INSTITUTE OF MARINE ENGINEERS.

SESSION  1893-4.

W. H. WHITE, C.B., LL.D., PRESIDENT.

FORTY-SIXTH PAPER

(OF TRANSACTIONS)

THE

Lubrication of Marine Engines;

A FEW DEFECTS AND SUGGESTED REMEDIES.

BY

Mr. W. MUNRO ROSS.

(MEMBER).

READ AT

58, ROMFORD ROAD, STRATFORD

ON

Monday, May 8th, 1893.

Discussion continued Monday, 15th May, 1893.

PREFACE.

58, Romford Road,

Stratford,

May 15th, 1893.

A meeting of the Institute of Marine Engineers was held here this evening, presided over by Mr. F. W. Shorey (Member of Council), when the discussion was resumed on a Paper by Mr. W. M. Ross (Member), on "The Lubrication of Marine Engines."

The Paper was read at the previous meeting, held on May 8th, and, in the absence of the Author, was read on behalf of Mr. Ross by Mr. J. H. Thomson (Member of Council).

JAS. ADAMSON,

Honorary Secretary.

making a few suggestions as to the more necessary remedies which may be, without any great trouble, adopted.

Defective lubrication has, probably, given a great deal of worry and anxiety to most of those who have been brought closely in contact with marine engines, and in an Institute like this there are very few, I presume, who have not had some experience of the working and troubles of marine engines. On that account I have written this paper, hoping it may induce a discussion on the methods of lubrication generally, and, perhaps, lead to much needed improvements. You may not coincide with my ideas, but I am sure a discussion on this subject will be very beneficial, and tend to useful and practical results, advantageous alike to the shipowners and the marine engineer. Great loss of power must be a necessary consequence of improper lubrication; and loss of power caused through this one defect alone, must of a certainty mean a great augmentation to the amount of coal, which, in the engineering department of steamers, is, without a doubt, the most serious point of consideration. But not only will this defect show in the coal accounts; it must appear as a serious item in the repair accounts as well, and in the end must certainly touch the pockets of shareholders and owners. It has been stated by Dr. Thurston, Professor of Cornell University—who, I think, may be quoted as one of our greatest authorities on the subject—in his work on "Friction and Lost Work," that the average loss per annum for an engine of one hundred horse-power, working a mill, is 100 dols. through friction alone; and if this is computed for a mill engine, it can be no less in a marine engine, in fact, I think the percentage would be greater. A considerable sum you will say; but I think it comes very near the mark. When we look back and consider in our own experience the number of shafts we have had to lift, the number of brasses worn through and requiring new metal, and the time and trouble expended in adjusting bearings, which, if at the first had received more attention in the arrangement of oil supply, would

have lasted a much greater length of time. The first cost of a few more feet of piping, and a few more oil boxes distributed around the engine room, would be very small, compared to the great after expense which must follow through the lack of them.

Many arguments might be brought to bear on this subject and I trust many will be—but I would here ask all to note that the references in this paper are solely to vertical marine engines. No doubt they could be applied to other machinery as well, but as this Institute is principally composed of marine engineers or those intimately connected with marine engineering, and the greatest number of Marine Engines of the present day are of the vertical type, I hope all arguments will be considered accordingly.

Lubrication may be divided into two classes—External and Internal. Let us first consider the External. One of the principal parts of a marine engine is the crank shaft and its various bearings, to which too much attention can never be given. In boring out bearings for a crank shaft, the general rule is to give a greater diameter than the shaft which has to revolve in them, a difference which may vary with the engineers, but in all cases the hardest points to come into action are the top and bottom centres and a gradual enlargement towards the sides. In the method of supplying lubrication to these bearings to which I refer, all oil holes are bored through the top centre, and, to enable the bearing to receive sufficient oil to overcome friction, the outlets have to be greatly enlarged and oil channels cut all over the bearing surface. This I consider wrong, and one of the greatest defects in antifriction that can occur in any bearing in which the shaft has a revolving motion—as the sides of the bearings (and by that I mean any part away from the top and bottom centres) must have the greatest division of the two metals—in other words less friction, therefore the outlets should be distributed into that space, so that the shaft in revolving will carry its lubrication with it, drawing its supply as from a reservoir—inducing a better flow down the oil

pipe instead of retarding it, as must take place when the pipes lead directly to the top centre of the bearings. Were it not for the enlargement of the oil tubes and the channels cut over the surface, no lubrication would take place in these bearings at all.

Nearly all main bearings are now fitted with white metal, or some other less tenacious metal than the brass itself. It is generally fitted in the outer brass or cast iron, as the case may be, in strips of about four inches in width, having one division on the top centre into which the oil holes are led. This method has its advantages, but I think if this white metal were to be divided into three surfaces, that is with two intermediate divisions only, we would give the bearing a better opportunity to distribute its work through all the component parts. We require only the bearing surface equal to the diameter of the shaft to ensure a correct bearing, and, instead of the former arrangement, we get the oil supplied into the space on either side, and the whole metal is left as bearing surface on the bottom and top centres,—the principal points of these bearings.

I do not think any great inconvenience would be caused by making this alteration. A difference would be required in the design of the cups, but if this can be proved to be the better way of lubricating, and, in consequence add to the life of both bearing and shaft, surely the designers can make the necessary alterations without any great trouble—for it is just as easy to design a thing properly as improperly ; I consider therefore, that all bearings in which the working part has a revolving motion, should be supplied with lubrication not on the top centre, but at some point away from that centre. Then each side of the bearing will always have a better supply and as a result we would have less friction and consequently greater power.

Let us now consider the lubrication of the crank-pin. The same defect is here seen as in the main bearings, and if it is wrong in one case, here it must show with greater force. The principal defect in crank-pin lubrication, I

think, lies in the method of supply from the boxes, as at present fixed in many marine engines. Many of you will still have in your recollection—because it is only of late years the system has been discarded—the long telescopic pipes which carried the supply to a centre box; a more extravagant way could, I am sure, never have been designed. It always seemed to me that half the supply was taken up in lubricating the pipes alone, and let the engineer in charge be as careful as he could, still there was always a great waste, for the pipes never seemed dry. This has happily been improved on, although it still remains in some of our older ships. The latter method, although without a doubt a great improvement upon the old style, I think, falls far short of perfection. Let us trace the connections. Generally we have a box fixed high up on the cylinder lagging, with pipes leading to another cup fixed on each side of the connecting rod jaw; from these cups lead other pipes (usually one from each) to another cup, fastened to the centre of the connecting rod, or at such a distance as to give clearance from the bottom corner of the guide, and to be handy for any oil to be given as the rod is working. From this cup run three pipes, one to each side and one to the centre. Now, from this last cup run three outlet pipes, but it has only two supplies, and these two, in five sets of engines out of six, lead directly over the side outlets; the centre pipe gets its supply only by chance. I do not say it never gets any, but I consider that every outlet should have its own special supply. From the first box there should be sufficient oil supplied to guarantee each of the pipes leading into the brass getting its own proper amount regularly, and on no account should this most important bearing be left to chance lubrication, as in some cases at present. We know it is necessary for oil to reach this bearing; it must surely, therefore, give greater satisfaction if the engineer can be certain that every drop reaches its intended part. With engines running at the high speed of to-day, and with the long connecting rods now in use, it is impossible for this pin to be oiled except automatically; let the greaser be ever so good, still there must be a great percentage lost

when oil has to be supplied in this off-hand manner. How many crank-pin bearings to-day can be run without using the water service, which, although at times a blessing, when considered relatively to the life of the shaft and bearings, is far otherwise. Many an anxious watch is passed, and many a gallon of oil is wasted through the defective supply to a bearing. Yet it can be easily remedied. Of course the old saying may be brought in—"it has gone for so many years, it can surely do now." But I hope I have sufficiently shewn the defect to justify a remedy, as follows:—Place the outlet holes not on the top centre, but somewhere on the sides; give each hole an independent supply pipe, and, if the engine is properly balanced, there will be a much better working pin, and with better working we have less friction, and, consequently, longer life to both pin and bearings.

Other bearings in which the gudgeons or pins have not a revolving motion cannot be treated in the same manner. As their frictional motion is equally distant from the vertical points, their supply may be considered as correct, but in a great many cases a more automatic system might be adopted; for instance, in beam links and pump levers, in most cases these bearings are not fitted with boxes or cups, but simply have a hole through the top brass, and although we know they require lubrication as much as any other bearings, still the supply is invariably left to the few drops given from the oil can, these sometimes reach their destination but oftener do not.

Let us for a little while leave the engine room and take a look at the tunnel shaft bearings, the principal of which is the thrust block. This is a bearing which stands, I may say, by itself, as the friction is on the fore and aft parts instead of top and bottom. Here some interest seems to have been taken in the lubrication supply, as every ring is fitted with its own pipe and syphon, but still I think there is room for greater improvements. Many of you will have seen, and perhaps assisted in the making of, extra receiving cups for the

fore and aft ends of the block, connected by an inclining pipe running towards the after cup, so that the oil which is continually working forward fills the cup to the height of the pipe and returns again to the after end, thus keeping the thrust, as it were, running in a bath of oil. This arrangement, all who have had anything to do with, must acknowledge successful, for after two or three hours running, the syphons can be entirely dispensed with and the bearing requires no further supply (if all the connections are tight) for many days. Now although this is a very old arrangement and its success cannot be disputed, I have never seen nor have I ever heard of it being fitted in the first place to a new engine, it being always left to the engineer of the ship to make and attach it himself, although he cannot always have either the time or material to do the necessary work in a proper manner. If it is of so much benefit, why cannot the designers see that it is done? They will go to a greater expense in fitting an elaborate water service, but the oil supply must remain in the old way. The other tunnel bearings do not require so much care and attention as the thrust, but even here I think better results would be obtained if they were all fitted with these fore and aft cups and automatically served.

A great many ideas have been recently brought before our notice for lubricating the propeller shaft with oil instead of allowing it to run in water, but I am afraid all are of too complicated a nature to be brought into general practice. If carried out in an easy and satisfactory manner, no one will deny I am sure, that it would be the saving of many a shaft now being ruined through running in salt water.

