DISCUSSION ON

# Mr. H. Ruck-Keene's Paper on "New Methods of Effecting Boiler Repairs"

AT 58, ROMFORD ROAD, ON

*Monday, November* 11, 1907.

CHAIRMAN:—MR. W. LAWRIE (Chairman of Council).

CHAIRMAN: It is rather unfortunate that the dense fog has prevented more of our members being present, as I am sure, from the conversation I have had with several, there is a great deal of interest being taken in the paper we are met to discuss. It has come as something new to most of the members I have spoken to, and they seem to be very anxious to know all there is to be known on the subject. I have no doubt, however, that there is a sufficient number here to be able to bring out more points from Mr. Ruck-Keene, although the paper was given in such a clear and forcible manner that unless one knows something about the subject, it will be difficult to find a vulnerable point in it. As it will be necessary to bring the discussion to a close in reasonable time in order to allow members to get home, I will just declare the meeting open for you to give your views or ask questions.

Mr. R. BALFOUR (Member): I am hardly prepared to take part in, far less to open the discussion, as I came with the full intention of listening to the remarks of others. It is a pity that so few members are present, but the elements are against a large attendance. I endorse all the Chairman has said in reference to the interest taken in the subject before us. Looking at these two pictures on the wall, representing as they do the eminent engineers of ancient and modern times, one is reminded of the many changes that have taken place in connexion with Marine Engineering. Old methods have had to give way to new. In connexion with the systems of welding put before us to-night, I think that in this country it is not an easy matter

to introduce new ideas. This is probably due to the prejudices of those likely to be affected. Still, we must not rest on our oars, but keep up to date. Recent developments have been brought about in the main by the keen rivalry with the foreigner, without which we might not have had a *Mauretania* or a *Lusitania*. We are told by Mr. Ruck-Keene that the systems of oxy-acetylene and electric welding have been in use on the Continent for some time, and apparently with success. From the results of the tests before us I feel sure that these systems of welding have come to stay. The oxy-acetylene system has been successfully applied in welding iron and steel drums or bottles intended for holding liquid ammonia, $NH_3$, and carbonic anhydride, $CO_2$, etc, and these vessels after being welded and annealed have satisfactorily withstood hydraulic pressures up to 3,000 lbs. per square inch. Consequently one is justified in accepting the system as being trustworthy for dealing with defects that are frequently met with, particularly in combustion chambers and furnaces of boilers. Engineers must admit that a doubling plate is an objectionable thing to have in any part of a boiler which is exposed to the action of the flame. Of course at the seams there is always a double, but this is unavoidable, the seams are generally single riveted so that as little doubling as possible is exposed to the flame. Cracks are often found in combustion chambers between the rivet hole and the landing edge, particularly at the attachment of the back plate to the side or wrapper plating, cracks not only from the edge of the landing to the rivet hole, but extending from rivet hole to rivet hole. I would like to ask Mr. Ruck-Keene if, in the application of this oxy-acetylene or electric system of welding, the rivets in way of these cracks would be removed. In view of this it would be advisable to have a test plate with a hole bored, and another plate with a hole punched in way of the oxy-acetylene or electric weld, and the drift test applied. I believe that it will stand the test, and the good results I anticipate will be of a very convincing nature to those who are doubtful as to the trustworthiness of these systems. In the furnace attachment to the back tube plate, there again cracks are found between the rivet hole and the landing edge, similar to those I have just mentioned. The landing edge is often chipped and caulked to overcome leakage to such an extent that it has resulted in cutting the whole of the landing edge out altogether and forming a new landing. This could be avoided by the application

of these systems. In a number of furnaces, where longitudinal and circumferential cracks have been found, studding has been resorted to, but, after all, that is not a permanent repair, it is only useful as a makeshift at an intermediate port or at sea to bring a ship home where permanent repairs or renewals can be effected. Where we possibly can it is always best to overcome this trouble by some means other than studding. Mr. Ruck-Keene has shown us how this can be done by cutting out the defective parts, whether cracked or corroded, and assures us that under working conditions it has proved to be a success.

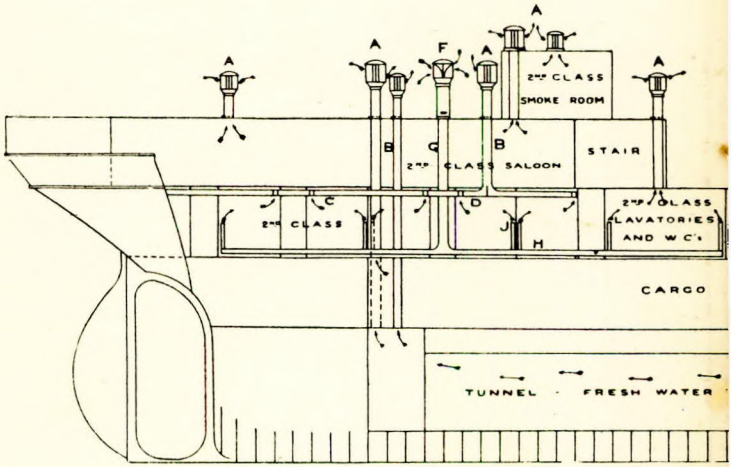
When I referred to drums being successfully treated, it may be said by some that these could be easily annealed, but Mr. Ruck-Keene has shown us both annealed and unannealed test pieces in which the results of tension and elongation compare favourably, which leaves little doubt as to its trustworthiness. It must be remembered that the parts I have referred to are chiefly under compression, and I have no hesitation in saying that, particularly for these parts, the systems could be adopted with much success. Seeing that these methods have been successfully applied on the Continent, we should do our best to hold our own in competition with foreign engineers. Before resuming my seat I may say that I believe Mr. Ruck-Keene is in a position to present to the Institution sample pieces showing the results of these processes for the benefit of those who are not able to be present to-night.

CHAIRMAN : We are very much indebted to Mr. Balfour for opening the discussion. It is a very important thing to our marine engineers if they can do away with patching furnaces, combustion chambers and elsewhere where the flame strikes on those patches. This is no doubt a serious matter sometimes for the engineer and the possibility of being able to overcome that trouble should be a matter of great interest to him.

Mr. E. W. Ross (Hon. Financial Secretary) : From what has been put before us, this is indeed a most important, although a comparatively new style for us to consider in the way of boiler repairs. It has been put to certain tests on the Continent, but as far as our own country is concerned I do not think it has been put to any really practical test. It is quite evident

that special men are required for this special work. It appears to me that there is a danger of burning the plates in the vicinity of the part being repaired, which would be detrimental to the strength of the plate and might result in it failing to pass the Board of Trade or superintendent engineer's requirements. Mr. Ruck-Keene has gone very fully into all the details as to most of the parts which are likely to be corroded, such as underneath the boilers in way of the front end plate, where water very often collects, at the backs of combustion chambers and other places, and I have in my mind's eye some plates which could be very well dealt with on this system if there were men near at hand who could do it so efficiently and well that it would pass the Board of Trade requirements. Apart from boilers, I should like to know if the oxy-acetylene and electric arc processes could be used for other work. Very often there are found in propeller or other shafts marks which attract attention. It is difficult to tell whether these flaws penetrate to the full depth of the shaft or not, at any rate they are cut down as far as they can be detected by the eye through a glass. Possibly they are on the surface, possibly they are not, but if they are cut down to a certain distance, thus weakening the shaft, it would be sufficient to condemn it. Would it be possible to fill up those flaws by these processes and the shaft still be retained as a fully efficient shaft ? I should think also it could be carried into effect in other parts upon the same lines. In connexion with these systems I have wondered how it was possible to weld from the underside, as in the case of the bottom of a boiler. I thought the metal to be welded on would have a tendency to drop off from the part to be welded, but I had the good fortune just now to see the sample of a repair shown by Mr. Ruck-Keene, or at least a deposit on a plate applied from the underside by the electric arc system, and it seems to me that this is a very suitable way of doing these upside down welds. Of course this is a new thing to us, we have had no experience of it, and I came here to-night in the hope of hearing the opinions of some who have had experience of the systems in operation.

