bottoms, it is time we adopted some means for protecting these parts. Generally speaking, about a sixth-part of the boiler at the bottom is left exposed, being liable to be splashed by the cold bilge water, especially if the boilers are set low in the ship. There should be some means for preventing this. The tops and sides of boilers are protected, then why should not the bottoms also? It is at the bottom quite as much as the top where we wish to preserve the heat.

With regard to the trouble which has arisen so often in recent years in consequence of leaky tubes in the boilers of the Royal Navy, I think the cause is not far to seek, for the custom is to employ a one thousand horse power boiler and try to get fifteen hundred horse power out of it. With a larger boiler there would be no difficulty in getting the power required.

MR. F. W. FILLMORE.

(*Visitor.*)

I was kindly invited to hear Mr. Wilson's paper on steam boilers, and to attend the discussion this evening.

The paper may be characterised as a summary of logical conclusions drawn from practical experience.

With the exception of the zinc question (whose laws of action are as yet unknown) there is not the slightest doubt that one and all the suggestions as to the working of the boilers at sea, their treatment in port, and handling in cases of sudden stoppage, are in obedience to the laws of nature, and, therefore, right.

The heat in a boiler is motion as much as a revolution in an engine, and a stoppage of that motion suddenly in one part of the structure sets up just the same strains as suddenly stopping the engines by putting a chock of wood under the web of the crank, or any similar method, although, perhaps, the result would not be quite so violent or disastrous. It is necessary that the boiler should be heated uniformly and cooled uniformly. The paper shows how this can be done.

The corrosive action in a boiler is not yet sufficiently understood to be able to prescribe a panacea for all the evils, but experiment and experience have shown that zinc (although in an unknown manner) acts so far as can be ascertained with unalloyed benefit, where a metallic contact is made and preserved. Doubtless there are many substances which under favourable circumstances combine and are active in their work of destruction in the boiler. Until these and their actions are thoroughly known I doubt if much will be done to eliminate the evil by any other means than zinc, which without question has extraordinary preservative qualities when and where properly placed.

THE CHAIRMAN.

(Mr. A. W. ROBERTSON.)

I thank Mr. Wilson for his paper, and agree with him that a thorough knowledge of the treatment of boilers is of great importance to the marine engineer, and that it is a subject on which there always has been, and is even now, a diversity of opinion. Still we must admit that since the introduction of the triple engines and high pressures, there is not quite the diversity that existed from ten to twenty years ago. Going back twenty-six years I recall my first experience with the jet condenser, when the scum was opened a few hours after starting, and kept open until the end of the voyage, the steam varying in pressure from 2 to 10 lbs., and the density of the water kept at about 1½ to 2 thirty-seconds.

From the jet to the surface condenser and compound surface condenser, a change was effected, but sad to say, in looking back, a great many of the engineers were too strongly wedded to the old system to face a change with a changed mind; hence the reason of Mr. Wilson having so many absurd and foolish actions to set before us in his paper. But that occurred from ten to twenty years ago.

My experience with compound surface condensing engines at sea dates back from 17 to 23 years ago, and

on shore up to the present time. I could give several cases in support of Mr. Wilson's contention that the boilers were not treated properly, but these, I must admit, in my experience were the exception, not the rule. Inefficient treatment of boilers occurred then the same as now. I would refer to a case that came under my notice 21 years ago. There were two steamers, sister ships, that I will designate A and B. A left London for Bombay six days after B; B arrived at Bombay four days before A. The boiler of B had scale about 1-32 in. thick; A $\frac{1}{4}$ in. to $\frac{3}{8}$ in., and boiler leaking. In consequence of the boiler of A leaking, B had to take her place and go to Akyab, and from there to Liverpool. The run to Akyab from Bombay occupied about 11 days, during which time the scum and blow off were not opened. From Akyab to Liverpool the run occupied 55 days, during which period the water was not changed in the boiler, the scale being, on arrival, about 1-16 in. thick. Another case occurred 19 years ago. A steamer arrived in London from Calcutta, when the chief engineer received a letter instructing him to allow the bearer and friends (a deputation from the Messageries Maritimes Company) to stand by while the boilers were being emptied, and to return to witness the doors taken off and be allowed to enter the boiler, and take away scale from the various parts, This was carefully done, and the members of the deputation put small pieces into their purses about 1-32 in. thick. These two cases were in steamers when the boiler pressure was about 60 lbs., and at no time during the voyage was zinc or soda introduced. The blow off cock was very seldom opened; the scum was used about three times a day, taking $1\frac{1}{2}$ in. to 2 in. at a time, commencing about the second day out, simply for the purpose of scumming the water and carrying off the film of oil which collected. But I must mention that the rose of the scum in each case was placed in a vertical position, so that it would break the oil film, and carry it off, on a varying height of water equal to the diameter of the bell mouth of the rose. The density of the water would rise towards the end of the voyage to about 4-32 or 5-32nds.

With reference to Mr. Wilson's remarks about the age of boilers. When he speaks of boilers being 20 years old —I know some much over that—and carrying within 5 or 6 lbs. of their normal pressure, I think it speaks volumes for the good treatment these have received. I agree with Mr. Wilson in his remarks as to the treatment of boilers under construction, and for the most part

under steam, and particularly on the necessity of good circulation when getting up steam. Good circulation is also most desirable when it is under steam, and I think the best agent that can be introduced is a good feed heater, particularly if the increased temperature required for the feed water can be obtained from radiated heat that would otherwise be lost.

With regard to the danger resulting from the presence of oil in boilers, it is in running or blowing the water out before the surface of the water is thoroughly scummed.

On the whole Mr. Wilson has given us a valuable paper, and great benefit should result from the free discussion. Now, as the night is pretty well advanced, we must close; Mr. Wilson will reply fully when the discussion is all in order.

Mr JAS. GIRVIN.

(Member.)

I had not the opportunity of hearing the paper on the "Treatment of Marine Boilers" read, but having received a copy of it on my arrival in port, I have considered the questions raised, and now beg to offer a few remarks, as I consider the improved treatment of boilers in many cases dates further back than given in the paper.

My experience of the management of marine boilers dates back to 1860, since when I have seen changes and improvements of various kinds introduced.

The pressure of steam in the first boiler I went to sea with was 15lbs., and the second 5lbs., and frequently we had negative pressure, if I may so say. Since that time pressures have been gradually increased until now my lot has been cast with 170lbs.