In bringing this part of my paper to a close, I trust I have clearly expressed myself, perhaps not so plainly as you might wish, but you may agree with me that the defects I have pointed out are not uncommon; and in the marine engine, brought up as it now is to great perfection in design, lubrication should not be looked over or slighted. Regularity is one of its chief features; and let the "greaser" be ever so careful and

competent, there must at times be periods in his watch, either through rough weather or extra attention required at some particular part, when this regularity cannot be carried out, consequently bad lubrication takes place. Every bearing throughout the engine should be supplied automatically and regularly, and if it can be carried out in small engines (as is now being greatly done), how much easier can it be arranged with the large machines.

Perhaps at this point a few words may not be out of place in regard to the rule in a good many steamers (not liners, but in what are called outsiders or tramps), of the engineers having to oil the machinery *unaided*. When we are trying to encourage better men and bring a more scientific training into every day use, it seems very wrong that trained engineers should be turned into oil feeders. No engineer in charge of a watch can properly devote his attention to all in his charge, be it ever so small, if his time has to be given up to oiling; something must be neglected to the owners' ultimate loss. Greasers should be taken from the firemen, good experienced men. This, I think, is one point which requires attention. The engineer on watch should devote his time to supervising and preventing waste or loss of coal and other stores.

Having so far remarked on the various methods of external lubrication, and pointed out what I consider a few of the many defects in its supply, let us look now at internal lubrication, and see if any alteration for good can be made in that direction. Without doubt, in recent years, a great improvement has been brought about here. The old pot impermeator has been entirely superseded by the automatic sight-feed—an arrangement in all its workings simple and effective. With the old style, oil was generally put in twice a day; if it worked, well and good; but generally it did not; now every drop tells a tale, and gives the satisfaction, with the knowledge, that all is going well. In the present day, with steam of very high temperatures, little, or perhaps, no internal lubrication is necessary.

Many engineers have entirely discarded the supply through the impermeator. But with this I do not agree. Granted that the high pressure steam requires no oil, when this steam reaches the low pressure engine the temperature has decreased greatly, and here it is where I always find that most mischief takes place. With the large working area of the low pressure piston, some lubrication, I consider, is necessary; very little suffices, but still some is required. If the impermeator, instead of supplying the oil to the steam at its first initial pressure, were so placed that the supply could be given at the time the steam entered the low pressure valve chest, I really think more good would be done, as the lubricating properties of the oil would not be destroyed through coming in contact with steam of high temperature, but would pass at once into the parts requiring it most.

With internal lubrication, we must not overlook that taken in with the piston rods—an amount, I am afraid, greatly overlooked by most engineers in their calculations. Although all given to these rods cannot be absorbed by the steam, still, I consider, at least twenty per cent. is used for that purpose; and on no consideration should any but mineral oils be used. With engines having top end rods, automatic supply is very easy, and I find that the bottom rods can be as easily supplied as the top, and, from my own personal experience, good results have been obtained, not only in the life of the packing, but in the wear of the rods themselves. With a pair of engines of 2,500 horse-power, I find that the piston rods (with top ends oiled automatically), and three valve spindles, require one pint per watch of four hours' duration, *i.e.*, six pints in twenty-four hours. Now, if, as I maintain, a fair percentage is absorbed by the steam while the rods are internally working, we have one to two pints used from this source alone for internal lubrication, and the impermeator being fixed to the low pressure valve chest would use ·8 pint. We have, therefore, used two pints in the twenty-four hours. Not a very large amount, and I do not think it can be very much reduced. The

supply required for the high pressure cylinder being taken in by the piston and valve rods, and for the low pressure by the impermeator.

In closing, I hope that however common the ideas thus brought to your notice and however simple the remedies proposed may appear, some good may result from this paper, in such an alteration as is required where a proper system of lubrication has been neglected and where no thought seems to have been given to any improvement, except as to sight-feed impermeators; and since their introduction how many different methods have been brought to our notice, each one of course better than its neighbour--but none I think has reached the root of the evil. Friction I would call the strongest enemy in a marine engine, and if lubrication is the best way to overcome it, the most perfect method should be adopted, let us all try to find it.

The following points have been present to my mind while writing, and it may be well to mention them here.

1. All revolving shafts should be supplied with lubrication, not through the vertical centre, but somewhere at the sides.

2. Every supply outlet to the crank pin should have its own separate supply inlet from the commencement to the finish.

3. Each and every bearing, whether small or great, should be supplied automatically, there should be no chance lubrication in connection with a marine engine.

4. No internal lubrication should be used, excepting through the impermeator affixed to the low pressure engine, and also by swabbing piston rods and valve rods with mineral oils alone.

5. Greater thought and more care should be given by designers and builders to the lubricating arrangements, and less to the superfluous water service.

DISCUSSION.

Held at the Premises of the Institute, May 8th, 1893.

THE CHAIRMAN

(MR. F. W. SHOREY).

Now that we have heard the paper read, I think it is one that is well worthy of a good discussion. It is on a subject that we certainly can discuss. It is not complicated, like some papers, with a lot of formulæ and figures that we cannot grasp at once, and I think there are many points in it that we can take up and thrash out. The author would infer that friction is due to the want of lubrication, but of course we know there are many things that cause friction besides the absence of proper lubrication. Want of proper design, an improper distribution of weights, a bad arrangement of bearings, and many other things, bring about a deal of friction which might be avoided. I know a steamer the engines of which are running with less than half the quantity of oil that is required by the engines of a sister ship. Doubtless that is due to the fact that the engines in the case of the first vessel are kept up and worked so as to involve the least possible friction. However, I will not take up your time further but invite you to open the discussion.

MR. McFARLANE GRAY

(MEMBER)

I have read the paper but I do not understand it. It is not by any means clear to me what the author is aiming at. I do not understand his descriptions of proposed improvements from the Paper itself, a sketch or drawing should have been forwarded to make the description plain.

MR. J. H. THOMSON

(MEMBER OF COUNCIL).

Mr. Ross sent the paper to my care and having read it over in the manuscript, I wrote and told him that if

he had made out two or three sketches we could have followed him better, but unfortunately there has been no time for a reply. In the absence of any sketch or diagram it is a little difficult to follow him. I should have liked a sketch of his method of putting in the oil at the sides of the bearings. It would certainly have assisted us a great deal if there had been some diagrams. I may say that Mr. Ross has been stationed out in Indian seas for some time. The paper was read in Bombay to our members there before it was sent home.

MR. GRAY: The author says, "Place the outlet holes not on the top centre, but somewhere on the sides." The outlet from what?

Mr. A. W. ROBERTSON: Of course the outlet from the pipe is the inlet to the bearing, and it seems that the author of the Paper means the outlet from the oil pipe to the bearing.

Mr. GRAY: You can make two or three meanings out of it, and it is really difficult to know exactly what the author means.

The CHAIRMAN: There is one point as to which I think we shall agree with the author, and that is that an engineer who has been properly trained for the position should not be altogether a walking oil can. A greaser should be appointed to look after that part of the business and assist the engineer on watch. I have often thought it a great waste for an engineer to be oiling the engines without an assistant or greaser.

Mr. GRAY: Why should not the engineer go about with the oil can? I fail to see the reason for the strong objection expressed by the author on this point. The author is trying to bring about a condition of affairs when the lubrication will be perfect, and it seems to me that the best way for an engineer to obtain perfection

is for him to go about the engine room with the oil can and see for himself where oil is needed. Let the man who is responsible for the good working of the engines supply the oil when and where it is required and not depend entirely upon a greaser. Where is the harm in an engineer using an oil can?

The CHAIRMAN: If an engineer is relieved from oiling he can attend to more important matters. Sometimes for instance he may have a furnace of fire bars come down, or he may hear a grunting or squeaking somewhere in the machinery and he has to attend to that, there are many other duties which demand the attention of an engineer on watch, apart from the ordinary routine of feeling the bearings and serving them with oil.

MR. A. W. ROBERTSON
(MEMBER OF COUNCIL).

I think I am right in saying that the subject matter of this paper is of very great importance. The author deals with the past and also with the present. He speaks of the lubrication of bearings when there were no oil channels such as are now introduced in connection with the white metal strips, he also refers to the oil pipe leading down to the top centre, and in the case of a close fitting bearing, of course, we have all seen evils resulting, as it was not possible in the rotation of the shaft for the oil to be carried down to the bottom, and hence the evils spoken of in the paper. With regard to these white metal strips, now fitted in most main bearings, everyone present knows that they were a very grand introduction, but I have never gone so far as a great many people in the matter of considering the change of metal to be alone the cause of the improvement. White metal in itself certainly makes a very fine bearing, but one great secret of the success of white metal for this purpose is to be found, in my opinion, in the recesses constructed in the bearings which serve as oil channels or reservoirs, and by means of which the oil is carried right round the bearing. These recesses also

pick up any dirt that gets into the bearing. I have had this principle demonstrated to my entire satisfaction by the introduction of recesses in brasses. I have pleaded sometimes with engineers to allow me to introduce these recesses, and invariably when they have been introduced an improvement has been effected. I contend that it is not the white metal so much as the recesses, which is the cause of the great improvement in the working of journals. The writer of the paper goes on to advocate the lubricating of bearings at the side, and I certainly agree with him with regard to bearings where the relief is not sufficient at the sides to allow of the free flow of oil to the bottom, but with white metal strips it is not necessary. The only objection to this plan with such bearings is, that if oil is supplied at one side of a bearing it is necessary that there should be another supply of oil on the opposite side, because the shaft does not always rotate in the same direction. If the rotation were always in the same direction the introduction of an oil pipe on both sides would not be necessary, but engines go astern as well as ahead, and it is therefore necessary to have the oil fed on both sides. Anything in the nature of automatic lubrication is of very great value, and in this connection I had very great pleasure in hearing from Mr. Thompson, the patentee, particulars of the Axiom Lubricator. It is a very fine style, in my opinion, of lubricating a journal. The apparatus consists of a cylinder which contains the lubricant and small delivery pipes convey the lubricant to the bearings. The mechanical parts regulating the passage of the lubricant and ensuring the required pressure, are also contained in the cylinder, and by a combination of wheels the speed or pressure of the piston which governs the supply can be so regulated that the cylinder can be emptied in four or a hundred and twenty hours. I have heard very good accounts of the steady flow of oil to the various bearings to which the Axiom system has been applied; but, of course, a special apparatus is necessary for the purpose of forming the connection with the top end of the connecting rod and also with the bottom end. With regard to the internal lubrication of the engines, a

great many of us will differ from what the author says on this subject, but the portion of the paper which will lead to the greatest difference of opinion is that part where the author objects to engineers using the oil can. Of course, in a large ship with engines developing 2,500 horse power, and where there are three or four boilers and two or three stoke-holds, the whole of the time of the engineers is occupied in looking after that which is of vital importance to the progress of the ship, and I certainly agree that they should be relieved of the duty of oiling. But has any gentleman present ever seen a ship of that magnitude where the engineers were called upon to use the oil feeders? During seven years that I was chief engineer in large vessels I was never called upon to do the oiling. I had a greaser for each watch, and as chief engineer I was not even called upon to keep a watch, but I think that, even in a large steamer, a junior engineer who is called upon to use an oil feeder obtains very valuable experience. In the interests of the Institute I would like to see this part of the paper deleted altogether, because I think it would be putting a very false view before the public. To carry out with regard to all small vessels what Mr. Ross recommends would be putting a burden on shipowners altogether too heavy for them in the present state of the shipping trade. I should be very much averse to it being laid down that engineers should not use the oil feeder in vessels up to a certain size. No doubt the line must be drawn somewhere, but I do not think it is for us, as an Institute, to attempt to draw it.