Mr. W. E. Farenden (Associate) : There are one or two questions I should like to ask Mr. Ruck-Keene in reference to these processes. In the first place, about what temperature is used in welding by the oxy-acetylene method ? It seems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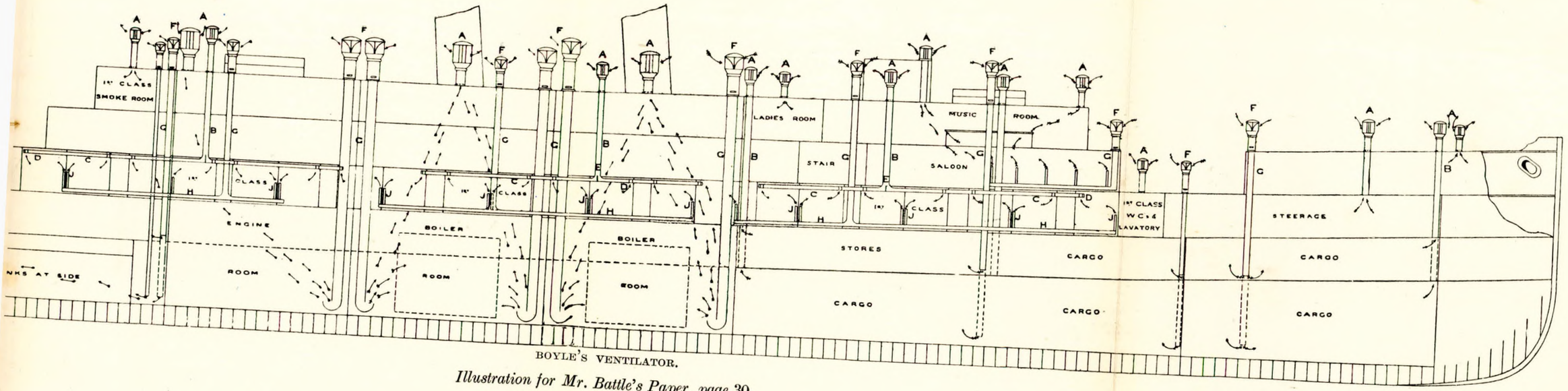



BOYLE'S VENTILATOR.

*Illustration for Mr. Battle's Paper, page* 30.

that a very intense heat is required, and it would be interesting to know what difference in temperature there is between this process and the ordinary system of welding. Would Mr. Ruck-Keene also tell us up to what thickness of plate he would recommend the application of these two processes for repairing boiler plates? He mentions principally in his paper combustion chamber plates and furnace plates. Looking at the results of tests of a plate welded by the oxy-acetylene system given on page 8 of Mr. Ruck-Keene's paper, in which four test pieces are given, two pieces annealed and two unannealed, the question occurred to me whether the plate was cut from any special part of the boiler, say the combustion plate, after being submitted to the process. In two of the plates the extension is given on a length of four inches and the other two on eight inches; the first two are marked as being cut from the solid plate, were the other two broken from the same particular plate? From the results given in the paper the stress on the material works out very uniform. As it is impossible to anneal the plates dealt with for repairs, Mr. Ruck-Keene mentions that the surrounding plate is heated so as to reduce any local strain set up in the metal. I should like to know whether this practice is always adopted in cases of repairs.

Mr. D. HULME (Member of Council): My intention to-night was to satisfy my thirst for knowledge on the subject by listening to the questions of other members and hearing Mr. Ruck-Keene's replies. One or two of the questions that occurred to me were asked by Mr. Balfour and Mr. Farenden, and I think the questions which have been asked have touched upon pretty nearly all the details that could be asked for. I may say in reference to some Babcock and Wilcox boilers which I am now in touch with, pitting is taking place in the shell, and in some cases it has formed cup-shaped holes, which might be taken as about two inches extreme diameter and extending to about three-sixteenths of an inch in depth. If this pitting goes on, it will be found necessary to reduce the pressure on the boilers, a course which would result in very serious loss. I should like to ask Mr. Ruck-Keene if it is possible to fill up these places by means of this new method. They are on the bottom part, and it would therefore require to be done from the underside. Could the work be done to the satisfaction of the insurance companies? I may say that, through the courtesy of my friend, Mr. Downey,

I have had the opportunity of seeing some work done by this process at Messrs. Fletcher's yard in repairing some furnaces, which to me appeared to be very satisfactory. I was discussing the question to-day with an Admiralty overseer, who said that in some cases he had found this to be very good work, but there had been instances that he had heard of where the parts welded on had actually dropped off afterwards, From what I saw I came to the conclusion that the welding would hardly be well done without going right through the plate, so that it would appear on both sides of the furnace plates.

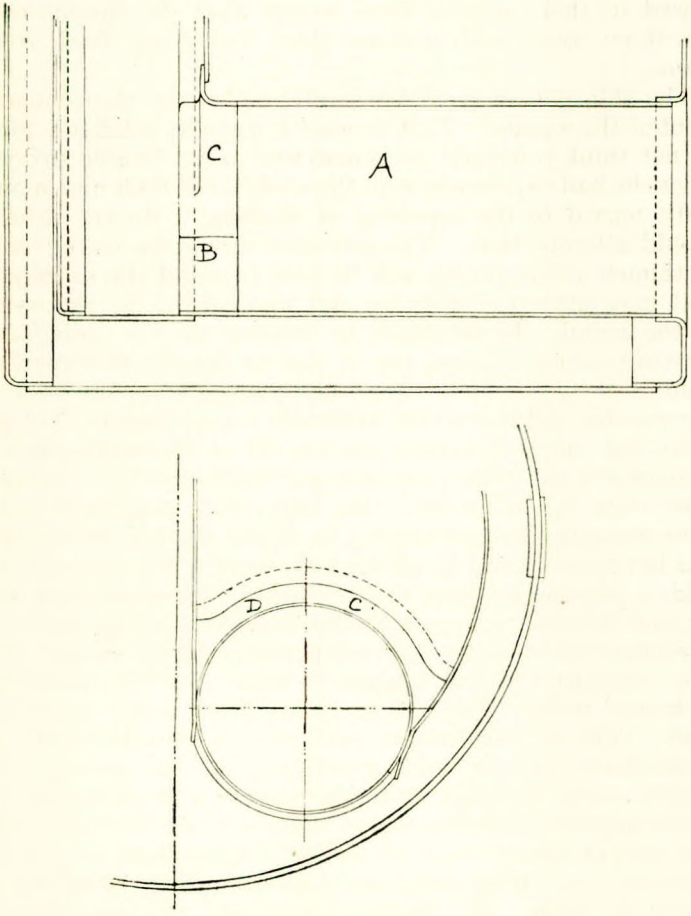
Mr. JAS. CAIRNS (Visitor): Sometimes the case arises in putting furnaces into new boilers, when about two-thirds of the furnace has been riveted up around the mouth, the weld cracks, say to about nine inches. The only way of dealing with this is to fix a double butt strap or a single strap double riveted, to which the buyer of the boiler might object. Could this new method be applied so that it would do away with the necessity of a strap and in such a manner that it would make the weld as good as it was originally?