With jet condensing engines the usual practice was to blow off by surface and bottom cocks, to keep the water registering a certain density by salinometer, such density varying according to the ideas of those in charge, or those on shore from whom instructions were received.

In 1864 I was on a ship which had surface condensing engines. Two boilers were supplied—as far as possible—with fresh water only, and the other with sea water; the working pressure was 50lbs. In all three boilers the density was usually kept at about ten ounces to the gallon; the result of this course of treatment was a sacrifice of the one boiler to save the other two, but the salt water boiler, although it had a good deal of scale, was comparatively free from pitting which attacked the other two. In the end the three boilers were taken out and replaced by two at 25lbs.

pressure. The engines were fitted with Spencer's condensers. With the new boilers the system adopted was to fill them up with fresh water at the terminal ports and supplement from the sea, but blowing off much less frequently and working at a higher density than in the former boilers.

In 1867 I joined a new steamer, and pursued the same course, and as experienee admitted, allowed the density to rise, to avoid the frequent use of the blow off cocks. I had a good deal of trouble with the tubes pitting; after about three years' service there was also pitting on the furnaces about the line of the fire bars.

In 1874, on joining another new steamer, I adopted the plan of using zinc plates for the first time, and found a great benefit to result.

The zinc was merely attached to the stays and tubes, and my former experience of pitting was not repeated, except to a very small extent. In this steamer I did not use the blow off cocks. I also used soda in these boilers, as well as zinc.

In 1878, having been appointed to a larger steamer, with four double-ended boilers, fired athwartship, I found a great deal of pitting on the furnaces and tubes. A good many of the tubes were then removed, and zinc plates fitted with direct contact to the furnaces and combustion chambers by means of several studs—similar to the plan referred to in Mr. Green's paper on "The Application of Zinc to Boilers"—and while in this steamer I had no further difficulty with pitting such as had apparently ruled while the steamer was employed by her former owners. I entirely discarded the blow off cocks and allowed the density to rise from 30 to 32 ounces to a gallon, which it often did by the end of the two months' run.

Since then I have always used zinc fitted on studs, with occasionally a little soda added to the water. The blow off cocks are never opened at sea. The surface cocks are generally opened for a few minutes before reaching the terminal ports.

Pitting in my present experience is unknown. The use of oil for internal lubrication has been gradually lessened and reduced to a minimum.

In working with three boilers out of four my experience is that the boiler not in use suffers most, the tear and wear of work does not punish a boiler so much as the want of use, even with precautionary measures to keep the boiler dry, unless these measures were very elaborate.

It may be interesting to mention that I have been with boilers filled up with fresh water at the terminal port, under

the treatment referred to as ruling in my latter experience, and have not emptied them for four-and-a-half months, that being the time occupied in a round voyage.

I give these experiences as a matter of history and to shew that the present system of treating boilers has gradually grown with us, and we are still improving on our past experiences.

I may add that recently the experiment was tried with boilers of 170lbs. pressure, of allowing the water to remain in the boilers for three days, until they were cool enough to enter after arrival into port; one of them had not been surfaced or blown off the whole voyage; two of them had been surfaced previous to arrival; the appearance of all three was similar, the water being quite clear and free from oil on the tops. The object was to see what like the water surface was before being disturbed.

After being emptied, the lower part of the shell inside, and the bottoms of the furnaces, and some of the tubes, were somewhat greasy.

The density on arrival was 1 oz., $\frac{3}{4}$ oz. and $1\frac{1}{2}$ oz. respectively.

Mr. JOHN TAYLOR.

(*Member.*)

I beg to offer a few remarks on Mr. Wilson's paper on the management of marine boilers, as my experience is at variance with the author's in a few points. My first experience commenced in 1873, with a new steamer fitted with the ordinary marine boiler of 65lbs. pressure. The custom then was to surface a few inches out of the glass each watch, the extra feed being made up from the sea, the result was a heavy scale after a forty-five days' run.

I joined another new steamer the latter end of 1875 with a pressure of 65 lbs., and worked under very different conditions. In port the boilers were filled up with fresh water; any extra feed necessary was supplemented from the sea, and strict orders on no account to use the surface or blow off cocks. After about one year's work slight signs of pitting commenced. Early in 1877 the superintendent engineer introduced zinc into the boilers, on the system so very common at the present time, that is, studs screwed into the furnaces and combustion chambers, and zinc slabs bored and faced to fit, and screwed up with a nut. The boilers were filled with fresh water and the loss made up from the sea, the surface and blow off cocks never being used. I may say the results were very satisfactory, as a good many steamers, similarly treated, are now running with the boilers

close upon twenty years old, and still carry the original pressure. One steamer I was on for some time was fitted with four single-ended boilers. The superheater drained into the two forward boilers, and through priming the density of the two forward boilers rose so high the salinometer would leap out of the pot. The two after boilers, with no superheater drains, could not be kept at a greater density than three to four ounces per gallon. On the completion of the voyage there was no preceptible difference between the boilers of high and low density. I fail to see the benefit claimed for salt water at the commencement of a boiler's career. I would be in favour of using pure fresh water. Generally, in running trial trips, the boilers are exerted to their utmost, and priming is very common. Clean, fresh water will be less injurious to the machinery than water heavily charged with salt. To form a scale on the parts most likely to be attacked by corrosion is very difficult, and I should say, dangerous in boilers with corrugated furnaces and pressure of 150 lbs. and upwards, as there is likely to be a heavy scale formed on the tops of the furnaces long before it begins to form anywhere else. If the boilers are in an unhealthy state and corrosion going on, it will find some bare iron to attack. The silvery scoured appearance of the wrought iron work of the engines, which the author of the paper attributes to caustic soda being used in the boilers, I have seen in engines when no soda of any description was used. A little zinc, judiciously applied in the boilers, I have found to stop all scouring of the engines. I would advocate the use of zinc, fresh water and filtration of the feed water, all scale and oil being avoided as much as possible. Even with no internal lubrication there is a quantity of oily deposit finds its way to the boilers from the rods and spindles of marine auxiliary engines.

Mr. WILSON'S REPLY.

In reviewing the discussion which has taken place on this paper, I feel I cannot do better than endeavour to deduce from it the evidence for or against the various points, which, as suggested by one of the speakers, I have taken the liberty of tabulating, and laying before you in the earlier part of this, the third, evening's meeting.