Mr. McFARLANE GRAY: I have seen the Axiom Lubricator at work, and, as stated by Mr. Robertson, you can set it to run out in four or a hundred and twenty hours, but you can also run it out as fast as you like. It is used with plastic grease, not oil. Another point about it is, that if you have an Axiom Lubricator applied to several bearings, one of which gets hot, then the hot bearing takes most of the grease. The heat melts the grease much quicker, and thus the hot bearing gets a larger supply. This is the report I received.

Mr. McEachran: Then the Axiom cannot be used for oil--only for solid grease?

Mr. Gray: It is used with solid grease, but the same principle of construction might be adapted for oil if there were any object for doing so.

Mr. A. W. ANDERSON
(Member).

I have read a part of this paper, and I have heard part read to-night, and I must say that from what I have read and heard I entirely disagree with the writer. For lubricating purposes the oil should be put in at the top of the bearing and it will then find its way all round I want the oil to be at the crown of the bearing I know a case where the engineers of a certain steamer could not get the cross-head to work without over heating, and it was found that there were gutters which took away all the oil from the crown of the bearing. I do not believe in taking in oil at the sides of a bearing. With regard to what has been said about an engineer going round with the oil can, I went about with the oil can many a time When I was at sea I never failed in going round the engines every half-hour to see that everything was right—up the tunnel and back again. I entirely disagree with the whole paper, and I think the author must have been thinking of a long time ago. I used a system of oiling automatically 18 years ago. I had it for several voyages, and I would have kept it to this day but I was ordered to take it out. Take the oil in at the top centre of a bearing and it will go to the bottom and all round if properly adjusted.

Mr. ANGUS MORISON
(Member).

I listened with much interest to the reading of this paper, and also to the remarks of the gentlemen who have already spoken, especially the remarks of Mr. Robertson, whose explanatory sketch was to me very instructive. Although I cannot agree with everything that is stated in the paper, I certainly do agree with the

author on some points. I think the arrangement advocated by Mr. Ross for putting the oil holes at the sides of a bearing a very good one, at least in main bearings. Reference has also been made to the advantages of white metal for bushes, but why is it that with white metal the journals wear down so much more quickly than with brass? I should very much like to be informed on that point. I should also like to know the melting point of good white metal. For several years I have been trying to find that out for the best and most suitable kinds of metal, but have not yet succeeded. With reference to crank pins, a better method of supplying the oil might perhaps be devised. Mr. Ross asks "How many crank pins can be run without water?" If from that we are to infer "not many" I must differ from him, as my experience in 18 or 19 ships has proved to me that a great many crank pins can be run without water. He also speaks of water as "a blessing." My humble opinion is that in its application to hot bearings it is more of a curse, unless in cases of extreme emergency, for it stands to reason that cold water poured on to a hot journal tends to alter the nature of the material in the matter of toughness, to develop fractures, and, in the case of a built crank, to shrink, and so loosen the crank pin. To stop and slacken back, provided of course that there is no chance of accident to the ship, is by far the best plan when a crank pin heats to excess. With regard to automatic greasing, my opinion quite coincides with that of Mr. Ross. In bad weather some bearings have, as often as not, to run a slender chance of getting the necessary supply of oil when hand-fed, and the result is badly scored pins and brasses. Mr. Ross believes in systematic internal lubrication evidently, and in this particular, until I am better informed perhaps, I am not at one with him. Personal experience again has taught me that a sufficient quantity of oil finds its way into the cylinders on the piston rods. This oil evaporates and impermeates the steam, thereby affording all the lubrication in the way of oil required internally, unless, perhaps, when going dead slow for any length of time, say in the Suez Canal, when the pistons will possibly

grunt occasionally, but a very small quantity of oil stops this unpleasant noise, and, as often as not, a puff of steam through the auxiliary starting valve will answer the purpose quite as well. Mr. Ross speaks of lubrication with an experience of only hot bearings, at any rate so far as we can judge from his paper, to emphasize his opinion, as it were. I can speak on the subject with an experience of both hot bearings and damaged boilers, and am not sure that I can be convinced to the contrary with regard to my opinion, as to which of these two evils is the least. Oil will find its way into the boilers where no systematic internal lubrication is the rule, and, in the boiler, all will agree, it is a source of danger, not only when it takes a thick gluey form, but also when it is deposited, as I have seen it in a damaged water tube boiler, in the form of sediment, in appearance more like coarse brown snuff than anything else, until rubbed between the thumb and fingers, when its greasy nature is disclosed. As the oil, then, will inevitably find its way into the boilers, a plan which I have seen work well is to let the density of the water rise to four or five ounces. Of course, I am now referring to boilers carrying from 150 to 180 lbs. pressure, when the feed water is invariably supplemented by means of an evaporator or from ballast tanks. The water then being kept about the density I have mentioned, keeps the oil afloat, so preventing it from depositing on the heating surfaces, and, as I have heard Mr. Anderson remark, giving it a chance to re-evaporate, and find its way back into the engines for further service in the way of lubrication. As to the advisability of a young engineer learning the use of the oil can, I can only say that, though he cannot be expected to do his own greasing in ships having engines of any great size, still it is very necessary, I think, that he should learn, as soon as possible, how to use it on occasion, and for many reasons. Where the use of the oil can always, when in a small ship, or the non-use of it by the engineer when his other duties and the size of the job necessitate the employment of the regular greaser, affects the position of the engineer, I fail to see. A certain amount of

self-respect—not self-conceit—is said, and very truly, to be necessary to make life tolerable; but let us take care that in seeking good ground on which to establish our self-respect and position, we do it in matters of greater importance than are involved in the question whether an engineer, however modern his training, should object to using an oil can if necessary. I beg to thank Mr. Ross for his very interesting paper, and I trust I have done my little in the discussion which he hoped his paper would evoke.

Mr. MELSOM: I do not believe that, with the oil-feeders at the sides, a bearing would be properly oiled when the engines were going astern.

The CHAIRMAN: With regard to a question asked by Mr. Morison, my experience is that bearings do not wear down more quickly with white metal than with brass. It all depends on the kind of white metal you introduce. There are a number of white metals in the market, but the best, in my opinion, is what is called the Thistle brand, and it is better than the more expensive kinds. The Thistle brand is a metal which does not cause the bearing to wear more quickly than if fitted with brass. At any rate, that is my experience.

A MEMBER: Mr. Morison means that the shaft itself wears more quickly with a white metal bearing than with brass.

Mr. A. W. ROBERTSON: The white metal presents a smoother surface to the shaft, and, in my experience, a shaft does not wear away so quickly with white metal as with brass. That is the result of what has come under my own notice. I cannot give you the melting point of white metal.

The CHAIRMAN: It depends entirely on the amount of antimony in the metal.

Mr. MORISON: Seaton says that white metal wears the shaft down quicker than brass.

Mr. W. J. N. BRETT
(ASSOCIATE MEMBER).

Mr. Ross has introduced us to a very pretty subject —lubrication and friction—and it is one that opens up a lot of ground for study. With oil channels in the centre of the top brasses of crank shaft bearings we get medium results, because the slight intermittent motion of the shaft assists lubrication, but, on the whole, the oil imperfectly covers the surfaces. If an oily pad, properly supplied with oil, be kept pressed against the side of the journal, the lubrication would be almost as good as if the journal were run in a bath of oil. The temperature of the oil has a great deal to do with friction. If the temperature be increased from 60° to 120° the co-efficient of friction will probably be about one-third, so, within certain limits, a rise in temperature decreases the co-efficient. The co-efficient varies considerably with speed. Sir Douglas Galton and Mr. Westinghouse have shown by experiments that in the range of speed between 4,000 and 5,300 feet per minute the co-efficient decreases. There is some point at high velocities at which it again rises, and with additional loads at high velocities, friction increases. When running heavy engines slowly the friction is very much greater than when running them at full speed, and it may be worth while discussing whether there is not a substantial gain in running marine engines at a much greater number of revolutions than is usual in the present practice. All surfaces should be as true as possible, and the lubricant should enter at the side of the bearing and act as a liquid wedge. Rough and badly machined surfaces are generators of heat and consequently losers of power, and I think great attention should be paid to machining new parts.

MR. C. McEACHRAN
(MEMBER).

In the early part of his paper Mr. Ross says: "When we look back and consider in our own experience the number of shafts we have had to lift, the number of brasses worn through and requiring new

metal, and the time and trouble expended in adjusting bearings. which, if at the first had received more attention in the arrangement of oil supply, would have lasted a much greater length of time." Is that the fault of the lubrication in connection with the brasses, is it the fault of the material in the bearings, or is it due to the slide valves not being properly adjusted? There is very often a good deal arising from other causes which is put down to the want of proper lubrication. The valves are sometimes so adjusted that the engines begin to thrash themselves in turning to go over the centre, which causes undue strain and takes more lubrication. With regard to the position of the oil holes in bearings, I differ very much from some of the gentlemen who have spoken to-night. I entirely agree with Mr. Anderson, whose remarks exactly coincide with my own opinions and experiences. You can put as much oil as you like into the bottom side of the bearing of an ordinary engine, but if you do not put oil into the top side that bearing will not run cool. However much you may oil a bearing at the bottom, my experience is that the shaft will not carry enough oil over the top to lubricate the top of the bearings There is no brass so tight but what there is space for the oil to pass down between the brass in the bearing and the shaft, and according to the diameter of the shaft, so you cut the oil groove along the crown of the brass. You carry this groove to within half or three-quarters of an inch of the end of the bearing, and it acts as an oil reservoir. As the shaft revolves in its bearing, so it gets lubricated by the oil in this reservoir. Some engineers simply make a channel which runs the oil out of the brass altogether, but put a plug in it, and you will find the bearing work all right. We all know the amount of waste that takes place in lubricating crank bearings, and there are very few marine engineers who have not brought this matter to the notice of superintending engineers, who in turn have brought it to the attention of the owners; but still the old plan goes on, with the result that at least a third of the oil intended for these bearings is wasted. I think it a mistake at the present time to use an oil can for lubricating any bearings; it

should only be used for filling the oil cups. A very great deal of oil might be saved by an automatic means of lubricating the bearings. I quite agree that a small amount of internal lubrication is necessary, but I cannot understand why it should be recommended that the oil should be put into the low pressure valve casing. I do not think that the high pressure piston rod takes as much oil into the cylinder as the author of the paper imagines, but with the low pressure rod it is different.