Mr. H. RUCK-KEENE: I am sorry there are not more here to-night, but undoubtedly there would have been if the weather had proved more favourable. I also expected my colleague, Mr. Bulow, of Gothenburg, who has personally seen a good many repairs carried out by the electric process of welding, would have been able to be present, but unfortunately he was obliged to return to the Continent only a few days ago. Before I begin my reply I thought you would like to see this sample of plate which he sent over. I was asked whether the electric welding could be done from the underside. I wrote Mr. Bulow and he sent me this sample of plate, which has been welded from the underside, to show that it can be done. In the first instance I do not take any credit of having anything to do with either of these systems. They happened to come under my notice, and seeing that these were new methods of repairing boilers which were essentially up-to-date, and being able to obtain some information in connexion with them, I thought it was only right that I should put before you the particulars I had obtained for further consideration and discussion, as I know the Institute of Marine Engineers is always striving to be up-to-date. With regard to the point raised by Mr. Balfour,

respecting cracks in the combustion chamber, that is a thing which either of these processes can very well overcome, and to which they can be ve.y easily applied. As to the rivets being cut out, it depends a good deal upon circumstances. In some cases the rivets were not cut out, they were absorbed with the material, which then made the rivet an integral part of the plate, while in other cases a more lengthy process was adopted, the rivets being cut out and the plate made good from the new material and then re-riveted. We have not had any drift test made, but I will try and obtain some and show you the results at another time. With regard to furnace cracks or corrosions, these I have already described in Fig. 3 on page 11, which shows a very extensive repair done to cracks. They are not all cracks, but what are often seen along the line of firebars and appear to be cracks, yet are really the marks of corrosion. These generally condemn a furnace, and I do not see any reason why these should not be dealt with either by the oxy-acetylene or the electric arc method and the furnaces saved. Mr. Balfour suggested presenting the sample pieces showing the results of the tests of these processes to the Institute. The samples are not mine, they belong to Lloyd's Register, but if I can persuade the Committee to do so I shall be very pleased.

Mr. Ross referred to special men being required. I thought I had made that clear in my reply to the former discussion on this paper. In my opinion special men are needed. By either of these processes the plate will be burned very quickly if the work is not carefully done. But there is no reason why men should not be trained for the work. There are trained boiler-makers and trained fitters, and I do not think it will take as long for a man to become skilled in the use of these processes as to make a fitter or a boiler-maker. But a man must have experience before he can undertake any responsible work, and it will probably take six or eight months' training to get a really good man, but by that time he ought to have a thorough knowledge and should be able to undertake the most difficult work. A man with a month or two's experience should be able to do smaller repairs, such as filling up cracks in way of the landing edges, etc. I heard of a very interesting repair the other day which gave satisfactory results. This was the case of a mail steamer which came into Marseilles with two of her furnaces requiring to be renewed, and the question was could the repair be effected in time. They had not got any spare fur-

naces, and with the saddle plate flanged up on the fire side of the tube plate, and with an Adamson ring in the middle, they could not get a new furnace in of the same section in one piece, as that part of the furnace in way of the saddle plate and Adamson ring would not go through the hole in the front end plate. In order to get over this difficulty the two defective furnaces were cut out by means of the cutting out blow pipe, and new furnaces, each made up in four separate pieces, were made and fitted in the manner illustrated in the following sketch.



First the barrel piece marked A was rolled out of a boiler plate and the longitudinal seam welded by the oxy-acetylene process, fitted in place and riveted to the front end plate, next a semicircular plate marked B was rolled and fitted in place and riveted to the combustion chamber ; next the saddle plate was made in two pieces, marked C and D, and fitted in place and riveted to the tube plate and combustion chamber plating ; and to complete the operation these four plates were welded together where they butted, there being about twenty feet of butt joints to be welded. So that the furnaces were renewed in their original form, except that the Adamson ring was done away with without there being any fresh riveted seams.

The ship got away within twelve days from the commencement of the repairs. That is what I mean by a difficult job. I do not think you could get a man who would be able to do that unless he had experience with the work for at least nine months. With regard to the repairing of shafting, I do not think we should attempt that. The processes should be more confined to thinner plates, which will be able to stand the extra strain that may quite probably be put upon them by the welding of the metal. In reference to welding on the underside, it certainly seems strange, but it can be done. An experiment conducted by one of the London repairing firms the other day showed that welding on the underside is quite feasible. A piece about four inches by three was cut out of the saddle plate of a furnace and the same piece was put back again and welded in place from the underside. The edges were chamfered so that there was an opening of about $\frac{1}{8}$ in. at one side and the other side was left open about $\frac{1}{2}$ in. all the way round. The piece was then held in position by wires and welded up, the experiment showing that this can be done in the furnaces in actual position. Mr. Farenden asked about the temperature of the flame. I am not a chemist, but I do happen to know what the temperature is claimed to be. The oxy-acetylene flame is said to be about 6,000° Fahr. at the hottest part, that is practically the part of the flame used for welding or fusing by this system. With regard to the question as to the thickness of plates, the processes may be applied to plates of almost any thickness, but at the present time I think we should confine them to plates up to about $\frac{3}{4}$ in. With plates up to this size a very efficient repair would be made. Mr. Balfour mentioned that these systems

would be applicable in plates under compression. I am of that opinion also. It is too great an experiment at the present time to start welding the shell plates, the shell being in tension, but in plates under compression there is no objection at all, because the strain is not so dangerous in a thin plate under compression as in a heavy plate under tension. I heard of a case of electric welding done a short while ago in Hamburg to a boat belonging to a London firm. As you no doubt know there is often much trouble caused in the front end plates in way of the furnace mouths, through cracking taking place, where the plates are flanged inwards or outwards, mostly inwards. Patches are put on inside and outside until at last it is found necessary to renew the front-end plates. In this case the front end plates in way of six furnaces were affected (three furnaces in each of the two boilers) and these front end plates where cracked were welded up from the water side by the electric process. It appears to have been very satisfactorily carried out, and I shall be anxious to see how it lasts after some months under working conditions. In reference to the test pieces mentioned on page 10 in the paper, these pieces were all taken from one plate. The plate was not in a boiler, but was welded up in the same position as if it were in a boiler. The first two samples given as "not annealed" and "annealed" were cut out of the plate, but not in way of the weld, as I wished to show the tensile strength of the plate itself. The other two pieces not annealed and annealed were simply cut right across the weld. As to the question of whether the surrounding plates are always heated, I do not know that it is always done, but as a general rule in the majority of cases it is found better to do this. It is only necessary to apply the blow-pipe flame, not at 6,000° but reduced to a less fierce heat, so as just to warm the plate and thus spread the local heating over a wider area. Mr. Hulme referred to the shell plates pitting at the back of the boilers. I am afraid, not being surveyor to an insurance company, I am not able to say that the work would be passed by them, but I think pitted holes of that description could be perfectly well done. As to pieces dropping out afterwards, if that is the case the work must have been very badly welded. In welding on the metal that portion of the plate which is being repaired must itself be heated to practically a molten condition at the same time and therefore all the parts are fixed together, making it impossible for pieces to drop out if the work is properly done.

Mr. Cairns asked if the crack in the weld of new furnaces could be repaired without necessitating a butt strap. I should say yes, I do not see any objection to these processes being used, it would be very much better than putting a butt strap on. All that is necessary is to cut away the defective part of the weld and weld in more metal. In describing the oxy-acetylene process I have made mention of a blow-pipe being required. Several firms claim to make the best blow-pipe for the purpose, but equally good results are obtained from several of them and I should not like to recommend any particular one. It depends a good deal upon the workman using it.

I should like to thank the gentlemen who have come to-night, braving their way through the fog, and am only sorry that there are not more here to give their experiences in repairing boilers by these processes.