First then, with regard to the pickling of boiler plates, Messrs. Green and Fish both look upon the proposal with favour as being a practice which would conduce towards making the electrical condition of the plates more uniform and thus render them more susceptible to the action of zinc over their whole surface. It would, moreover, enable the

white zinc paint, which, I contend, the interior ought to be coated with, to adhere more firmly. Mr. Duncan thinks that no benefit is likely to accrue from this, and Mr. Johnstone, while admitting that he has had no experience with this pickling of plates, tells us that he has had very good results from the use of white zinc in boilers. Messrs. Smith and Birkett believe in the use of this paint, though Mr. Latta does not agree with it when the boilers are new, as his experience is that it does not stick on.

By a re-examination of my paper he will see that his experience exactly coincides with my own, and it is for that very reason that I have been led to propose this pickling, for I have found that it is only after a certain period, when the plates have assumed a condition similar to that which could be attained by pickling, that the paint appears to adhere properly.

Mr. Green thinks that great care must be exercised in the manipulation of the plates, and also the selection of a pickling medium, and he tells us he proposes making some experiments on the depositing of zinc on plates by electrolysis, the results of which, I am sure, we shall all be very glad to hear laid before this Institute.

Until the reading of this paper, I was unaware that it was a practice to pickle *boiler* plates, as I suggested, although I knew that the shell plates of the vessels built for the Royal Navy were so treated; but since then I have been informed that the Admiralty specify this to be done in the case of all boilers which are now built for them, although I cannot discover whether it is also the custom to paint the insides as I have proposed. I would also take the liberty of mentioning that I understand now that the pickling medium is not diluted sulphuric acid, as mentioned in the paper, but diluted hydrochloric acid. Taking it altogether I think I may conclude that with regard to this point, as it is already practiced to a considerable extent, and as the weight of the evidence in the discussion is favourable, the pickling of plates during construction, and the painting of same with white zinc is advisable as conducing to the durability of the boiler.

With regard to the second point, I think I may say at once that all the speakers have agreed that it is very necessary that steam should be very gradually raised, and several have particularly mentioned that they agree with me when I say that too often when steam is first raised by the builders, it is done too hastily. It is to be hoped that instances such as that which Mr. Sage cites are very rare, although I am afraid that in certain classes of steamers,

the raising of steam slowly is not nearly so carefully attended to as it ought to be.

In proposal number three, relating to the use of salt water for a short time in the beginning of the life of a boiler, we have a decided division in the opinions expressed by the several speakers who have mentioned this point. Of those who are directly in favour of such a course being adopted, I may mention Messrs. Birkett, Shorey, Nicoll, and Bruce, whereas against it we have the opinions of Messrs. P. Smith, Graham, and Leslie, We have, however, Messrs. Duncan and Tyler, both in favour of getting a scale on the boiler as soon as possible, although they disagree with me by saying it is a lime scale and not a salt scale which is required. Now, I say it is exactly such a scale we do obtain, and not a salt scale, for that which is got from sea water consists principally of sulphate of calcium, which becomes insoluble in water at a low degree of temperature, and therefore deposits much earlier than any of the other constituents, the soda portions of the sea water remaining soluble for a much greater length of time.

In Professor Lewis' "Inorganic Chemistry," he informs us that in a sample of scale taken from a boiler using salt water, he found that 8½ per cent. was sulphate of calcium, whereas soda chloride or common salt was only present to the extent of 2¾ per cent., so that it is sufficiently shown that the *lime* scale which the two gentlemen mentioned wish to see, is actually obtained from the sea water. No doubt there are other results, which chemically take place through sea water in the boiler when under steam, but these, where detrimental, are counteracted by the use of zinc. Mr. Adamson draws attention to the fact that we do occasionally find salt in boilers, notably so in superheaters and especially after priming has taken place. I think this is perfectly obvious, for under these conditions the salt water is completely evaporated, leaving all the insoluble portions deposited.

In the book already quoted, we are told that in a gallon of sea water there are 1,850 grains of chloride of soda, as against only about 451 grains of all the other ingredients of solid matter, so that in a deposit of the kind there must always be a decided appearance as well as taste of salt. It is for the same reason that we find the deposit caused by a small leak on the shell of a boiler to be composed principally of salt. The means of obtaining a scale as proposed by Mr. Tyler, I have heard of being tried before with very good results, so it was said, but personally I have never used it, though I am inclined to think it might be beneficial.

I think, therefore, that again I may say the consensus of opinion is that it is advisable that salt water, if it can be got clean and not mixed with mud and other impurities, should be used for a short time. It appears to me I have been misunderstood by one or two of those who have spoken on this point, so would again say that it is only at the beginning of the life of the boiler this should be done, and that thereafter only fresh water should be used.

With regard to proposal number four, there is really only one of the speakers who seems to be inclined to think that oil in boilers is a good thing, and he may easily be pardoned for giving us this opinion. I myself am perfectly of the same mind that this oily material round the water line does no harm to the boiler, but the difficulty is that it does not always deposit itself there alone; it gets down on to the furnaces and owing to over-heating, has been the cause of many serious damages to these parts. It is for this reason that I have brought before your notice the advisability of having mechanical means for filtration of the feed water. I should have liked to have had more evidence as to the state in which a feed filter, such as I have mentioned in the paper, is found in opening up for examination, but it appears to me that the invention to which I drew attention, has many more qualities than are required for its purpose. Mr. Bruce tells us that the apparatus is certainly the best filter in the market at the present time, and I understand he speaks with some authority, having had the opportunity of viewing the boilers of a ship which had been using one and which showed that it had given very good results; and since the paper was read I have been informed that it is now being extensively introduced into both the Royal Navy and the Mercantile Marine, so that we no doubt ought soon to hear more about it. I think I may again say that it is unanimously agreed that it is necessary to have some means of clearing the feed and consequently the boiler water, mechanically, and I quite coincide with Mr. Birkett when he says that a good filter, if we can only get it, is more economical than the use of brine cocks.

As to the use of soda in boilers, I think the opinion of the majority of the speakers is also in its favour, and I think the means adopted by Professor Lewis in the apparatus by which he attained his object of clearing water also of the low temperature scale forming qualities, is sufficient to show in what manner soda, when put into the boiler, does its work. The only difference lies in that in the former these qualities were removed before water went to the boiler, and in the latter this was done inside. Here,

therefore, I think we have at least one agreement between theory and practice as Mr. Lilly wishes. Mr. Fish thinks that soda can be introduced in too great quantities, which is no doubt the case, and there are possible instances in which it might do positive harm, such as in the case of a boiler with rather limited steam space, in which it might have a tendency to create priming. If used judiciously, however, I think there is little doubt that it is to be commended. The use of caustic soda is deprecated by Mr. Adamson, although on the other hand Mr. Barringer tells us that in the preparation called "Zynkara," which he considers to be a compound of caustic soda and zinc, the good effects to boilers are principally obtained from the former ingredient. Mr. Fish does not appear to have observed the good results from "Zynkara" that Mr. Barringer has obtained, although I may here state that some time ago I happened to be conversing with a friend of my own who used it and gave it a very good name, both as a cleanser and preventative of corrosion.