Mr. J. H. THOMSON: When one of the speakers was referring to the high pressure on the bearing, a way of getting over that difficulty suggested itself to my mind. Instead of having the oil ways in the brass of the bearing, why not put them on the shaft?

Mr. ANDERSON: I am afraid that Mr. Gray would be condemning the shaft if we did that.

THE CHAIRMAN: The hour has now arrived for adjournment, and, if you are agreed, the discussion on the Paper will stand adjourned, and be resumed on Monday, May 15th.

ADJOURNED DISCUSSION

ON

"LUBRICATION"

AT

58, *Romford Road,*

ON

MONDAY, MAY 15TH, 1893.

THE CHAIRMAN

(Mr. F. W. SHOREY).

We are met to continue the discussion commenced last week on Mr. Ross's paper, "The Lubrication of Marine Engines." In the discussion last week we

wandered from the point somewhat, and I think it would be as well if we endeavoured to keep to the subject matter of the paper. There are two points dealt with by the author—external and internal lubrication, and I think we should confine our remarks to those points as much as possible. I see one or two gentlemen present who asked some questions last week, and if it will be of any assistance I will just give some information that I have obtained on the subject of some of those questions. I will also make a few remarks on one or two other points. Mr. Ross says he purposely refrains from dealing with the different qualities and kinds of oil used for lubricating, but there is a great deal in the character of the oil used. You may have everything connected with the machinery in the most perfect order, but if you have to use oil as harsh as water the working will be very different from what would be the case if a good full bodied oil were used as a lubricant. Mineral oils are now taking the place of vegetable oils, and I think it will not be out of place to give the distinctive characteristics of a good mineral lubricating oil. They are : 1st, purity and transparency ; 2nd, good body, also termed viscosity, and 3rd, high flashing point. In many oils, owing to neglect and carelessness in refining, small quantities of soda and even some traces of paraffin are sometimes left. A simple method of checking the character of a mineral oil, which can be carried out by any of the members when at sea, is as follows : Pour into a test tube equal quantities of oil and boiling distilled water ; shake the contents well until the mixture has a milk-like appearance and then stand it in cold water for two or three hours. After this, if the upper portion consists of a transparent oil and the lower of clear water, with a thin stratum of a whitish milk-like appearance between the two, you can depend that the oil has been well refined and is free from soda. If you wish to test the oil to find out if it contains acid, alkali or vegetable oil, a good and simple plan is to wash the oil with a weak solution of litmus instead of water, and heat it in a water bath. If the litmus does not change colour this is a proof that the oil is free from vegetable oil,

acid or alkali. A mineral oil, equal in quality to a good olive oil, should come up to the following :

Specific gravity	..	·911 to ·914
Burning point	..	477° Fahrenheit.
Flashing point (closed test)		379° „
„ „ (open test)		414° „
Viscosity at 60° F. about 500.		
This oil at 20° F. is still fluid.		

Mr. Morison at the last meeting asked at what temperature does white metal melt. This depends very much upon the mixtures of the metal, for some anti-friction metals contain more antimony than others

Antimony melts at about		..	810° F.
Tin	„ „	..	442° F.
Lead	„ „	..	612° F.

As most white and anti-friction metals are composed of these three minerals, it will be seen that the melting point would range somewhere between these.

THE HONORARY SECRETARY.

There was, I think, some misunderstanding last week as to the meaning of the author in regard to several points set forth in the paper. Mr. Ross's contention in regard to the non-supply of greasers in the engine room is—I apprehend at least—not that engineers object to carrying the oil can, but that an engineer who has entire charge of engines and boilers, and other machinery, has other and more important duties to perform than oiling the machinery *unaided*. In the criticisms to which expression was given at the last meeting, it seems to have been entirely overlooked that the reasons given in the paper for the views held by the author were not based upon considerations of the kid glove element. We know there are many steamers sent to sea with only three engineers all told, in steamers with engines of over the indicated power referred to last week, and it was to cases of that kind that Mr. Ross was probably alluding in his paper. I

do not consider that the remarks as to engineers being above their business is at all pertinent to the question involved in the paper. I do not suppose that any of us think ourselves above carrying an oil can, or anything else that is required in our business; and what Mr. Ross points out is that engineers have much more important duties than that of greasing to attend to, and that if they have no assistance in the engine room something must be neglected—be it refrigerators, electric light machinery, or pumps. I have been furnished by a member, who is unable to be present, with some figures with regard to a vessel fitted with engines indicating over 1,000 horse-power, in which no greasers were employed for some time. The engineers had to do all the greasing, and on that voyage they used 4·6 gallons of oil per day, including the main engines and the deck machinery. These figures are based upon the actual results obtained on the voyage. On the following voyage a cheaper oil was supplied, and the consumption went up to 5·27 gallons per day. On that voyage they had greasers. On the next voyage when greasers were also employed, and when a superior kind of oil was used—the same as on the first-mentioned voyage—the consumption was brought down to 3·29 gallons per day. The member in question attributed this decrease in the oil consumption to the fact that greasers were employed, so that the engineers were able to attend to other work in the engine room, in addition to supervising the oiling of machinery. With regard to the lining up of main bearings, I am afraid that Mr. Ross must have been a little unhappy in his experience. He asks how many shaft bearings have we had occasion to line up—how frequently? May I say once in about nine or ten years? I should say that is about the average life of the main bearing of a crank shaft before it is necessary to line up with new white metal. I agree with what was said last week about the cutting of oil gutters at the top of the bearings, and I cannot say that I follow the remark made with regard to the oil not running down the sides, because, as has been said, the bearings are generally made wider at the sides to allow the oil to go down, and it is at the

top and the bottom of the bearing where the oil is most wanted. As to the white metal, a good deal of the success is, doubtless, due to the fact that there are gutter-ways cut in between the strips, and the oil gets into them; but when these gutter-ways fill up, owing to the oil and grit in them becoming solid, they give trouble, and the shaft has to be lifted before they can be cleared, or, if the brasses admit, they can be taken out and cleaned. It is very difficult to gauge how much oil is used per 100 indicated horse-power. It depends a good deal on the speed of the engines, and whether they are developing full power. I have never seen any statistics given to show what the average consumption of oil is. It is often very difficult to obtain an accurate account of what coal is used, and to ascertain the consumption of different steamers between one voyage and another, with the different circumstances in each case. We have, however, something to enable us to gauge the coal results approximately; but it appears there is not much information to guide us as to the consumption of oil per indicated horse-power. I believe that in the Royal Navy olive oil is used almost entirely, which seems rather a peculiar circumstance, as it does not appear to be used to any extent in the merchant navy. It would be interesting to have some data on this subject

A MEMBER: Olive oil will work better with water than any other oil.

Mr. ANDERSON: You get a good lather with mineral oil. I know that from experience.

MR. MELSOM

(MEMBER).

I have also had experience of the effect of water and oil in connection with Mitchell's economizer, which I found saved 50 per cent. of oil on the first voyage, but as all the shafting journals were discoloured I knocked it off. Mr. Adamson has referred to the paragraph as to the engineer using the oil can. I

think we should take exception to these words "No marine engineer of modern training should be asked unaided to act as the oil feeder," and substitute words to the effect that no engineer of a ship with engines above a certain horse-power should be called upon to do the greasing, as the meaning seems capable of misconstruction.

Mr. BERRIL
(Member).

I think the author means that when an engineer has to look entirely after and attend to the greasing himself he must neglect something that might cause serious loss to his owners. The question resolves itself into a consideration of wherein lies the economy of expecting more from a man than he can possibly do with justice to everything.

Mr. Anderson: I would not allow any engineer to have charge of a watch until he can use an oil feeder properly. I have had to teach a good many young engineers how to oil, and I have found that, as a rule, they start by pouring more oil into the crank pit than on to the bearings. With regard to the recommendation of the author of the paper that the oil should be supplied at the sides of the bearing, I certainly prefer that it should be supplied at the top centre. There is one party who will benefit by putting in the oil at the sides where there is no friction, and that I should say is the owner of the repairing shop.

Mr. W. WHITE
(Member of Council).

I am very sorry that I was not able to be here last week when this paper was read, but I must say I am decidedly opposed to that portion which recommends that engineers should not be called upon to do the oiling. What will be the result if this view is to be enforced with regard to small steamers carrying two engineers and three firemen? These vessels can scarcely pay their way now, and in my opinion it would be decidedly wrong for it to go forth from this Institute

that the owners of such steamers should be called upon to engage two extra men to act as greasers. It should not go out from this Institute that greasers are wanted in ships of this class. The author proposes to make all lubrication automatic, and yet he wants two greasers to attend to this automatic machinery and do nothing else.

THE CHAIRMAN : Mr. White has been speaking of small steamers carrying two engineers and three firemen, but that is not the class of boats Mr. Adamson and others referred to.

Mr. WHITE : What does the author say. He does not say anything about boats with engines of over a particular power. He says that the modern engineer should not use the oil can. Why should he not use the oil can ? Who is to teach the firemen to be greasers and to point out the parts that want lubrication ? Why, the engineer of course. The engineer might just as well do it himself as teach the fireman.

THE CHAIRMAN : I do not think you catch the meaning as the author intended it, in respect to the greasers.