Mr. JAS. ADAMSON (Hon. Secretary) : Like others who have spoken, I quite expected a full attendance to-night, and I know there would have been if the weather had been more favourable. We are much indebted to Mr. Ruck-Keene for favouring us with this paper in the first instance, and are also indebted to him for coming to-night and further elucidating one or two points which were not quite clear to many of us. I dare say we all came with the express purpose of listening, as of course we are labouring under the disadvantage of not having had practical experience with these welding processes, but I am quite certain that we hail with delight new processes of this kind to economically and efficiently do the repairs necessary in boilers. I say that in order that I might disabuse Mr. Balfour of any idea of prejudice. I apprehend that we have all come with open minds to-night, we have come with the intention of hearing of what has been done, and if the new processes are good, I hope that some of our ship-repairers in the neighbourhood will prepare to adopt them to this end. I expected most of the foremen boiler-makers here to-night, but the condition of the weather has no doubt intervened. Mr. Ruck-Keene has referred to the partial annealing of the plate, and I believe that is one point which might be considered detrimental to the system—the difficulty of dealing with local heating—as we know what our experience has been in the past. Of course nowadays with the altered conditions under which steel is produced there are not so many of those experiences of eighteen or twenty years ago, but

most of the members who can look back to that time will remember the cracks often seen, and especially those due to local heating. I do not know whether anything has been done with a view to cooling the plate down very gradually after the repairs are completed, as that itself would be a kind of annealing, if the heat could be all kept in under cover, and the plate cooled down slowly, so that the strains would gradually disperse and natural expansion and contraction take place. We all know that an untrained boilermaker could not do work of this kind, it would be absolutely necessary for him to have some experience, and another matter in connexion with the human element is the effect that these processes have upon the eyes of the men who are using the acetylene lamp or the electric arc. We have heard of the successes, but we have not heard of the failures, and that is really a thing which I think we ought to try and get some information about that we may profit thereby. I heard of a steamer being repaired by this process in the Millwall Dock a few days ago, unfortunately I did not hear about it in time for me to get down to see it. I have pleasure in proposing a hearty vote of thanks to Mr. Ruck-Keene for his paper, and also for devoting himself to the discussion to-night in spite of the dense fog.

Mr. R. Downey (Visitor) : On the invitation of Mr. Hulme, I came here to-night. I am foreman boiler-maker with Messrs. Fletcher, Son and Fearnall, who are adopting the system. We have tried the experiment of dealing with the saddle plate Mr. Ruck-Keene spoke of, and have also added pieces to make up the thickness of the front end plate of a boiler where it was worn down very thin. We took a plaster impression of it in order to see what has been done. It seems to be a perfectly satisfactory job, and answers the questions of Mr. Hulme as to whether it is possible to raise the thickness. The lap of a tube plate in the combustion chamber was worn away to about $\frac{1}{4}$ in. from the edge of the holes and by this process we have brought the lap to its original width, similar to that described on page 14 of the paper. It is not a boiler-maker's friend in one sense, but the men can adapt themselves to it. Some of the old men do not like it, but one or two of the younger men seem to have taken to it. In my opinion it will be a valuable thing for doing away with the numerous small patches so often found necessary, in repairing the furnaces especially.

Mr. HULME : I should like to make a statement in connexion with the " human element " referred to by Mr. Adamson. A boiler-smith or a smith of any description who knows by sight the temperature of the iron for the purpose of working it, could work the blow-pipe very easily, the only difference being that he gets the heat a little higher ; I have demonstrated that for the last ten years in using oxygen and nitrogen for brazing purposes. The copper-smiths are able to do the work in a very short time, and in some cases of copper pipes there is a considerable body of metal in them. Any copper-smith will be able to use the blow-pipe in the oxy-acetylene system with very little experience.

CHAIRMAN : Before putting this vote formally to the meeting I should like to ask Mr. Ruck-Keene whether any of this work has been done actually under his supervision. The paper has been a most valuable one and we are indebted to Mr. Ruck-Keene, and also to Lloyd's Register for allowing their surveyors to put this information before us.

Mr. R. BALFOUR : I should like to support Mr. Hulme in reference to smiths and boiler-makers being able to adapt themselves to the use of these systems. They know when the metal reaches the heat necessary for working it. It is a matter of constant practice with them, and they would soon be able to adapt themselves to any other systems where the same knowledge is required.

Mr. A. ROBERTSON (Member) : One thing that occurred to me was as to whether there have been any chemical tests made on these welds, and also, in connexion with this particular plate mentioned by Mr. Ruck-Keene, whether any special care or attention was taken so see that the wire used was of the same chemical analysis as that of the plate. Would it be necessary for the material used for filling up to be of exactly the same analysis as that of the plate to be welded ? I should like to second this vote of thanks most heartily.

The vote was carried with acclamation.

Mr. RUCK-KEENE : I thank you very much for the kind way in which you have received my paper. With regard to the effect upon the eyes of the men using this process, it would

prove very injurious if coloured glasses were not used. It is very important that blue goggles should be used in every instance. I was in Newcastle some time ago and saw there another system in which the metal is melted by means of the electric arc produced by the carbon pencil. There the heat was very intense, and not only were blue goggles used but also a wooden helmet with blue glass front to go right over the head. I have not had any chemical test made of the welded parts. The wire which I mentioned was only to hold the plate in position, the metal for the welding used was mild steel or Swedish iron. I again thank you very much for the way you have received the paper.

A vote of thanks was accorded to the Chairman, on the motion of Mr. Hulme, seconded by Mr. Farenden, and the proceedings terminated.

# Ventilation, Heating and Berthing

By Mr. A. E. BATTLE (Member of Council),

READ AT

THE ENGINEERING EXHIBITION, OLYMPIA, *September* 28.

## DISCUSSION

*On Monday, December* 2, 1907,

AT 58, ROMFORD ROAD, STRATFORD.

CHAIRMAN: Mr. E. W. ROSS (Hon. Financial Secretary).

CHAIRMAN: The discussion is to be resumed to-night on Mr. Battle's paper on "Ventilation, Heating and Berthing," a subject which, to my mind, does not get the consideration it deserves. Ventilation and sanitation go together, and I think this is another matter which needs much more attention both in our buildings ashore and our fabrics afloat. I am sure a number of the members will have something to say on Mr. Battle's paper, and I have much pleasure in declaring the meeting open for discussion.

Mr. G. W. NEWALL (Member): In order to open the discussion, with your permission I shall make some sketches on the blackboard of a system of ventilation, known as the D. C. Green system, fitted in a number of the P. and O. and East India steamers a good many years ago. I was sent over to Stettin in Germany some twenty-two years ago to fit up this system in three of the North German Lloyd vessels. At this time it was widely adopted in large passenger steamers and I had rather a good deal to do with it.

The distinctive features of the D. C. Green system are the nozzle and double cone, which are represented in Figure 1. The up-pipe A in Figure 2 has a cowl fitted above the deck, and the nozzle is connected by a pipe C with a tank or reservoir in which there is a compression of about 15 lb. of air to the square

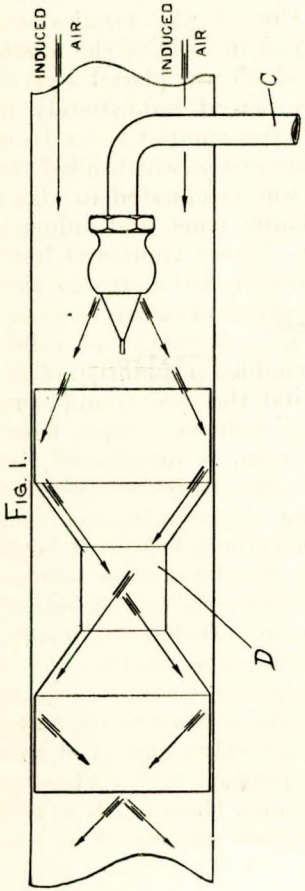



Fig. 1.