With regard to the zinc question, number six on the list, it appears to me that here again we are almost all of one mind, viz., that it is necessary, that it should have good contact, and that it should be placed in the boiler before any water is put into the boiler for the purpose of raising steam. Mr. Lilly questions why there should be such a variety of opinions as to which is the best way of fixing the zinc, and as to whether it is electrically or chemically the benefit is obtained. It appears to be that the opinion of the majority is that it is the former, although I may state that personally I am of opinion that there may be good obtained by both means. I am convinced, however, that the benefit obtained by good contact is certainly with less expenditure of zinc. I cannot explain further, but experience tells us that it is beneficial and therefore we use it. Mr. Adamson tells us that zinc was introduced to his knowledge about sixteen years ago, and what is the consequence? He also tells us that he can point out ships, now eighteen to twenty years old, which still retain the original boilers working at the original pressure. From these statements he wishes also to say that the dates mentioned in the paper are not correct, but it is also from the same facts that I say they are correct. What I wished to be understood was that the boilers of ships which were eight to ten years old about ten years ago, and to which no zinc had been applied (and there was a considerable number at that time) were practically worn out. That there are instances of long lived boilers, I cannot and will not attempt to deny, and in proof I can only draw your attention

again to one case mentioned in the paper. I therefore think we must all agree with Mr. Tait when he says that we cannot do without zinc for our boilers, even although we are told by Mr. Bruce that zinc is not necessary if we use Edmiston's filter, soda alone being all that is required. I am afraid, however, that we have not had enough experience with this filter to say this authoritatively, but if it be found that such is likely to be the case, I am sure I may predict a very grand future for that apparatus.

I am glad to observe that with respect to the seventh question I have the support of Mr. Girvin, though I am sorry we have not had more of such opinions, as this was a point on which I particularly wished to have further evidence.

As to the eighth point, namely, the use of brine and blow off cocks at intervals, I am afraid the general opinion is against me, although I am supported by Mr. P. Smith. However, to avoid any misunderstanding, I should like again to say that it is only in terminal ports I can think of recommending such a course being taken, unless there is a possibility of replenishing with good fresh or distilled water.

With regard to the opening of furnace and smoke box doors, there appears to be a slight difference of opinion. Mr. Greer thinks the opening of the latter can do no harm, and says he would open them in preference to the former. Mr. Johnstone says likewise, although he admits that when the smoke box doors have been opened he has observed a sudden burst of flame come back through the ashpit. Now that is exactly what happens, and it is that sudden rush of cold air that does the damage. It does not require half-an-hour or so to do this, in my opinion it is done instantly. Mr. Slater gives us his experience with regard to this, which bears a very great resemblance to my own. Mr. Adamson also supports me, and therefore I think we may conclude it is not advisable to check the draught by either means.

Respecting injury to boilers likely to take place during the cleaning of fires when at sea, Mr. Bruce tells us that nothing of the kind can happen if we will only use Howden's forced draught system. Theory tells us that this is most likely correct, but practice and experience have yet. I am afraid, to give it confirmation. Stopping the fans will no doubt accomplish all in the checking of the draught as Mr. Bruce states.

On point number eleven, I think we are all pretty well agreed that steam should be as slowly lowered as it is raised, and that on no account should the water be blown completely out of the boiler by the pressure of steam. The use of the donkey connection which I have mentioned as

being the best means of circulating water in getting up steam has been mentioned by one or two of the speakers as a most efficient means of getting the water out of the boilers when emptying them, instead of blowing out or running it into the bilge, an opinion which I most heartily endorse. Of the three methods of getting rid of the water, certainly this is the first, then running into the bilge, and lastly, the blowing out under pressure.

From the foregoing, I think it may be safely concluded that the system of treatment of boilers, as proposed in the paper, is generally approved, although there still remain a few suggestions from the various speakers which I think deserve attention.

Regarding the matter of circulation in a boiler, there is not the slightest doubt that it has very considerable influence on its durability. Mr. Shepherd brings to our notice a new system of circulator on which we may some day have the opportunity of giving our opinions, though apparently it is still merely in the experimental stage.

That feed heaters are of considerable value is, I think, generally admitted, and Mr. Graham thinks that we have not utilised the waste heat which passes away up the funnel to its fullest extent. If I remember rightly the late Mr. Kemp, of Glasgow, gave considerable attention to this in the production of his compound boiler, on which he read a paper to the Institute of Engineers and Shipbuilders of Scotland about four years ago, but I do not think the system has been found of any great benefit, and I believe it has been practically abandoned.

I am altogether of the same opinion as Mr. Adamson in the matter of saving all the fresh water that can possibly be done, and must endorse his ideas as to the means of accomplishing such. It is an undoubted fact that we lose a very considerable quantity of fresh water in large passenger steamers that might easily be saved if a few fittings were placed for the purpose, and it is therefore advisable to take all opportunities we can for saving this very valuable commodity.

Mr. Latta asks my opinion as to the action of the gases which are contained in the feed water. I think it is a generally accepted opinion that these are rather injurious if allowed to get inside a boiler, but from experience I think I am safe in saying zinc is altogether sufficient to do the work of preservation. I cannot say what might be the case were we to use a heater with air extracting apparatus, similar to that of the Messrs. Weir, feeding into a boiler without zinc, but I must say that I should be very sorry to

use it in such a manner, and I would most certainly expect corrosion to be going on.

Mr. J. T. Smith makes a very important remark when he tells us that a boiler which has been run out, ought never to be filled again without being opened and washed out, or otherwise cleaned. I think I can safely assert that several accidents of a serious nature have taken place owing to inattention to this advice.