Mr. J. H. THOMSON : I am very sorry that the author is not here to explain his ideas, but I think he has been rather unfortunate in the way he has expressed himself. My idea of what he means is, that in no modern engine room should the engineer of the watch be expected to be the oil feeder. Mr. Ross has been in ships with engines of, say, 2,000 indicated horse-power. His training has been in vessels of that class and he has obtained his ideas from his experience in those vessels. From the conversations I have had with him I think he quite recognises the necessity of a young engineer learning to use the oil can. I know that in his younger days he had to do it, and I think it would meet the objection if he would alter this particular paragraph in the paper and say that in no modern engine room should the engineer of the watch be expected to

use the oil feeder. I think we are straining a point in this matter. If we had the author here we should have got over the difficulty at once.

Mr. MELSOM: With reference to what was said last week about the axiom system of lubrication, I should like to ask Mr. Robertson if the solid grease used in that system will stand the different temperatures of the engine room? Will it melt and run?

Mr. A. W. ROBERTSON: In replying to this question, I may say that in referring to the Axiom system last Monday night, I think I made it perfectly clear that I was not speaking from personal knowledge. The system was submitted for my consideration by Mr. Thompson, the patentee, and he informed me that they introduced the Axiom with a view to it being used with a special grease of their own manufacture. Judging from Mr. Thompson's remarks, I should say that it serves all the requirements which Mr. Melsom has just referred to. More than that I cannot say. I am extremely sorry that I had not the pleasure of hearing the whole of Mr. Adamson's remarks with regard to what was said last week as likely to prove the knotty point in the paper, namely, the question of engineers using the oil can. Mr. Ross alluded at the very outset to what he called outsiders, or tramp steamers, and he said that, in his opinion, no such vessel should be allowed to run with an engineer as oil feeder or greaser. If the author had not used the word "elevate" in relation to engineers in this connection, I might have accepted the construction suggested by Mr. Adamson and Mr. Thomson, but, with the word "elevate" introduced, I fail to see how we can deduce any other meaning from the words of the author than that adopted last week. The word "elevate," as used in the paper, is misconstrued, or rather misapplied, in a great measure. Marine engineers will not elevate themselves by avoiding the use of the oil can, but by respecting themselves and those about them, by seeking all the education and enlightenment they can possibly obtain from Institutes of this character and by the study of modern books. That is

the way in which I would like to see engineers elevate themselves, and I object very strongly to engineers being elevated by neglecting the use of the oil can. I have a very strong objection to anything in the nature of cant or caste, and that which has been introduced into this paper partakes very largely of both. With his opportunities at the present day an engineer should be prepared not only to keep his watch but oil his engines, and, if necessary, show the way in cleaning the bilges, and then wash and dress and sit in the saloon with the passengers. Anything like cant or caste should be carefully excluded from the meetings of this Institute.

THE HONORARY SECRETARY: I take no exception to what Mr. Robertson said last Monday night, but I certainly do take exception to the interpretation drawn that the author of the paper wants a footman to follow up an engineer in his duties in the engine room. Surely we have not fallen so low as that. The dignity of labour is, I hope, of higher esteem than that interpretation of the paper indicates. In the absence of the author, I am anxious that justice, at least, should be paid to his probable intentions. Every paper should be fairly and squarely criticised, and no misconceptions should be landed upon a member when he is thousands of miles away and not able to answer for himself. With regard to the matter of elevating the engineer, I cannot say that I have at all altered my opinion as to the meaning. Mr. Ross says that an engineer has many more important duties to perform than oiling, in the engine room and in connection with the boilers, and that an experienced greaser should therefore do a certain amount of the oiling. I never imagined Mr. Ross to mean that an engineer should have no part or lot in the matter of greasing the engines. He means that no engineer travelling to the East should have the entire charge of engines and boilers without a greaser. I think that is what he means, because he is writing from the East, and is judging from the steamers he sees out there. He bases his opinions on his experience and on what he has seen. Of course there are different

classes of steamers, and let each class be judged and dealt with according to what is best for such class of vessels. Perhaps the best plan would be to modify the paper from what now appears in the proof sheets in order to avoid any ambiguity, as I think there can be little doubt but that our desire is utterly opposed to the idea of encouraging engineers to be, as has been remarked, too big for their job.

MR. A. W. ROBERTSON: I omitted when I was on my feet before to refer to a point in the paper which I rather approve of. I allude to that part where the author recommends the lubrication of the bearing at the sides Mr. Anderson made a remark to the effect that we do not want bearings lubricated at the sides. I should think there is not a single member of the Institute who would advance the idea that because an oil pipe is led to the side of a bearing, it is for the purpose of lubricating the side at the expense of the bottom. I think it must be clear that Mr. Ross was referring to the brasses when he spoke of lubrication at the side. In olden times they had not the relief in the brasses they have now, and a great many sea-going engineers know from experience that when once a brass gets heated up, the edge or lip grips the journal very hard indeed. I contend that under such conditions as these an oil pipe leading to the sides would be a very great advantage, for the reason that it takes the oil to a part of the bearing below the point at which the lip has gripped the journal, and the oil is thus enabled to get to the bottom of the bearing. I have taken the bottom brasses out of engines where there was no bearing at all at the bottom; the bearing was at the sides.

MR. GIRVAN
(MEMBER).

I regret that I was not here last week to hear this paper read, and the commencement of the discussion upon it. There have been many discussions with regard to oil channels cut in brasses, and I remember a number of tests being made for the purpose of ascer-

taining the relative effects of oil holes placed in different positions on the brasses. If I remember rightly, the results of those tests showed that oil holes a little off the centre produced less friction and better working than when on the centre. I have put the oil holes at the side, and have found great benefit from them. The great objection to putting the oil holes on the top centre is that that is one of the points where you have got the greatest pressure. I certainly think the oil holes should be a little off the centre. I have found that the top brasses of a crank pin wear away quicker than the bottom, and I attribute that to the fact that a certain proportion of the metal is taken away to provide for the oil holes and the oil channels. With regard to what has been said about engineers using the oil can, I do not think that the author in what he says on this subject is speaking of small steamers. In my younger days it was only in very large ships that they had greasers, and there were very few sea-going engineers but what had great trouble in teaching young men to use the oil can. No engineer is fit for his work until he can use an oil can, and that is where a greaser has the advantage over a young engineer. A young man going to sea for the first time, ships, perhaps,as third or fourth engineer He has charge of a watch, and when he has to grease he is often in the greatest difficulty. You cannot expect him to be as competent as a greaser who has been at it for years. I think all engineers should be able to use an oil can in every department.

MR. ANGUS MORISON
(MEMBER).

I am much obliged to the Chairman for the information he has furnished as to the melting points of various kinds of white metal, but I desire to repeat my question, still unanswered, as to the probable causes, why, with white metal bushes, journals wear so much quicker than with brass bushes? And whether, with reference to the chairman's remarks on the different qualities of oil, there can possibly be any chemical or electrical, as well as a mechanical action, to account for

the fact? In my own experience I have noticed the result of the action, and in his manual of marine engineering, Mr. Seaton, referring to the point, says, so far as I can remember —"White metal does not work well in cross heads. It has a tendency to abrade, and to wear the pins oval. In bearings having only a small angular motion, this tendency is great, and is rather peculiar." The subject is to my mind one of considerable interest, and the possession of facts bearing upon the question might be of value to us in enabling us to draw inferences which might, perhaps, lead us on this particular point, at least, intelligently to modify our present systems of lubrication, both as regards the oils used and the methods of their application. With regard to the admission of oil to the sides of a bearing, my opinion as to the advantages of such an arrangement has been confirmed by the remarks on the subject made by Mr. Girvan, and I quite agree with him in thinking that at any rate the oil-holes in a bearing — at least one in which the journal revolves—are better in a position, say, at an angle of 60° or 70° to a horizontal line passing through the bearing transversely to the line of the shaft, than when they are exactly on the top. As far as crosshead bearings are concerned, having only a vibratory motion, the oil had better perhaps be supplied on the top, though, as regards the cutting of the gutters, a little art, otherwise added thought, is required. One superintending engineer, under whom I served, condemned most emphatically the practice of cutting a gutter or channel along a crosshead brass in a fore and aft direction, his argument being that by so doing the bearing surface was reduced where most necessary, and further that the danger of cracking the brass was greatly increased. With regard to what may be termed the hydropathic treatment of hot bearings by the application of water, I can only repeat my remarks of last week. If you find, as will occasionally happen, for some occult or undiscoverable reason, even in the best regulated engine rooms, that a crank pin bearing is in such a condition that a very short time will elapse before it becomes blazing hot—keep yourself cool, and if you think there

is little likelihood of the ship going on shore or knocking up against anything, check your steam, get "big Monday" and the spanners ready, and ring "Stand by" and "Stop," with about as much of an interval between the two ringings as you might expect from the bridge if the ship was running into danger. Then stop, slacken back, and get under way again with as little delay as possible, ringing up "Slow ahead" until you are sure there will be no need for a second stoppage. By following this mode of procedure, when unfortunately the occasion arises, I am convinced, from experience, you will do the best that can be done under the circumstances. By deciding at once to stop, you save oil, time, and last, but not least, nervous force, for what sea-going engineer does not know how depressing are the effects of trying to nurse a hot bearing back to its normal temperature? and to be depressed is to be weak, and "to be weak is miserable, suffering or doing." The bearing that has been heated must, of course, be examined at the first port of call, if there is anything like reasonable time to have the job done; and here again time will be saved if the slackening back treatment has been resorted to in preference to the hydropathic, and—peace, ye spotlessly arrayed chief engineers, where such be—the hard-working second or third may stand the chance of a bath and time at least to change his boiler suit before sailing time. That the effect of water on bearings is injurious, whether applied occasionally or systematically, can be proved by facts, and the man who undertakes to argue against facts commits himself to a hopeless task. By the way, it is to my mind a very significant fact that the East Indian greasers, who in my earlier days at sea were known as "pani wallas," or, those who water, to make a free translation, are now called "tael wallas," or, those who oil. *Verbum sat sapienti.*