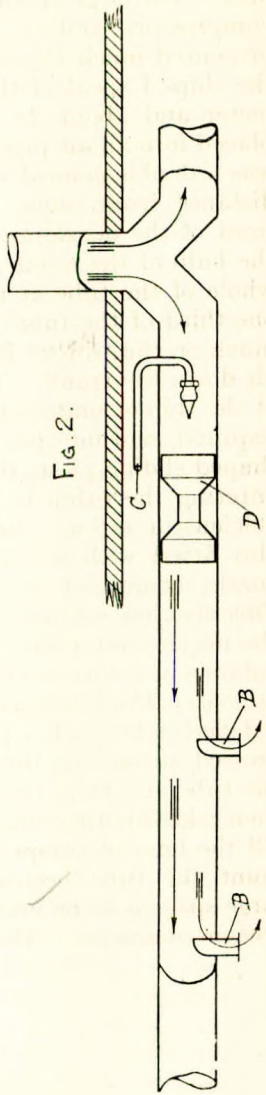



Fig. 2.

inch. For large steamers they were fitted with rather massive compressors, and as a great volume of air was required they presented much the appearance of a cold air refrigerator. In the ships I speak of the cylinders were about 20 inches in diameter and about 26 inch stroke. One of the nozzles was placed into an air pipe or trunk, and just in front of the nozzle was a double conical shaped piece D which was placed a given distance from same. The cone was placed immediately in front of the nozzle, and as the air left the annular space from the bulb of the nozzle, it formed an air piston which filled the whole of the tube at that point and was attenuated to about one-third of the tube's area by the double cone, and induced, much on the Gifford Ejector principle, a great volume of fresh air down the trunk. The trunk was usually led along the side of the ship or underside of deck to the different cabins or where required, and interposed in the pipes in each cabin was a dish shaped sliding piece, B, Fig. 2, which enabled a quantity of air entering the cabin to be regulated, and this was found very efficient in action. In the third figure is shown a down tube, also fitted with a cowl, into which again is introduced the nozzle, connected by a small pipe to the reservoir or tank. This also has a double cone piece, which closes in the air from the nozzle, and acting as an air piston induces behind it large volumes of air to be carried to ventilate the large areas such as saloons. The lower part of the figure shows the attachment of a deflector for such a place as in a saloon. In Fig. 1 the compressed air coming through the nozzle impinges on the side of the tube and from there it impinges again on to the cone. It then takes another shoot off the side of the cone on to the tube. All the lines of compressed air cross each other and so at this point the tube becomes filled with induced air. Where a large space is to be ventilated this pipe may be as much as two feet in diameter. The mushroom shaped casting, Fig. 3, is

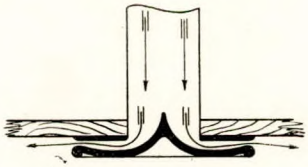


Fig. 3.

fitted at the lower end of the tube, and that deflects the air in the same way as a disc deflects the air from a fan if placed in front of it, so that the fresh air coming in is spread out and radiates all over the saloon. The shape of the nozzle is such that as the compressed air increases in pressure, the cone gives way to it. It is automatic, sliding backwards and forwards, and the best results are always obtained for any varying pressure at the moment. If the pressure falls to one-half, the cone slides up, giving the best air piston for the introduction of the incoming current, due to a spring fitted within the cone portion of the nozzle.

Mr. F. M. TIMPSON (Member) : In relation to Mr. Newall's remarks he has not shown any arrangement for allowing the impure air to escape, would there not be a deadlock in this system if the air is forced in and no arrangements provided for its exit ?

Mr. NEWALL : Of course a ship is not so hermetically sealed that the foul air would be unable to get away. $Co_2$ from human beings is a very heavy gas and tends to fall to the lowest part of the deck and I think, in such a system, the new air coming in on top of the old, will force the bad air through any crevices, badly fitted doors or other openings, even if the ship is battened down. If this class of ventilator is put into a closed space, and by means of the compressed air a little pressure can be put on, say $\frac{1}{4}$ of a lb. per square inch, the fresh air can be admitted all the time the system is working, so that I do not think it is necessary to make especial provision for the exit of the foul air. Under ordinary circumstances, of course, there are plenty of exits for bad air.

Mr. J. H. REDMAN (Assoc. Member) : I should like to ask Mr. Battle whether he considers that $CO_2$ would fall to the bottom of a room. If the air were perfectly still and the same temperature as the $CO_2$, that might be the case, but as the $CO_2$ is warmer than the air as a rule, I should think it rises and leads to a large quantity of foul air being present at the top of the room. Therefore if the fresh air is introduced there it will be contaminated with the impure air, and I should like Mr. Battle's opinion as to whether the top of the room is the best place for the introduction of fresh air, or half-way down or in some other

position. In the sketch on page 33 of his paper Mr. Battle shows a bucket in the middle of the ventilator. That is very bad for the ventilation, certainly, but the bucket would not be there all the time. The berthing accommodation shown in the sketch on page 35 would prove very uncomfortable in warm climates—the galley at one end and the stokehold at the other. I hope that is not a very usual arrangement. I have seen similar instances but none quite so bad. With regard to the ventilation I might mention that I have seen the Thermo-tank fitted as a cooling system in ships trading with the East, and I should think it would be very suitable in hot climates.

Mr. TIMPSON (Member): I do not think Mr. Battle has mentioned anything in his paper with reference to the ventilation of the tunnel shafting. I do not know if there have been any new arrangements in the last few years, but I generally found that the tunnel was a very warm place and there seemed to be a great lack of ventilation there. I think there is great scope for making that part of the ship cooler than it generally is, not only because of the discomfort to the engineer but from the fact that the bearings there are generally warmer than they should be, chiefly from this cause.

Mr. G. W. NEWALL: I may say that the system I have described to you is an ideal one for the ventilation of the tunnel. The air shaft is placed right aft, and a $1\frac{1}{4}$ inch or $1\frac{1}{2}$ inch nozzle fitted into it with 15 lb. pressure of fresh air from the compressor, inducing pure external air right at the back end of the shaft tunnel and blowing all the hot air towards the engine-room. Some of the North German Lloyd ships I believe were fitted in this way. The nozzle is placed about six feet from the top of the tunnel, and on turning on the cool compressed air it induced a splendid draught which made it a treat to get into the tunnel, which was often the coolest place in the ship.

Mr. F. E. SHEPPARD (Member): I have noticed in some of the old cattle ships, live cattle are sometimes carried quite close to the living and sleeping rooms. Who has the official advising authority to point out the discomforts and insanitary conditions attaching to practices of that kind, the Board of Trade or the Sanitary Authorities? It is the engineer who is usually most largely affected; the cattle are put along the

alley way where the living rooms are. Another thing I have noticed lately even in comparatively new ships is that winches have been fitted on the deck above the engineers' room—the rooms where they must try to sleep. If the ship is in the colonies where the winches are working night and day, I am afraid very little sleep can be got.

Mr. REDMAN : I should like to ask Mr. Newall what would be the comparative cost of compressing a small quantity of air to a high pressure to induce the draught as compared with the cost in power consumption of having a fan to move the same quantity of air, and whether it would be worth the trouble to fit up the forced draught fans so as to draw air from the tunnel and warm corners of the engine-room.