Both Mr. Thomson and Mr. Birkett draw our attention to external corrosion. I think that now-a-days we have not the same reason to complain of this that we formerly had, though there are no doubt occasional instances to be found in which this does take place. These are in boilers where the setting is low and the bottoms almost inaccessible. I would, however, specially mention that if air casings on spaces behind baffle plates in uptakes, &c.. are allowed to get filled up with soot or other similar substance, there is nothing tends more to promote internal corrosion in steam spaces, and therefore care should at all times be taken to see that these places are kept clear.

In conclusion, I must thank those members who have contributed to this discussion, and I can only hope that the views therein expressed will induce all of us to give still more attention to the stokehole, and those portions of the machinery contained therein.

INSTITUTE OF MARINE ENGINEERS.

BRISTOL CHANNEL CENTRE.

PREFACE.

35, Stacey Road,

Cardiff,

November 16*th*, 1892.

A meeting of the Institute of Marine Engineers —Bristol Channel Centre—was held in the University College, Cardiff, this evening, presided over by Professor A. C. Elliott, D.Sc. (Local President), when the Paper by Mr. W. W. Wilson on the "Treatment of Boilers," read at the previous meeting held on November 2nd, was further discussed.

The discussion was well sustained, and is reported in the following pages.

GEORGE SLOGGETT,

Honorary Local Secretary.

BRISTOL CHANNEL CENTRE.

Mr. DAVID GIBSON.

(*Local Vice-President.*)

Mr. Wilson's paper is a most instructive and valuable one, and the subject opens out so many channels for discussion that it is impossible to deal with it thoroughly in our present limited time. With regard to zinc, I have found its cost more than outweigh its value as an anti-corrosive. This cost amounts in six years to almost that of putting in new furnaces. Soda is equally effective and much cheaper, and when judiciously used in conjunction with lime is more satisfactory than any other substance in common use. The use of evaporators, feed filters and injectors, all contribute to the better preservation of the boiler when properly attended to, and soon repay their first cost.

Mr. JOHN McCALLUM.

(*Member.*)

I think I may safely say that the interest in the design, construction and treatment of boilers has never been so keen as it is now, therefore the paper of Mr. Wilson on the treatment of boilers is most opportune.

That the design of the modern boiler is exciting attention is proved by the fact that a special committee is at present investigating as to the best type of boiler suitable for high pressure and forced draught for the Navy, and we also have the results of experiments carried out by the late Dr. Kirk, by Mr. Yarrow, and by Mr. Blechynden, of Barrow, who assert that the tube plates as now fitted to the modern boiler, are too thick, and the loss in heat transmission through tube plates above $\frac{1}{2}$ in. in thickness is 25%. The efficiency of the iron boiler tube above the steel one, was also placed beyond doubt. The introduction of steel in the manufacture, the introduction of high pressures and of forced draught, the many failures which have occurred in most unaccountable ways, and the complications which have risen, have necessitated the introduction into our engine rooms of such contrivances as the evaporator, feed heater, and oil filter to counteract the evil effects set up in recently designed boilers. The advantage of forced draught, in getting a higher efficiency from a boiler than could be got from it with a natural draught, has made it possible to economise boiler space, but at the expense of leaky tube ends, and Messrs. Yarrow and Blechynden are to be complimented for throwing some light on those failures. I think in boilers fitted with forced draught,

all water spaces in direct contact with heated surfaces should have much wider water spaces than are at present allowed.

I do not agree that the opening of tube doors is not detrimental to the tubes. This argument that the current of hot air is still coursing through the tubes, is feasible enough, but in my experience, when tube doors were opened, furnace doors and ash pit dampers were closed, so the cold air had to get in somehow to the backs to replace the hot air, and nowhere easier than through the lower row of tubes, which as a rule are the first to leak, also the cold air passing through open smoke boxes and past the front tube plate is a source of evil. The assertion may be correct in theory, but in practice I have found that boilers which have tender tube ends, seldom fail to put in evidence when doors are opened. Although we cannot sweep tubes without opening the doors, I think this is conclusive evidence of the evil of doing so, and the less it is done the better, and if it is not the cold current of air affecting the tubes, I should like an explanation of what is the cause, and I quite agree with Mr. Ryder, that in the event of a sudden stoppage, never open tube doors, but close up dampers, and let safety valves do their work, and I warrant the captain will give the engineer sufficient warning the next time he wishes to stop.

Leaky tube ends are principally caused by dirty tube plates and dirty tube ends, and I have known boilers, formerly so troubled, run for years without leakage, provided the plates were kept clean. Opening smoke box doors and cleaning fires aggravate the evil, as also does an overdose of soda, which is a good medium in a boiler when judiciously used, but it is not in my opinion to be compared to zinc as a safe anti-corrosive, as it puts a hard flinty scale on the boilers which is difficult to remove, and forms an element of danger in over heating, and subsequently leakage. I know of boilers so treated, filled with fresh water and boiled for several days, and then this course prove ineffectual in removing the scale, and when you take into account that the cost of scaling the average Atlantic Liner is over £300, what would be the cost had the scale been like the above! An excess of zinc, as far as I know, has never been injurious to a boiler. The electrical action will only take up a certain amount and no more, and it is not a question of the more you put in the more you will waste. I think Mr. Green in his paper on the application of zinc to boilers, has fully gone into this, and I would recommend Mr. Gibson to

give his paper another perusal, feeling certain his opinions as to the merits of zinc would alter. I also think he may see reason to alter his opinion, viz.: That the cost of zinc used in six years to keep a boiler in good order, was sufficient to give the boiler new furnaces. I think this is hardly so if we reduce it to figures. Take the average rolled zinc plate, 20 lbs., and allow eight in a boiler of three furnaces for three months, which gives close on six cwt. of zinc for the year, and at 30/ per cwt.—a good margin—the total cost for the six years would be £54, which amount would not be sufficient to pay the cost of repairs of the furnaces up to the date it was decided to renew them. The cost to renew a furnace crown alone would be about £50.

Zinc is efficient at all temperatures, but soda is not soluble at high temperatures, and the reason I affirm that zinc is more reliable than soda as an anti-corrosive, is that unless the engineer is intelligent enough, and is accustomed in the use of litmus papers, he may put in an excess of soda or otherwise, and in both cases be injurious, but with zinc it is beyond his control. It is regular in its action, and any inattention does not affect its efficient working, providing it is fixed properly.

There is more danger of corrosion with the modern type of boiler, using fresh distilled water, than with the old type, in which the acids formed by the decomposition of the oils were neutralised by the salts in the boiler. These acids in the modern boiler are more free to act, the water being fresh owing to the use of evaporators. Mr. Edmiston's filter has reduced this evil to a great extent, but it is not a matter of surprise to us, when we note the effect of acids in fresh and salt water that so many high pressure boilers are running now and in good order, under the old conditions, without evaporators, &c.