On the question of internal lubrication, also, I can only repeat a former opinion, this opinion being founded on facts observed during my experience with marine engines of two, three, and four cylinders, and land engines of two cylinders. To my mind

the "probable evidence" with regard to the matter approaches a "moral certainty" that—otherwise than in a case where superheated steam is used—systematic internal lubrication is unnecessary. My experience has been that oil evaporated from the piston rods impermeating the steam together with the steam condensed on the cylinder walls and valve faces, has been ample for all lubricating requirements, excepting only when the engines are going very slowly. Granted that there is a certain amount of power lost, the question arises whether it is not wiser, at least at the present stage of our knowledge, to resign ourselves to the acceptance of this loss, partial as it is, rather than risk a greater, perhaps a complete loss, in the disabling of our boilers in a manner which nothing but the presence of oil accounts for. I have quoted the expression "probable evidence" and wish to show by a simple application of mathematical symbols and signs, how it can be applied to the question at issue. I am not here referring to engineers only, but to us as beings of a high but limited intelligence; "probability is the very guide of life," and this is true in respect of higher matters than that under discussion—hence the general value of the formula which I hope to make clear to any who, even in reading up for "extra," may not have come across it. "Probable evidence," we are told, "is essentially distinguished from demonstration by this, that it admits of degrees, and of all variety of these from the highest moral certainty to the lowest presumption. In questions of difficulty, or such as are thought so, when more satisfactory evidence cannot be had, or is not seen, if the result of the examination be, that there appears, upon the whole, the lowest presumption on one side, and none on the other, or a greater presumption on one side, though in the lowest degree greater, this determines the question, even in matters of speculation, and in matters of practice, will lay us under an absolute and formal obligation to act upon that low presumption of probability, though it be so low as to leave the mind in very great doubt as to which is the truth. For surely a man is as really bound in prudence to do what, upon the whole, appears according to the best of his own

judgment"—and I might add and that of those in whose judgment he has confidence—"to be for his happiness as what he certainly knows to be so."* Probability may be predicted, that is to say, affirmed, whenever in answer to the question whether a particular proposition is true, the affirmative chances predominate over the negative, yet do not so as virtually to exclude doubt. Let *a* represent the affirmative side of the proposition or problem for solution or demonstration to be tried, *b* the negative side, and let the evidence or facts known be exactly balanced between them.

Then $a : b :: 1 : 1 = 1.$

Let the evidence preponderate on the affirmative side 100 : 1, the expression then becomes

$$a : b :: 100, : 1 \therefore \frac{a}{b} = \frac{100}{1} = 100.$$

Let the evidence be to the negative side 100 : 1, then the expression becomes

$$a : b :: 1 : 100, \therefore \frac{a}{b} = \frac{1}{100}$$

And it is clear that

1. When the second side of this equation consists of an integer or an improper fraction the proposition is probable. 2. As the numerator becomes indefinitely great it represents probability approaching towards certainty. This it can never adequately express, but no fixed limit can be placed upon the advances which can be made towards it. 3. When the second side of this equation consists of a proper fraction the proposition is improbable. 4. As the denominator becomes indefinitely greater, it represents improbability approaching towards negative certainty, or as it is sometimes, perhaps improperly, called impossibility.

To broaden the definition, to reduce truths, events past and future, and questions of conduct accurately

* Introduction to Butler's "Analogy." See also for formula a paper on "Probable Evidences" in the Nineteenth Century for March, 1879.

into the form of propositions false or true, take for the first, the symbol *is*; for the second, *has been* or *will be*; and for the third, *ought to be*. In one or other of these forms every conceivable proposition can be tried in respect to its probability.

Among other questions, gentlemen, this formula can be applied to that of internal lubrication, and having been tried with a due consideration of the value of the arguments and facts referable to each side, at present at my command, I find that the necessity for such lubrication is represented in concrete form, as follows: Granting *a* to represent *is necessary*, and *b is not necessary*

$$a : b :: 50 : 100, \therefore \frac{a}{b} = \frac{50}{100}; \text{ or } x = 2,$$

until, at least, further facts or arguments are forthcoming.

Having also applied the formula to the oil-can question the result has been very conclusive. The young man of science ought to learn to use the oil can, if only for the very good reason that the education of the muscles affects the development of the mind, and, all things being equal, the cunning right hand is the most likely to be linked with the subtle thought. And which of us but will admit that it requires a cunning right hand to go round and oil an engine of even 100 horse-power nominal, of course, to be exact, pump links and all, say about two o'clock in the morning, with a beam sea running high, the rain coming down in torrents, the skylights shut, and anything but science dripping from one's fingers. No fancy sketch, gentlemen, but personal experience perhaps of many another member of the Institute.

One question more and I have done. Will Mr. Ross, whom I beg to thank most heartily for his paper, kindly inform me in his reply what his experience has been in the matter of lubricating dynamo commutators, and, if he has tried them, which he considers best, vaseline, French chalk, or any other lubricant?

THE CHAIRMAN: There is just one point that I should like to mention. Mr. Morison spoke about internal lubrication as being unnecessary, and he also stated that the presence of oil in the boilers was injurious. We all agree with him there, because, as I said at the commencement, many oils contain acids and other deleterious ingredients. But a little internal lubrication for the valves and pistons, is, I think, necessary. Take two rubbing surfaces and at first let them be dry, then give them just the least drop of oil, and you will find a great relief. The object is to get a system of lubrication that will use as little oil as possible, but give it at the right time and in the right place. If you oil your steam after it has left the boilers by means of a mechanical lubricating appliance affixed to the steam pipe, and admit a very small portion at each stroke, you will find that practically the whole of the oil is absorbed and that none of it gets back to the boilers. Mr. Morison also asked why it is that with white metal bushes journals wear down more quickly than with brass bushes? I cannot say that I ever heard anybody else make that remark. I do not know why it should be the case, and I have yet to learn that it is the case.

Mr. J. H. THOMSON: I think that when Mr. Ross returns he will very likely desire to supplement his paper, and possibly he will be prepared to reply to the criticisms of the various speakers.

Mr. BERRIL: Mr. Ross says in his paper "We require only the bearing surface equal to the diameter of the shaft to ensure a correct bearing." Does he mean by that that the length of the bearing should be equal to the diameter of the shaft?

The HON. SECRETARY: He means that, I think, but the usual practice is a diameter and a half.

Mr. BERRIL: I do not advocate bringing greasers into a small ship, and I would not like it to be inferred that I object to oiling, because I think there is nobody in the room who has done more of it than I have.

MR. H. C. WILSON
(MEMBER).

I was much interested in the paper read on the 8th inst. also in the discussion which followed, and while I do not find my experience as a sea-going engineer agree in all respects with Mr. Ross, I am quite at one with him on many of his points.

That the present arrangements in the engine rooms of many tramp steamers for lubricating the main engines are very defective, is, I think, quite true, and the extra worry and work entailed on the engineers, to say nothing of the extra expense to owners, for repairs and wasted oil, are considerable.

With regard to the remarks made when the paper was read, as to the proper position of the oil inlet, in a main bearing, my experience of the matter is that the simplest and most practical way is to drop the oil upon the top centre of the shaft, through properly spaced holes in the crown of the brass, the pitch of the holes to be in proportion to the length of the journal.

I have never found any real difficulty in getting the oil to the point of greatest pressure, *i.e.*, the bottom centre of the bearing. I have never been able in any ship I have been in to get the main bearings to run so fine as to prevent the oil going right round the brass.

That central holes have the effect of weakening the brass, there can be no doubt and this is the reason we so often find our main bearing and crank pin brasses part across the crown and in the direction of the oil holes.

The idea explained so well, when the paper was read, of introducing the oil at a point off the centre, in fact, well down the side of the brass, may be as good in practice as it appeared on the black board, but I have never found eccentric straps, for instance, run any better, or with less oil, from the fact of the oil inlet being well off the centre.

The efficient lubrication of the crank pin has not had that attention from designers as a rule, that the importance of the bearing demands, and the crude and wholly unreliable methods of oiling the bottom ends makes one wonder how the brasses run at all.

That some automatic arrangement is now imperative for the lubrication of the high speed modern marine engine is clear, as it is an impossibility to use an oil feeder quickly enough to be of much use. I must here record my entire disapproval with Mr. Ross, in his remarks about the engineers having to do their own greasing. Enough was perhaps said at the time the paper was read, and I have no wish to say more than this, that it is a mistake to disparage the young man greaser, whether he has science dripping from his fingers or not. The intelligent oiling of a pair of engines is, in my opinion, a study in itself and constitutes a splendid training in regularity, system, and quickness of hand and eye, which should be, I think, cardinal points in a sea-going engineer, and I myself am proud of the ability to grease a pair of engines with any one.

Mr. J. H. THOMSON : On behalf of Mr. Ross I thank you for the way in which you have received his paper and I have no doubt he will be very pleased to read all your criticisms.

INSTITUTE OF MARINE ENGINEERS.

SESSION  1893-4.

BOMBAY CENTRE.

A MEETING

OF THE

MEMBERS OF THE INSTITUTE OF MARINE ENGINEERS

Was held on the 6th of MARCH, 1893,

IN THE PREMISES OF THE

P. & O. ENGINEERS' CLUB, BOMBAY

(Kindly granted for the occasion),

WHEN

MR. W. M. ROSS

(MEMBER)

READ THE PAPER ON

"LUBRICATION,"

Now Published in the foregoing pages.

MR. W. W. WILSON

(VICE-PRESIDENT)

OCCUPIED THE CHAIR.

A Discussion ensued after the Paper was read, and the following Report of the proceedings has been received from Bombay.

THE CHAIRMAN

(MR. W. W. WILSON, VICE-PRESIDENT).

I think we may congratulate ourselves to-night in having the writer of a paper here to read it before us in person. A fortnight ago we had our first meeting, at which a paper, which had already been read before the parent Institute at Stratford, was laid before us for discussion, and I must say it was very encouraging then to see the numbers that came forward, but we have considerably more to-night. We are now getting the first of the paper that is to be read, and I hope it is the precursor of many more, which we may have under the same conditions. The subject of Lubrication is one which up to the present has not been brought before the Institute, except slightly in the course of the Paper on "Friction." I hope, therefore, that every attention will be given during the reading of the paper, and that a good discussion will follow.

———:o:———

MR. W. GARDINER

(MEMBER).

I have listened with much pleasure to the paper just read by Mr. Ross, on lubrication. It is, in my opinion, a subject of great interest to most of us here to-night, more especially so when we remember some bearing we may have had working warm and we have had to use extra oil on our watch to cool it down. I think that Mr. Ross has very ably brought before us the defects in lubrication such as we have to contend with, and as this is the first foreign-made paper read at this infant branch of the Institute of Marine Engineers, I think he deserves our best thanks for the trouble he has given himself to write it.