Mr. NEWALL : I think if the adaptation, on an ordinary passenger steamer, of the system I have sketched is considered, it will be found much more economical than a system of fans. To work that system of nozzles and inducing the draught there is only one compressor necessary, driven by steam power, fitted on any 'tween deck, not necessarily in the engine-room, and the compressed air from the reservoir can be led by small gas pipes all over the ship. Wherever it is desired to introduce air, a trunk from a cowl is brought to the spot, and in the ships I have mentioned just now there would possibly be 100 or more of these nozzles in different places, say, one feeding three cabins, another feeding one cabin, perhaps six in the saloon, and so on, the distribution being arranged according to circumstances. Imagine a ship about 400 feet long in which a current of air is required throughout the whole of that length from the firemen's quarters to right aft. If, instead of using compressed air and trunks you wished to cover the same space by means of fans, it would mean that perhaps 20 fans and 20 engines or motors would be required, and it is quite plain that the cost of 20 such fans would be much more than that of the nozzle system. But apart from this, another objection is the room which the fans with their motors would take up. To put a fan into a casing to force air would occupy much more room. I think the nozzles would be far ahead of a fan. One double-acting air compressor would be required, say, 20 inches diameter and 30 inches stroke, driven by a steam cylinder direct on, and would take up a space with its flywheel, of perhaps 18

feet by 4 feet. But that is only one engine to look after : if fans were used it would have a great many more elements, each requiring special attention.

Mr. REDMAN : It is quite obvious that fans take up a lot of room, but the Thermo-tank system seems to be a very suitable one. In the ship I saw there were five fitted on the upper deck and each was driven by an electric motor.

Mr. TIMPSON : I do not think we are quite up-to-date in regard to the general heating arrangements on board ship. Excepting in the case of yachts I have never seen hot-water heating fitted for ship use in this country, but in quite a number of these yachts there is a special boiler fitted in the stokehold and hot-water circulation throughout the ship. Undoubtedly this is a very comfortable method, and it is an economical one, also besides preventing a good deal of corrosion by maintaining an even temperature. There are various objections to heating by steam, not the least being the unpleasant smell, and I certainly think the hot-water system would be more economical and pleasant.

CHAIRMAN : Ventilation is a subject to which attention is given in connexion with large up-to-date ships, but comparatively little thought is given to the ventilating arrangements in some of the small coasting craft. Reports are sometimes seen of men going in and lighting a bogie fire, and the next morning it is found that one or two are suffocated or unconscious. If the door is closed there is no ventilation ; no doubt the ventilators are there, and on deck they are quite in evidence, but down below they are placed or squeezed in here and there until three quarters of their efficiency is done away with. I think the system described by Mr. Newall is better than our old friend the steam induction ventilators, but unfortunately there is the trouble of the special machinery necessitated by it. In these days it looks as though a system of ventilating fans obtains more favour. If the D. C. Green system of ventilation had been of much value I should think it would have been more widely adopted, but at the present time electrically driven fans seem to be coming more into use for ventilating purposes. Electric fans would be of very little use in the tunnel, and there I think this system of nozzles would be a good thing for inducing the fresh air.

Mr. TIMPSON : I do not think the system of fans can be giving every satisfaction, as I have noticed there have been several inquiries lately for the old style of punkah but electrically driven.

Mr. W. WATSON (Member) : It would be interesting to have Mr. Battle's opinion as to whether Boyle's system, or any other natural draught system of ventilation, is altogether satisfactory. If so, it would save the heavy initial expense of a system of nozzles, and of course the running cost would be practically nil as compared with the considerable sum necessary for the running of a system of electric fans or a system of nozzles. I think also emphasis might be laid upon the necessity of the thorough ventilation of bunkers, so as to eliminate the risk of fire due to spontaneous combustion.

Mr. TIMPSON : Would Mr. Newall inform us what method was used in compressing the air—was a separate engine used ?

Mr. NEWALL : Yes, a steam driven air compressor direct on, with a connecting rod, similar to a cold air refrigerator with a heavy flywheel. The air was sent into a receiver where it cooled down, sometimes by water. The difference between it and the refrigerator is, that one is working at about 60 lb. and the other at 10 to 15 lb. per square inch of pressure.

Mr. A. ROBERTSON : Has this system of nozzles been used in connexion with the engine-room ?

Mr. NEWALL : Yes, very widely. It is specially applicable for that part; also the stokeholds and bunkers.

Mr. ROBERTSON : I should think it would be a disadvantage against the system that there is so great a volume of air to deal with. What would be the largest size of pipe used in an ordinary engine-room.

Mr. NEWALL : It would be about two feet, but of course the induced air could be regulated as required. The size of the pipe or trunk depends upon the space to be ventilated. For cabins it would be down to, say, six inches, for the coal bunkers it would perhaps be 1 foot 6 inches. The nozzles were made in all gas sizes, from $\frac{1}{2}$ inch to 2 inches.

Mr. A. ROBERTSON : For every cubic foot of air forced in with the compressor, how many cubic feet would be induced ?

Mr. NEWALL : I cannot say, but there is a great difference. possibly ten to one. The compressed air forms a perfect air piston down the trunk.

Mr. W. HOWELL (Associate) : Is there any hissing noise due to the air escaping ?

Mr. NEWALL : Practically none, the shape of the nozzle prevents hissing.

Mr. A. ROBERTSON : I think it would add to the value of the discussion if Mr. Newall could give the relative quantities of compressed and induced air, as, after all is said and done, that is the essential point in this system of ventilation. If all the ventilation is to be done by the compressed air it would be a very expensive system, but if a large proportion of air is induced by this system the value of it increases in proportion to the amount of air induced.

Mr. HOWELL : I wish Mr. Battle had brought the engine-room and stokehold more into the question, as most of us have had experience of very hot engine-rooms, with temperatures up to 110 and 120 degrees, and little or no notice seems to be taken of the engineer at all in respect to working and living in such an atmosphere. Does Mr. Battle consider that legislation could be brought to bear on the subject so that the engine-room should not be allowed to get above 100 degrees, by means of an efficient ventilating apparatus being provided under regulations, either fans or the method described by Mr. Newall. It seem to me the passengers are studied and the working staff not. I know of ships where they have the induced draught for the first-class cabins, but the men who spend two-thirds of their time in a hot engine-room have to be content with cabins insufficiently ventilated. The best is expected out of men and practically the worst conditions are given them. It is noted that firemen occasionally jump overboard, and it is put down to madness ; but it is not sufficiently considered that in the tropics these men work in an atmosphere of 130 to 140 degrees for 8 hours per day, are berthed in close, confined quarters

and probably are supplied with inferior food, especially on some tramp steamers. While going into the food question, the men's personal comfort while at work should be looked into more, and the engineers and firemen more especially considered, and legislation introduced under which men could have a safer atmosphere to work in. I do not mean with regard to the presence of carbonic acid gas or other impurities, but more with regard to temperature, the engine-room never being allowed to get above 100 degrees. One thing I hardly understood in Mr. Battle's paper is where he states, on page 27, that " a change of air three times an hour is all that can be borne under ordinary conditions." I think the average cabin can have the air changed more than three times an hour without disturbing it. The ordinary cabin with a port and doors opening into an alley way could be ventilated with safety, and more than three times an hour have the air changed.

Mr. M. Lang (Assoc. Member) : I should like to support the last speaker. There is no doubt as to the necessity for better ventilation of the engine-room, and I do not see why some representation could not be exerted to put the matter before the proper authority in order that something might be done towards securing the better comfort of the staff on board all steamers.