I agree with Mr. Wilson in almost every particular, but he has evidently forgotten to mention the lagging of the boiler—which certainly adds to its efficiency—and also to suggest the best means to get rid of the corrosion in fronts of boilers caused by drawing fires and cooling ashes. I would also beg to mention a practice carried out by a superintendent engineer during the construction of his steamer's boilers. He has holes bored and tapped through the plate at each seam, before the boiler shell is put together, and he afterwards applies by hydraulic presses a mixture of red lead and oil when the boiler is put together, till it almost oozes out at the seams. He has never any trouble with leaky bottom seams.

Cleaning fires, as the firemen commonly do unless watched, is dangerous to a boiler. The old style of shoving the fire back, or throwing it one side, and cleaning one side at a time, is certainly better than the easy but dangerous method of drawing all the fire out and re-starting it from another with live coal,

In conclusion, I would say that the life of a boiler depends in the first place on its construction, on its treatment and care by the engineer in charge, and also on the good circulation of the water inside, and any means adopted to ensure a continuous and reliable circulation when under weigh, deserve our earnest consideration.

Mr. DAVID GIBSON.

Mr. McCallum has endeavoured to show that my assertion concerning the cost of zinc is incorrect, but I also can produce, and reduce my case to figures to prove it. He puts down the price of a furnace crown at £50, but I have had a new furnace complete put in for £40. His estimate of the quantity of zinc used is also under that of actual practice. And every two, rather than three months, the zinc plates will want renewal to be effective. But Mr, McCallum appears to have misunderstood the point of my argument. I did not say zinc was altogether bad—as he seems to construe my meaning—but merely that soda was equally effective and much cheaper. I still hold firmly to this belief, for I have long investigated the matter, and must therefore speak as my experience has taught me.

Mr. JOSEPH WILLIAMS.

(*Member.*)

The paper which we have met to discuss this evening is valuable because it contains the recorded experience of an observant engineer, with the addition of the conclusions at which he has arrived after reflecting on those experiences. There is apparently no sufficient reason why some of our sea-going members should not follow his example, and form themselves into a kind of permanent Research Committee for the accumulation of facts such as that relating to zinc, for instance, on page 18; much more very valuable information would be gained in this way. In the last complete paragraph on page 8 Mr. Wilson has referred to the difference in the extent of scale deposited when working at different densities—in a way which leaves us to infer that a difference of two or three thirty-seconds to the "orthodox limit" makes "really

little difference in the extent of the scale." This statement appears rather questionable, as *much less* scale should be deposited when a boiler is worked at high (safe densities) than when it is worked at low densities. Let us take a common example here; a single ended boiler which is filled with, say, 20 tons of sea water preparatory to a voyage to Bombay, which will occupy 30 days from Cardiff; let us further suppose that we only lose 10% or 2 tons of steam and condensed water per day, and that we make up all losses from the sea, and never blow the boiler throughout the voyage. On arrival at Bombay we find that we have pumped 60 tons of sea water into the boiler, and that the density of the boiler water is now about 4-32, as $20 \times 60 = 80$ tons at 1-32, but as 60 tons have been evaporated, the density will be approximately as stated.

Next, suppose the same ship to make another voyage, and that the engineer has received instructions not to exceed the "orthodox limit" which, for the sake of simplicity and in the absence of Mr. Wilson's figures, we will assume to be 2-32; the losses and means for making them up remaining as before. The density limit will be reached in ten days, after 20 tons of sea water have been fed into the boiler. During the remaining 20 days of the voyage the engineer will require to blow out as much as he loses to maintain the density at 2-32 (as 2 tons per day will be the *nett feed* required from the sea), and instead of 40 tons he will now require to put 80 tons of sea water into the boiler before completing the remainder of the voyage; 20 tons as before remaining in the boiler on arrival at Bombay.

Comparing the two voyages, we find that in the first case, by allowing the density to rise 4-32, we had to raise 80 tons of sea water to the boiling point due to the pressure; in the second case, when the limit of 2-32 was maintained, we had to raise $20 \times 20 \times 80 = 120$ tons of sea water to the boiling point due to the pressure. With the pressures commonly used, the scale-forming coustituents in the sea water will be mostly deposited before the boiling temperature due to the pressure is reached; so that comparing the two results, and supposing other things equal, we see that the amount of scale would vary as the numbers 8 and 12, or 50% *more scale* would be deposited in this case, by working *fresh* than by working dense, when sea water is used as "make up." My own observation leads me to infer that this theory accords with practice.

Mr. JAMES PEASE.

(*Member.*)

With reference to a point that has been raised respecting the use of scums, I do not see that a definite rule can always be laid down, as it must so much depend on the nature of the water used, and whether any oil is used in the cylinders, and what oil. If salt water is used in the boilers without any alkalies, scumming would certainly be useful in removing scum from the surface, but should soda be used the action is entirely altered. I must draw your attention to the point that the calcium sulphate is changed to calcium carbonate, which latter is wholly precipitated as an impalpable powder when the temperature of the water reaches 290° Fah. This powder is of light specific gravity, and insoluble in water, so naturally floats to the surface, and we may assume collects at the quieter parts over where the down circulating currents exist. The mineral oil that has been experimented on by Professor Lewis gave specific gravity of ·889, and from similar causes would probably collect about the same place, coating and eventually permeating the floating particles of carbonate of lime; its specific gravity is thereby increased. This impermeation is found by experiment to take some time before a sufficient density is reached to allow it to sink with the convecting currents. This should be removed by scumming before it has a chance of doing mischief, scumming, however, as little as possible at one time. The water should be only a little above the scum dish when the blowing is commenced, so as to make sure of taking away only surface water and making the operation as effective as possible for the amount of water ejected. Had time admitted I should like to have referred to the presence of cupric salts in some lately published analyses of scale taken from a boiler that had been fed with condensed water until the apparatus broke down—to elicit some opinions whether, considering the heat expended in evaporation, some means of preparing sea water might not be advantageously compared with the present method as to efficiency, liability and cost.

Mr. JAMES FERRIER.