With regard to internal lubrication, I think if those present will look up our Chairman's paper on "Engine Room Practice," read at the Institute at home, they will see that he also dealt very fairly with it. I do not know if Phillips's patent was the first or not, but I do know that the Sight Feed Lubricator is a great advan-

tage and comfort to the engineer on watch. I have often sailed with the old style and did not like them and never knew whether the oil had left for its duty or not.

I have heard of an ingenious arrangement of force pump for lubricating the worm of our most approved steering engine gear. I understand it to be the invention of two members here to-night. They will be able to explain its arrangement better than I can. I think, as it did act well, that it would also be suitable for the Thrust Bearing, combined with the arrangement Mr. Ross speaks of in his paper.

As to the eccentrics, I again agree with Mr. Wilson that the pan or trough fitted under them for holding oil and fresh water for the straps to dip in every revolution, is very suitable, and I am sure there are few that have sailed with this arrangement that have not experienced its worth, and whoever was the first to introduce it deserves our best appreciation.

What I would like to see is an arrangement for lubricating the crank-pin and crosshead bearings to ensure that they get the oil required, and stop that eyesore to most engineers,—the hand oiling that has at present to be resorted to. If this could be done it would be a a great gain to ourselves and employers also.

MR. DREWRY
(MEMBER).

Mr. Ross has so exhausted the subject in the direction of his paper, that I must ask permission to wander a little further afield. We have the choice of four kinds of lubricants—viz., animal, vegetable, mineral and mixed. It depends on the conditions under which we have to lubricate, which is the most suitable. Animal and vegetable oils contain several kinds of acids. They may also obtain or develop acids during the process of refining. Now, it is possible to buy these oils so well refined that they contain no active acids; yet, without exception, they are liable to

develop a very large percentage of active acids by storage. While under the influence of steam they simply decompose, or separate, into palmitic, stearic, oleic acids, and glycerine; in fact, several patents have been taken out for so separating them by steam, but owing to the loss of much glycerine by this process, I understand, it had to be abandoned. Cylinders, piston rods, &c., lubricated with animal or vegetable matter are simply acid extractors at work.

Vegetable oils, without exception, oxidize, or dry. This drying varies, from the paint oil, which dries quickly, down to the castor and olive oils, which dry but slowly, and only show it, as a rule, by gummy bearings. All vegetable oils gum more or less, and machinery so lubricated requires a much greater pull at starting.

There is a danger of fire in using vegetable oils, for cotton, jute, or any material of that kind, saturated with vegetable oil and kept in a dry, warm place, is very likely sooner or later to spontaneously ignite.

We often find pieces of waste smouldering in places which point to spontaneous combustion, and packing soaked in vegetable oil may (if the engines stand long enough) generate sufficient heat to ensure a hot rod when they start. All fish oils are acid and drying oils. Mineral oils contain little or no acid. Most of the professors and chemists tell us that they are hydrogen and carbon in various proportions, and that not only are they free from acid, but they cannot develop acid. Deville, of the French Academy of Science, found traces of acid in all the samples of mineral oils that he tested, and as much as 3% in some cases; he also states that they are liable to generate acid. However, in spite of this, it seems to be generally accepted that they are free from acid, and also that when mixed with other oils they practically kill the acid and drying tendency of those oils.

The danger lies in the low flashing and evaporating point of many of these oils, and great care should be

used in selecting them. They should not flash under 350° for outside, or 500° for inside lubrication. Reed gives the temperature of superheated steam at 380° to 400°, so that 500° does not leave too large a margin, especially if the oil enters at a time when friction is causing an increase of temperature. I do not suppose the oil would flash in a steam space, but none of us can say what it would do, and cylinder covers have been blown off on several occasions when no priming had been going on and when the engine had been running for some time. In a gas engine cylinder, where it would come in actual contact with the flame, a still higher flashing point may be required. They should not lose anything from evaporation when exposed to a temperature of 200° for ten hours. Oils that evaporate quickly are apt to leave a bearing perfectly dry.

The N. E. Cotton Masters' Association of America called in Professor Ordway to test the oils in use in their cotton mills. He tested from all the mills and found oils in daily use which flashed at 180° and lost 25% by evaporation when exposed to 140° for ten hours. These were the worst cases, but they help us to understand the fearful fires they have in America.

Mixed lubricants generally consist of animal or vegetable and mineral oil, and some of the most efficient lubricants in the market are mixed in this manner. The animal or vegetable matter contains better lubricating qualities, and the mineral oil prevents it from gumming or attacking the metal with its acid. However, as many of the mineral oils are cheaper than the other two, there is danger of getting a large percentage of cheap mineral oil in these mixtures. The mineral oil used in mixing should be of the best cylinder oil class. The cylinder oils are usually supposed to be pure mineral oils. Certain brands are specially mixed for heavy horizontal engines, and contain a certain quantity of animal or vegetable matter to give a better lubrication; it may be necessary in some cases, but certainly not with marine engines. Now if you test your cylinder oils by painting a thin film on glass and then

exposing it to the air, you will find many of the samples dry like paint oil or varnish; you can then safely say they are largely adulterated with vegetable or fish oil, and are unsuited for internal use.

The best cylinder oils are mineral oils of good body settled in tanks at high temperature, filtered just enough to take out grit and other impurities (but regardless of colour or appearance), then treated with steam to carry off volatile oil in them. The most expensive cylinder oils, but by no means the best, are oils of the first-class filtered through animal charcoal under great pressure, until they assume a good colour and appearance. This is done by the Cheeseborough patent process, and from what I read, it adds to their cost and detracts from their quality as lubricants, and lowers their flashing and evaporating points.

Many cheap and good-looking cylinder oils are distilled from the tarry refuse of petroleum. It may be taken as a good rule that all distilled cylinder oils should be avoided. Also that some of the worst, as well as some of the best, cylinder oils are black oils.

Now, in selecting our oil, we must remember that what will be a good oil at a certain speed, temperature, or pressure per square inch, will be a bad oil under different conditions. Several very eminent men have given a lot of attention to this subject and many experiments have been made. They find that there is a certain speed of minimum friction; friction gradually decreases up to that speed and gradually increases as that speed is increased or decreased. This speed seems to vary with the conditions, for while most of the experimenters found it between 100 and 200 feet per minute, Westinghouse, in testing his brakes, found it to be 5,000 feet per minute.

Mr. Veitch Wilson found in his experiments with the Stapfer oil tester that a high specific gravity was no advantage in an oil for outside use. He points out resin oil as having the highest specific gravity, ·99, at

the same time being one of the worst lubricants. He found that the thinner the oil that would keep the surfaces apart, the lower was the co-efficient of friction. Castor oil running on the same bearing and under the same conditions as sperm oil kept the bearings 28° hotter. He points out, however, that the thinner the oil the greater the quantity required, and in the thin mineral oils tested, he found that while he kept enough oil on the bearing, the temperature was 37° in one case and 41° in another lower than with castor oil, yet the oil lasted so short a time that the supply could not be kept up. Later he made further trials with mineral oils, but although the temperature remained lower so long as a copious supply of oil was kept up, the difficulty of supplying was such that in nearly every case the brasses got discoloured or cut, and often the oil had evaporated before the machine could be stopped. The belt of his machine got slack towards the end of his trials, and he found that although he could still test his thin oils, with the thick oils his strap slipped so much he could not start the machine.

Beauchamp Tower found in his experiments that temperature has an effect on friction. He points out that lard oil at a temperature of 120° had only a third of the friction that it had at 60°. Many years before Veitch Wilson had pointed out that it had only a third of the body at 120° that it has at 60°, probably it has less friction because it is thinner.

Now these testing machines are not altogether reliable, if Veitch Wilson had reduced the surface of his bearing by half, probably the castor oil would have proved the best, as the thinner oils would have been squeezed out; again, if he had increased the bearing surface, a thinner oil still would have proved the best, perhaps one of the thin mineral oils.

Turning now to actual practice, in the engine room where almost all the bearings have the pressure alternately top and bottom and are comparatively easy to lubricate, the oil easily works about the journal and

if it is squeezed partly out on one stroke, it has a chance to work back on the other. But in thrust bearings or heavy belt pulley shafting the case is different, the pressure is steady and the oil must not only be thick enough not to squeeze out, but it must be thin enough to wedge in. Quick running machinery heats with a thick oil, while on slow running the change from thick oil to thin is less apparent. In factories that have added machine after machine till the engine is loaded to the full extent of its power, a thin oil free from gumming is necessary, even though a much larger quantity be used; for the engine will not drive with a thick oil on thousands of spindles and other working parts as in a cotton factory, or other places of that class, where oil holes and pipes are in thousands. On the other hand, because an oil is the most suitable oil to use leaving London, it may not be the best to use in the Red Sea, or other hot parts of the world. In certain seasons of the year the oil will only have a third of the body in the Red Sea that it had in the Channel. In a case like that, more should be used, or it should be thickened up with castor or other thick oil.

Castor oil on the other hand should be thinned down when in cold weather, do not leave it for the engine to thin it down by drag or friction, or by increasing the heat of the bearing. Castor oil at 120° is almost three times as thick as sperm oil at 60°, so that at 120° it is almost too thick for our use. (All temperatures are Fahr.) Now cylinder oil should be put in as thick as possible, for if an oil like castor oil is three times as thick at 120° to what it is at 180°, I leave you to imagine how thin cylinder oil must be when at the temperature of steam, hence it is best to give it a good start. The drawback to sight feed lubricators is that the oil is often selected because it suits them and not because it is a good oil. If the oil is too thick to work in them they should be placed in a hotter part of the engine room.

I cannot agree that oil should only be sent through the low pressure engine. Good cylinder oil will pass

through the high pressure and thicken up again and show as oil at a leak in the low pressure, so that if it does no good it takes no harm. In one ship I was in we had a leak in the jacket, and cylinder oil worked out there and trickled down, almost the same in appearance as when first put in. There are two lessons to be drawn from that incident, the first is that good cylinder oil will pass through steam at 90lbs. and emerge from a leak in a jacket at 20lbs. pressure as good actual oil ; the second lesson is there must be nothing drawn off between the oil inlet and the high pressure or expansion valve, or the oil may be drawn off too. In the case cited the oil inlet was in the main steam pipe and the jacket steam was drawn from the main steam pipe nearer the engines. When a small horizontal engine has been running some time without cylinder oil—give it a few drops, you will find a very perceptible increase in speed, this points to the advantage of internal lubrication, it is also the best way of oiling the rods.