Mr. A. E. Battle : I must confess that this paper has brought forth more discussion than I anticipated, because I suppose if there is one subject that everybody concerned thinks very little about, it is practical sanitation. With reference to the Green system of ventilation, I have heard of it and have seen it before to-night, but I have always understood it as being one of those systems which might be described as " a very good attempt," but not quite so efficient as it was expected to prove. I have not had any experience with it, but one of the complaints I have heard in connexion with it was the objectionable hissing noise caused by the escaping air from the nozzle. Another similar system was introduced in which steam was used, and in this case there was a series of cylinders inside the pipe. First of all a flow of air was obtained and then this air, especially in the case of steam, lost its velocity, and to overcome that these cylinders being introduced caused the air to impart its velocity to another layer and so on until there was a solid

piston of air at the top. Whether or not it is a fact that the noise proved an objection I do not know. The question was raised about carbonic acid gas. It is not the carbonic acid gas which causes the trouble. Any one could go into an atmosphere which contained 25 per cent. of carbonic acid gas and it would not have any effect upon him except to cause him to expand his lungs a little more. Carbonic acid gas is non-poisonous. Those who have anything to do with refrigeration will remember the point often brought forward in examinations in connexion with the $CO_2$ system of refrigeration that the whole of the charge of carbonic acid gas could be discharged into the engine-room without hurting any one. The object of ventilation systems is not to remove that gas, but to remove the animal, vegetable and mineral impurities given off by combustion. The reason carbonic acid gas is referred to is because it indicates the presence of these other impurities, but it does not matter whether we get rid of the gas itself or not. It is true carbonic acid gas is what might be termed a heavy gas. If a vessel containing the gas were broken in a room, the gas would naturally tend to sink, but as it became diffused it would rise again and within five hours there would be as much at the top of the room as below. Therefore it is not only the moving of carbonic acid gas or the moving of the lower circles of air in stokeholds or other places that has to be considered. Any system of ventilation to be efficient must provide an exit for the impure air. That statement is not on my own authority merely; it is substantiated by Dr. Parkes, Reid and many others. In almost any case it would nearly be sufficient to leave the incoming air to look after itself, and to a great extent if free ingresses for the air were provided it would be sufficient, but I am of opinion that any system which does not provide some means of abstraction as well as propulsion is unsuitable. I would rather see a system of extraction only, as in that case one could be sure that the foul air is being got rid of and not banked up in corners. Systems of ventilation are often spoiled by bad arrangement, and often, by a little re-arrangement, they could be greatly improved. I think we are inclined too much to confine ourselves to one system and one only. It is necessary, if the ventilation is to be thorough, that different types should be fitted on the same ship, one only being preferable to another according to circumstances. The Boyle is one of the best systems that I know of, in its place, the Thermo-tank also is one

of the best in its place. Possibly the best thing to do would be to have both systems fitted and still have a few of the ordinary ventilators in addition. To ventilate a small space, however, the systems must be combined with a system of heating, because, if in an ordinary room the air is being changed four times an hour with an ordinary temperature of 40 degrees, there is an appreciable draught, and it is necessary to heat the air so that the draught may not be appreciable. Therefore any system used should be combined with some system of heating. Mr. Redman referred to the illustration of the bucket in the ventilator. I really think that it is often found there. It does not matter whether it is at the top or the bottom, the space is always blocked. Even if the bucket is removed, the fact that one quarter of the space is obstructed is sufficient to spoil the efficiency, and if proof is wanted of that it is only necessary to stand in the forward stokehold under the ventilator where this practice is adopted. With reference to the carrying of cattle and what the Board of Trade can do in these matters, I am afraid that we cannot hope for very much from them at the present time. There are regulations with respect to the ventilation of berths to provide for spaces at the top and sides, but even those regulations are interfered with when at sea. It is not much good the Board of Trade leaving a hole here and there and passing the ventilation as being in accordance with the regulations. The men who come down to investigate the matter have not given much consideration to the subject, the importance of which is quite evident when it is considered that men are specially trained ashore in matters relating to ventilation, heating and everything in connexion with sanitation of dwellings, and I do not think much can be expected until there is included in the syllabus for surveyors a little experience in or knowledge of hygiene. There is another authority existing, the Port Sanitary Authority. I am not certain, but I think there is one inspector, or there was some years ago, doing the London Docks, St. Katherine's and a little bit of the West India.

Mr. SHEPPARD : He has three or four assistants now whose duties are apparently to inspect chiefly the frozen cargoes coming into port.

Mr. BATTLE : That does not suggest sanitation. They

should not be called sanitary inspectors but inspectors of meats and food.

Mr. SHEPPARD : I know of one case where the inspector discovered that there was but a single partition between the mess-room and the W.C. This he recommended to be doubled.

Mr. BATTLE : That is often a point that requires attention. There is supposed to be a bulkhead between the W.C. and other rooms ; there should be no connexion with any part of the ship, and yet scupper holes are cut between the lavatory and the mess room, and the lavatory is not even fitted with an ordinary sanitary tank. I think if we were to aim first of all at preventing the foul air from the lavatories from entering the berths we would be doing a great deal, and this end could be achieved by judiciously arranging the sounding pipes of tanks, because in that tank various impurities are collected, carbonic acid gas is formed, and also, if salt is present, free chlorine and many other poisonous gases, which, if the tank is badly arranged, pass up the pipes and enter the room. Another point in connexion with the lavatories is the arrangement of the scupper flaps, which, upon opening, allow a current of air to pass right through, finding its way into the various rooms. Many improvements could be made if only the ship designers thought a little more on the subject or attended a few lectures on hygiene.

Mr. TIMPSON : Recently ships have been fitted with the " Hermes " system in which all lavatories run to a common tank fitted with a non-return valve, and when a certain height is reached it flushes itself automatically.

Mr. BATTLE : The trouble with systems of that kind is that very often solid matter gets on the valve and keeps it open. An ordinary leather valve would be most efficient, but the trouble lies in the engineer being so hard worked that he has not time to attend to it, and no one is specially deputed to see that the system is kept in efficient working order.

Mr. TIMPSON : This system was designed in the United States and is largely adopted there.

Mr. BATTLE : There is always trouble with the tank and it

means that after being in use for six or eight months the system requires to be completely cleaned out.

Mr. TIMPSON : I have had some experience with this system, and was surprised to find how little dirt there was after being eight months in use. It has been fitted to many ships recently built.

Mr. BATTLE : I was speaking some time ago to a representative of a well-known firm of sanitary engineers who are endeavouring to improve upon it, and I was told that the tank gets completely clogged up, until it becomes more of a nuisance than a benefit. They replace it by air. With reference to heating, I suppose we are improving in that particular direction, but as engineers it will be interesting to view this subject from an engineering standpoint. In a tramp steamer heaters are often seen discharging over the side. Now it must always be remembered that the steam passing over the side represents for every lb. of steam the loss of 966 British thermal units of heat, so that any system of that kind must cause a very great loss of heat. I am not in favour of steam heating, and I certainly advocate a hot-water system in preference. In the steam heating system water has to be turned into steam, it passes through the pipes and gives up a certain quantity of its heat, much of it is lost by condensation and in other ways, and it eventually finds its way back to the condenser. Now if a small independent boiler is used entirely for heating, all that is necessary is to raise the water a few degrees, and a very efficient system of heating is obtained at less expense. But no system of heating, either by steam or hot water, is satisfactory unless there is combined with it a system of ventilation. It should not be supposed that heating a room is all that is required.

With reference to carrying live cattle on deck I am afraid that the only hope at present is to call attention to the conditions and advocate better. When one contrasts the conditions ashore to-day with the conditions of fifty years ago, and then finds that at sea the conditions are the same to-day as they were fifty years ago ashore, one can certainly hope that in the near future the attention of sanitary authorities will be more directed to the mercantile marine. With reference to the carrying of cattle I may say that there is a regulation that steerage passengers shall be partitioned off from the cattle, but

it is not uncommon for some of those passengers to find an interesting old bullock looking over into the berth, reminding them of the country. Certainly it is very unpleasant, especially in the winter months, but one satisfaction is that smells of that kind, although objectionable, are not injurious to health, and it is a most difficult thing to get the nuisance removed because it cannot be proved injurious. I am afraid if we approached the sanitary authorities on that point they would bring that round on us as a weapon and suggest that we ought to be pleased to have such healthy quarters.