(*Member.*)

I very much regret having been unable to read Mr. Wilson's paper through before this meeting, as I consequently am not in a position to discuss the particular points he has brought forward, but being called upon to

give my experience concerning boilers generally, I will state a few of my ideas as briefly as possible. I strongly advocate boilers of large steam and water spaces; by water spaces I mean those between the furnaces and combustion chambers; it is not possible to give the boiler fair play when these spaces are contracted, nor can convection take place freely if the currents of water are impeded at these most important parts. Ample steam space should always be provided without the use of domes; in the ordinary ocean-going steamers it is most advisable to have the capability of the boiler in excess of the horse power of the engines. I would dispense with the use of zinc plates, and use soda moderately. I never found opening of tube doors cause the back ends of tubes to leak. Blow-down cocks or any other fittings should not be put under the bottom of the boiler, as they are liable to get blown off by bolts corroding. Scum accumulates mostly in making steam, and the cocks should be used very little after the engines are away full speed. I advocate boilers being cleaned out at every possible opportunity, and more particularly under the combustion chamber; they should be wiped out clean after washing.

Mr. JAS. C. SOULSBY.

(Member.)

Having been requested to offer some remarks *re* Marine Boilers and their Management, I may say that the marine boiler is at present, and has been for some time, engaging the attention of the engineering world. Scientists also are devoting their researches to the same end, in respect particularly to steam and its capabilities under certain and varied conditions; these, however, in the management of boilers I leave out of consideration.

Treating boilers outwardly depends on: (1) Careful stoking and good fuel; (2) Attention to connections and feed water; and (3) Apply tests to feed water to ascertain whether acid is present, and in what quantities, also whether any excess of alkali is prevalent. It is easily ascertained by the use of litmus papers, which should be more extensively used, and engineers urged to use them.

I have never used zinc or electrogens or any other preparation with zinc as a base, and have had charge of machinery as chief engineer on large steamers and gun boats about twelve years, during which time I have had no difficulty with boilers, but on the contrary, found invariably the best of results by adopting alkalies of

mild descriptions—as prepared lime and common soda, &c.—as antidotes to acid or galvanic action.

I have paid particular attention to cleanliness, removing loose matter, scale, and any oily substance, and finally washing out with hose from the feed donkey. I should say avoid scumming and blowing down, except under very exceptional circumstances. Feed circulation is a desideratum which should be kept well in view throughout the boiler, together with injecting feed water at the highest temperature possible.

Mr. T. KERMAN.

(*Member.*)

I have listened very attentively to Mr. John McCallum, and the remarks he has made are good, sound sense. The first part of his remarks I would refer to is leaky tube ends. This, in my opinion, arises from different sources, and is considered at the present time to be causing a great stir in our Navy. In the iron-clads fitted with forced draught, on recent trials during the manœuvres with the squadron, an order would suddenly be given "full speed, use all power you can." The forced draught would immediately be put in action, and in a very short space of time the furnaces and combustion chambers would be like a blast furnace. Then suddenly an order is given to stop. Forced draught is suddenly dispensed with, the effect on the tube ends is disastrous, as might be expected. To cope with this condition of things those in charge were bound to resort to some method to protect the ends, and it is now considered best to use iron tubes with the ends ferruled. These are giving great satisfaction. I have referred to this because I consider it the part of an engineer's duty to study the temperature we have to contend with at the present day. Mr. John McCallum's remarks in reference to tube doors being opened only when actually necessary, point out that the expansion and contraction have to be considered, and thoughtfully, by those in charge. Mr. John McCallum, referring to Mr. Wilson's paper, wishes to point out the deterioration that takes place in the pitting of furnace sides, &c. I should like to give my opinion on this matter, My first impression is that the construction of a boiler greatly serves to make the treatment of the inside vary, and so also as to its longevity. I am of opinion that too little notice is taken of the design of the boiler. It is customary for ship and engine builders to use their utmost endeavours to supply the bare quantity, or as small a boiler as is consistent

with the horse power of the engines, and in many instances leave us with too little water and steam space, and when this is so we have a very difficult obstacle to contend with, and a very bad machine; therefore we find that different boilers require different treatment. In Mr. McCallum's remarks he observes: "Are soda, lime, or zinc plates necessary?" I may state that each of these substances, being a purifying element, is, in my opinion decidedly necessary. It is also remarked by some of our members, "Why does pitting take place in the boilers, especially in the furnace sides?" My opinion on this point is that it is caused by the variation of heat. It is a well known fact that when water—say at 140°—enters the boilers, it immediately makes for that part where the extreme heat is, and that part is the furnace sides, hence the impure water arrives at this point, and by heat the impurities are extracted, and it necessarily follows that here the greatest action must take place. The consequences, as remarked, vary according to the water space, the smaller the water spaces the greater the pitting, this also applies to the combustion chamber where the spaces are narrow. There is one more instance I would wish to draw your attention to, and this is a case that has lately come under my notice. It is in that of a boiler only six months old, where the tubes have eaten away on the under side. The top side had a slight scale, but on scraping the underside they appeared like phosphor, and were completely eaten through. This boiler is of small dimensions for the engines, and requires extra forcing. I may say there was neither soda, lime, nor zinc plates used. The steamer I refer to is running out of Swansea and Port Talbot, and the water there may also assist this deterioration, especially when no preventative is applied.

MR. ROBERT DAVISON.

(*Member.*)

I quite agree with Mr. Wilson that new boilers should be filled with sea water, for by so doing a thin protective scale can soon be got on the heating surfaces. The tubes particularly need this protection to guard against the corrosive action of impurities in the water. By scumming and blowing down occasionally for the first few days steaming, this is readily procured. At the same time the scale on the furnaces and other parts may be rather more than is desirable. This can be removed in the ordinary way; but the tubes are of the first

importance as they are the chief sources of trouble from pitting, and the first parts of the boiler that suffer.

I have known the tubes in new boilers where the engineer has failed to get a covering of scale on them during the first voyage, pit to such an extent that some of them had to be renewed after the boiler had worked only six months.

As to the smoke box doors being opened when no funnel damper is fitted, I remember on two occasions where the tube plates were thick with scale, and the back end tubes in a bad state (probably from being repeatedly expanded by drifts), that on opening the tube doors the boiler commenced at once to leak at the back ends of the tubes.

MR. JOSEPH HARDY.

(*Member.*)

I am averse to zinc or any other foreign substance being used in boilers. Periodical cleaning and scaling is a simpler method of treatment, and all that is necessary to keep the boiler in the best condition. Let this be done whenever possible, and let the superintendent in charge see it properly done, and we should not hear so much of wasting away and leaking of boilers as at present.

MR. RICHARD J. FIELD.

(*Member.*)

This is a paper in which a great diversity of opinion will exist amongst us. Different boilers require different treatment. The manner in which we might treat one boiler would altogether upset the working of another. In my opinion one of the principal causes of priming is a confined or crippled steam space, and to illustrate which I will give you an instance. Some years ago I took away a new boat from one of the principal north country builders. This boat had a pair of circular boilers with a horizontal steam receiver fitted between them, the bottom of this receiver being some 15 inches below the tops of the boilers. We had also a Galloway tube fitted in each combustion chamber extending from the bottom of the chamber to the top, and the distance available for both water and steam (that is between top of combustion chamber and crown of boiler) was about 24 inches There was also fitted in each boiler an internal steam pipe of 9 inches in diameter (horizontal, and extending the whole length of the boilers) with a

neck four inches deep connecting the internal pipe to crown of boiler. When the water gauges showed one inch of water there were three inches over tops of combustion chambers, and 21 inches from surface of water to crown of boiler, and deducting diameter of steam pipe (nine inches) and length of neck (four inches), equalling 13 inches, left a space of about eight inches between surface of water and under side of internal steam pipe. These boilers could not be treated in an ordinary way, and at sea even in the best of weather, would prime in spite of all precautions taken, due, in my opinion, to the Galloway tubes and crippled steam space. Scumming you could not attempt, if you did, bad matters became very much worse, and blowing from the bottom had to be resorted to. The following boat I had charge of had boilers of very different construction, the steam space being about double the area of that in the former boilers, with neither internal steam pipes nor Galloway tubes. These boilers you could work in any manner, and I never knew them prime, even when filled up with very indifferent water from the river Thames. I think this will demonstrate that crippled steam spaces are as much a cause of priming as dirty boilers, or even more so.

With reference to zinc plates, I consider they are good if properly fitted. The object should be to get a perfect contact between the zinc plate and the part of the boiler affected by corrosion, or showing signs of becoming so. A good method is to fit zinc plates on to studs in the manner advocated by Mr. Phillips in a previous paper. Zincs, as sometimes applied by being merely put into iron boxes, suspended by hangers to the boiler stays, are, in my opinion, both deceptive and useless. I have noticed this in practice, and am therefore quite in accord with Mr. Wilson on this subject.

Opening of smoke box doors suddenly when under steam at full pressure, and fires at full height, is a thing to be avoided by all possible means. The rush of cold air past the front tube plates and up the funnel is most injurious—more harm is done by such treatment in five minutes, especially to a shaky boiler, than can be repaired by as many days of work after reaching port.

MR. WILLIAM BALL.

(*Member.*)

I have taken a deep interest in this paper, coming as it does under a heading of immediate and principal interest in engine room practice. We must all feel indebted to

the author for compiling such a useful paper for discussion on a subject too, which has occupied probably more attention than any other engineering problem.

Mr. Wilson in this paper does not offer many suggestfons but what are in well-known practice. Some of them are good, others are questionable. But the treatment and management of boilers is a very wide question; even our most scientific and practical engineers are more or less at variance, especially on the points of the best treatment for preventing or deterring the destruction of our boilers.

It is well-known that from the moment the boiler is put to work, the agent of destruction commences to act also, in a greater or less degree of violence, according to circumstances, and amongst others, to the construction of the boiler, and in no small measure its future life depends on the treatment it receives at the hands of those who may have the management of it.

Many points in the management we know how to deal with, but in such matters as wasting of structure by galvanic action set up internally, there seems to be some doubt as to the best method of treatment.

The useful proportions of zinc have been referred to I have used it in various forms, sometimes in a closed box. where the feed water can pass through on the way to the boiler; suspended on hooks carried from the stays in different parts of the boiler, zinc placed in boxes in the immediate vicinity of the feed and upon studs; and from observations I have no doubt that the zinc used in this way does prevent or neutralise the galvanic effects more or less, but I find that unless particular attention is paid to having good contact, the zinc will be simply wasted, and the desired end not obtained. I am further of opinion that the use of zinc does not give nearly so good a result as the trouble and cost warrant, still I would use it until I could find a better and more reliable agent.

I must say I quite agree with many others that the use of soda should be more extensive. Soda is certainly cheap, and it has been proved over and over again with some waters, to have the desired effect of arresting corrosion, and there is one thing again in the favour of soda, that it is scarcely possible to do harm, unless very carelessly used.

So concluding my remarks, I am in hopes that the discussion on the above useful subject may on an early day be brought up again.

Mr. W. WILSON'S REPLY.

I have to tender my best thanks to the members of the Bristol Channel Centre for the remarks which they have contributed on my paper. I feel that I have but little to say further than I have already done in the paper and in my previous reply. I cannot however pass the remarks by Mr. McCallum, in which I think I can recognise one who appears to have given the treatment of the marine boiler considerable study. He evidently can appreciate the value of zinc as a boiler preservative, and I am quite of his opinion that it is doubtful if the cost of the same will pay the expense of new furnaces in the time stated by Mr. Gibson, if it be properly applied and attended to. Besides it is not only the cost of new furnaces that has to be taken into account; there are other parts of the boiler which are just as liable to corrode as the furnaces. Mr. McCallum also gives us a very good suggestion for improving our shell plate joints, viz.: that system which he has seen adopted of forcing red lead and oil into the joint by pressure. This I have seen applied in seams of butt straps when a persistent leak took place, but I quite agree that it is a practice that might be safely carried out even in a new job. I must apologise for not introducing a few of the further minor points of boiler treatment, such as that of the manner in which fires are drawn and damped almost in the ashpit, by saying that although these were in my mind when writing this paper, still I felt that I had taken up quite enough time of the Institute in what I had written, hoping that a few of those details would be brought out in the discussion.

Mr. Williams shows us by means of figures that in feeding our boilers with salt water, we will get even less scale, if we work to higher safe densities, than if we were to keep brining to prevent density going over the "orthodox limit" of the salinometer. Like himself, my own experience is that practice proved theory to be correct in these circumstances.

There seems to be a general approval of the use of soda, and I must admit that with one or two of the speakers I perfectly concur in the opinion that a great deal depends on the construction of the boiler as to the real success of its subsequent treatment; still, I can only once more repeat that if it be not treated well, no matter what is its construction, the marine boiler will all the sooner show signs of decay.

Again I must thank all members who have, in giving their opinions, tried to make this paper of such importance, that it may in the future prove of value to us all.