Mr. ROBERTSON asked what would be the quantity of air induced by the system of nozzles referred to by Mr. Newall. It is generally estimated that the compressed air carries with it 200 times its own volume.

The HONORARY SECRETARY : I remember a discussion on Green's system of ventilation in the first year of the Institute's history, and have been looking up the different views expressed at the time regarding it. I have here the first volume of the Institute for session 1889–90 ; on the last night of our first year we had a paper on this subject from Mr. Sommerville, who died many years ago and whose son is a member now. There is an illustration in this volume of the same nozzle which has been brought before us to-night by Mr. Newall. Mr. Buckwell, who is still a member of the Institute, referred to Green's system of ventilation, but not with the nozzle—it was by utilizing the heated air in the annular space round the funnel to induce the colder current. Pipes were led underneath the seats in the different cabins, and these were connected with a pipe which terminated in the funnel casing into which the vitiated air passed ; I saw several steamers so fitted, both for the cabins and bunkers. Mr. F. W. Shorey described the nozzle and referred to it as being fitted in the North German Lloyd steamers of that time, and spoke favourably of them. Mr. J. H. Thomson referred to an interview he had with Mr. Green a short time before his death, and in the course of his remarks he said—" I had the pleasure of meeting him on several occasions, and also of seeing his system in operation at his offices in Queen Victoria Street, and he frequently said that all the patent nozzles and fans, etc., for removing the vitiated air would be useless unless there was provision made for a fresh

supply of pure air to take its place, and he looked upon the means of collecting and distributing the fresh air as being equally as important with his patent nozzles and their application." Mr. W. McLaren, in the paper he gave last year on "Ventilation" referred to this paper of Mr. Sommerville and also to one by Mr. Hoey on the same subject. Here are one or two remarks made at the meeting in February, 1890.

"In addition to carbonic acid gas or carbon dioxide, reference may be made to the presence of bilge gas, which, unlike carbonic acid gas, has a very ungrateful odour, and while the one is frequently used to add to the pleasures of the table the other certainly interferes with both the appetite and the digestion. It is of moment to keep the bilges clean by means of disinfectants and 'elbow grease.' The accommodation provided for engineers in very many steamers is out of all keeping with the nature of the duties they are called upon to discharge—this is beyond question. The slight saving in first cost and the prospective earning power of what is thus saved is generally purchased at much above the true market value. Not only is there want of ventilation but want of light, both in respect to the accommodation itself and those who are responsible for the policy which designs it. The more important lines of steamers cannot be taxed with this short-sightedness; still it rules in lines of lesser note, leading to frequent changing of engineers and the ruin of much valuable machinery for want of that interest and pride which every true engineer takes in the work committed to his watchful care. It stands to reason that a man whose personal comfort receives some attention and thought from his employer will endeavour to show his appreciation by making every effort to crown with success the ventures of that employer. The contrary proposition does not always follow, but I may say it tends to follow in inverse ratio to the strength of moral courage added to high ideal of duty possessed by each one serving against removable burdens imposed by those in authority." Those remarks were made at a meeting held in February, 1890, and they are still applicable. I had in view the remark that Mr. Sheppard made with regard to the position of winches. I was on board a ship the other day and was astounded to hear the winch running full speed ahead immediately over the chief engineer's cabin. With reference to the punkah, the great difficulty has always been to get the slight jerking movement which gives effect to the wave of air moved.

That has been accomplished in the punkah which was shown at the recent Engineering Exhibition at Olympia, and I have since seen a representative of the company taking measurements on a steamer with a view to fitting it up. I think that was always the objection to the mechanically driven punkah; it was too mechanical, and did not give the slight jerk which the true punkah-wallah always gives. I understand this new punkah which we saw at the Exhibition has been fitted in a good many hotels in the East and has evidently met with success. I think inspectors have been more in evidence within the last few years.

Mr. BATTLE: There are not enough of them to cope with the work.

The HONORARY SECRETARY: I have seen evidence of improvement with regard to smoke, and also of cases where the berthing arrangements were altered to suit the requirements of modern ideas.

Mr. REDMAN: Are these the Local Government Board inspectors?

The HONORARY SECRETARY: The inspector for the smoke nuisance is in connexion with the Sanitary Authority of the Port of London, but it struck me as remarkable that the local council should take cognizance of the height of a hatchway coaming in place of the Board of Trade. I do not know how far the requirements are being carried out, but I have seen in some cases they were carried out literally. With regard to the smoke nuisance, I think the almost universal practice in those ships where North Country coal is used is to provide 40 or 50 tons of Welsh coal for the donkey boiler to use in port and in that way the regulations are complied with. In connection with this smoke question—and it is à propos of Mr. Battle's paper—about fifteen or sixteen years ago experiments were carried out with a view to making smoke a by-product of the engine-room or stokehold by passing the smoke through a system of water spray, collecting the carbon and selling it afterwards as a pigment for colours. I do not know whether anything came of it but I have not heard of it lately. When Mr. Hoey's paper was read, cases were cited of steamers with very narrow and

lofty engine-room skylights, and the fine ashes and débris instead of passing up the stokehold ventilators came through the engine-room, being induced up the engine-room skylight, the result became disastrous to the main bearings. The skylight evidently acted as a funnel, and the heated air drew up the particles of dust and grit from the stokehold.

I move that a hearty vote of thanks be accorded to Mr. Battle, not only for reading his paper at the Engineering Exhibition but for coming to-night to reply to the discussion. I hope that the paper and discussion will induce more consideration and study on a subject which I do not think we have touched on anything more than the fringe of.

Mr. HOWELL: I have pleasure in seconding this vote of thanks.

Mr. BATTLE: I must thank you very much for the vote of thanks you have passed so heartily. It has been a pleasure to me to give the lecture, and I feel honoured to think that it has been so much appreciated. With reference to the subject, I hope at some future time to take up another section of sanitation, namely, sanitary appliances, such as are required for the storage of water, purifying of water, and the fitting of lavatories, as they are fitted and as they ought to be fitted. Marine ventilation and sanitation are subjects which will soon force themselves upon the attention of the Port Sanitary Authority or the Board of Trade with the more general adoption of turbines for steamers. I had the pleasure of a run over to France in one of them, and the one thing that struck me was that much thought had been given to making the engine such a marvellous production, but no thought was given to ventilation, and the heat was positively intolerable. It will no doubt be very objectionable for engineers during the time things are developing, but I think that within the next few years there will be legislation, not only in sanitation, but in ventilation, heating, berthing and other requirements for the personal comfort of those who elect to go to and fro upon the surface of the waters.

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VOL. XIX.

*PAPER OF TRANSACTIONS NO. CXLIII.*

## ON THE REPAIRS TO THE HULLS OF IRON AND STEEL SHIPS.

BY

MR. ROBERT ELLIOT, B.Sc. (VICE-PRESIDENT),

*Read Monday, October 28th,* 1907.

CHAIRMAN: MR. JOHN CLARK (MEMBER OF COUNCIL).

ALSO

*PAPER OF TRANSACTIONS NO. CXLIV.*

## REPAIRS TO MACHINERY.

BY

MR. ROBERT ELLIOTT, B.Sc. (VICE-PRESIDENT),

*Read Monday, November 18th,* 1907.

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

ADJOURNED DISCUSSION

ON THE ABOVE TWO PAPERS

*Monday, December 16th,* 1907.

CHAIRMAN: MR. W. LAWRIE (CHAIRMAN OF COUNCIL).

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