I had to do my own oiling for the first three years of my sea-life, and I did not like it, but I found that if a man really cares to work his worsteds properly he can make the lubricating as nearly automatic as the sight-feeder and need only fill his cups every two or four hours.

MR. C. ANDERSON, JUNR. (MEMBER).

I listened with great pleasure to Mr. Ross while reading his paper, but there was one part with which I cannot quite agree. If I heard Mr. Ross right, he mentioned near the end of his paper that during the last two decades very little had been done by designers or builders of engines to improve lubrication. I am sure all here will agree with me when I say that the number of hot bearings has very much decreased during the past twenty years, and that is greatly owing to the improvements made by designers and builders in giving much larger bearing surfaces to all bearings, and although they may not have looked at these improve-

ments in the light of better lubrication, yet there is no doubt that these increased surfaces give lubrication a much better chance of doing its work effectively.

MR. H. CHISHOLM

(MEMBER).

Read by the Chairman.

Through the courtesy of Mr. Ross, I had the pleasure of hearing his valuable and instructive paper on lubrication read privately. I need not tell you that it would have afforded me still greater pleasure to have heard the paper read and discussed, to have congratulated Mr. Ross on his excellent paper, and on being the first member to read his own paper before the members present in Bombay. I must say that after listening attentively to the reading of the paper, I entirely agree with the main points contained therein.

Having the oil pipes led into the sides of bearings with revolving shafts would possibly be an advantage, but I question if the cost of alterations to existing arrangements would warrant it. Mr. Ross has requested us to confine our discussion to vertical engines, but as he has quoted a mill engine, and until recently most of them were horizontal engines, he will pardon me for giving an example of bearings, which, although oiled practically on the sides, were an utter failure till alterations were made in the shaft. As most of you know, bearings wear in the line of motion; consequently bearings in a horizontal engine are adjusted at the sides rather than at the top and bottom; the most slack will in this case be at the top where the oil is applied, still in the case I speak of the oil was not carried round, as the weight of the shaft prevented it, and until flats were cut on the shaft to allow the oil to be carried round, very little lubrication took place on the bottom of the bearing.

This would not take place in a vertical engine, as with every revolution of the engine the shaft is eased off the bottom bearing.

I quite agree that three oil pipes down the connection is waste of pipe and the labour to fit it. Two fitted nearer the centre of the bearing would be better and more effectual. The only possible excuse for three being fitted would be that one might get choked up.

Having the impermeator, or oil supply led into the low pressure valve casing is, from my experience, the correct place, and as little oil as possible should be used there, lubricating the rod with mineral oil should be quite sufficient, unless where the initial pressure in the low pressure casing is very low, or when starting the engines. When using superheated steam it might be necessary to use more internal lubrication.

I regret that Mr. Ross did not refer in his paper to the present method of applying oil to the guides. As a rule a pipe is led to the top of the guides, where an oil channel of a more or less ornamental design begins, and often is carried down to near the bottom, or only for a few inches. We all know this is not correct, as in the first instance the oil will run down these channels and never get near the surface, and in the other it will be thrown off by the shoe. Two pipes should be fitted to each column and led into the guide at half stroke and equi-distant from the centre, with oil-ways cut across the face of the guide, so that the shoe can work the oil gradually from the centre to both ends.

It would be a saving to shipowners and an advantage to marine engineers at sea and bring more credit to designers and engine builders, if two thirds of the cost at present spent on elaborate and useless water services could be spent on a better system of lubrication.

Considering what friction is, and the requirements to overcome it, I should say that a great many bearings are designed with insufficient area to work well. In designing an engine, it is a very simple matter to make the bearings longer; they would wear less and work better, and give the lubricant more chance of doing its work efficiently and economically.

Mr. Ross truly observes that for most of the improvements in the marine engine, designers have to thank the men who go to sea in the engine room, and I hold with the eminent engineer who said that one ounce of practice is worth a ton of theory.

MR. DANIEL CARMICHAEL.

After having listened to the reading of Mr. Ross's very able paper on lubrication, I may say that I cannot endorse his statement, that marine engine designers and builders, have given very little thought to the most essential part about an engine, that is the bearing surfaces. In my experience when first I went to sea, a hot bearing was not the most unusual thing likely to happen, but quite the reverse. At the present time, what with the use of good anti-friction metals, and a liberal amount of bearing surface, the troublesome and annoying hot bearing is becoming a thing of the past. As regards the introduction of oil into the sides of the bearings instead of the top, I believe this would not work at all well for crank pins. The part to get the oil first, is, I should say, that part which has the greatest strain, and it is a well-known fact, that the greatest amount of friction is on the top brass on the down stroke, and if the oil is carried into the centre of that brass, and suitable gutters cut to allow the oil to get freely along the pin, and sufficient bearing surface, there will not be much room for improving the method of introducing the oil.

In the discussion to-night no mention has been made of a roller bearing for tunnel shafting, a model of which is now in the Institute Museum, in London, this form of bearing could be used with great advantage for tunnel shafting, and would greatly reduce the amount of friction, which is such a great source of loss.

In closing my remarks, I can only say, that, if engineers would pay particular attention to the training of their greasers, and endeavour to do away with the

pernicious habit of pouring the oil down the oil pipes, in unknown quantities, at unknown periods of time, and endeavour to keep their oil cups full, instead of filling them up at the end of the watch, there would be a great saving of oil, much better lubricated engines, a greater reduction in the number of hot bearings, and the good old-fashioned syphon would be more appreciated and understood than it appears to be at the present time.

THE CHAIRMAN.

The discussion has been so well sustained by other members that I have little to say, still I cannot let the opportunity pass without expressing my opinion on one or two of the points, which have been brought out in the paper for discussion.

In the first place, Mr. Ross advocates that instead of letting the oil go in on the top of a bearing where it is the custom to lead it, it ought to be taken in at the sides. There is no doubt that the argument is a very good one, but if the bearing is properly constructed and attended to, there is no necessity for any such arrangement, the oilways on the top fulfilling all the required conditions. It is absolutely necessary to make sure that these oilways are thoroughly chamfered off or rounded, so that when the oil gets in, it may have a chance of wedging itself in between the shafting and the metal of the bearings. I am afraid that, in too many instances, this point is neglected by young engineers, and many bad running bearings might be traced to inattention to this simple matter. It is often the case that in crank pin and other bearings the brass supporting strips for the white metal are open from end to end of the bearing, so that, as the oil gets in to these strips, it naturally flows out towards the end which may for the time being (owing to the trim of the ship) be the lowest, and the consequence is that more oil is required than would be, were these necessary strips filled up flush at each end, and the spaces thus transformed into gutters in which at all times there was a bath of oil lying. It

has been my custom for some years now to recommend this being done in all crank pin bearings, for the reason that, in one ship I was in, I found a very great benefit from it, and when the edges are well chamfered off, as already mentioned, it makes a very good working bearing.

As an argument against the absolute necessity of putting the oil in at the side, I would also mention that the reciprocating movement in a marine engine tends, at the end of each stroke, to allow the oil to get in, even although there may be no chamfering off of the oilways, &c.

I am inclined to be favourable to the introduction of oilways in the shaft instead of in the bearings. I cannot say that I have been with such an arrangement, but I am convinced that it would be a good one. I have seen it applied on board a French mail steamer, but as to the results I cannot speak. Such an arrangement is, I understand, used with very considerable success in large mill engines, in which the heavy driving spur wheels or rope pulleys, sometimes weighing 150 tons, altogether precludes the possibility of the reciprocating motion of the engine from easing the shaft at each end of the stroke In such cases I understand it is the custom to cut flats at intervals round the bearings, and I understand that several very badly running engines have been cured by this means. I have no doubt that some of our members who are now connected with mill engines could bear out my statement.

Like Mr. Anderson, I cannot quite agree with Mr. Ross that there has been little done in the way of improving the design of engines by the builders, and that it has been left principally to the engineer at sea to make improvements. No doubt Mr. Ross's statement is fairly correct, for very many little nick-nacks which at the present day are found to be absolute necessities in the engine room, have been thought out and constructed in perhaps a primitive way, during lonely hours at sea. Still, at the same time, the designer has

undoubtedly improved the marine engine, in the direction referred to by Mr. Anderson, very much indeed during the last 20 years.

In conclusion, I think we may congratulate Mr. Ross on his paper which has opened up a subject which is a very important one, and when it appears in the "Transactions," I think that very valuable information will be contained in the discussion, for it is more in the latter than in the matter of any paper that the value is to be found.

I may, I hope, now ask you to give Mr. Ross a hearty vote of thanks for his paper, and I may also thank the members and other friends who have come here to assist us to-night, both by their presence and their remarks.

APPENDIX.

SEA-GOING ENGINEERS AS GREASERS.

(Reprinted from the *Liverpool Journal of Commerce* of June 9th, by kind permission of the Editor.)

An interesting paper by Mr. W. MUNRO ROSS, on "The Lubrication of Marine Engines," read at a recent meeting of the London Institute of Marine Engineers, has certainly served its purpose, for much discussion has been thereby evoked. It is somewhat strange that the question of the best method of decreasing friction among the various parts of a marine engine should arouse a controversy involving an undue amount of heat in the participants. The author attempted to prove that revolving shafts should be oiled from the sides, not through the vertical centre; that oiling should be automatic, not dependent on chance; that builders and designers should pay more attention to the lubricating arrangements; that internal lubrication should be done away with, except through the impermeator attached to the low-pressure engine, and by swabbing valve rods and piston rods with mineral oil

only; and last, but not least, that no marine engineer of modern training should be asked to act as oiler in addition to his other and more important duties. There is an almost insuperable difficulty in applying one hard and fast rule to all classes of steamships, from the tiny tramp to the gigantic liner. It is well known that too frequently men who have passed the prime meridian of life are apt to regard the good old days with a feeling of fond regret; and there are others who have a curious knack of culling certain statements from papers read at meetings of societies, utterly ignoring the context, and then proceeding to argue as though the original writers had actually intended these passages to bear exactly the same meaning as the critics are pleased to place upon them. Mr. Ross has apparently fallen among both classes of objectors, and the discussion will serve a good purpose. The principle of the division of labour applies in an engine-room at sea as elsewhere on dry land; and it almost goes without saying that the oil can should not be in the hand of a marine engineer more than absolutely necessary. The gist of the last clause put forward by Mr. Ross was evidently misunderstood; he did not assert that engineers should object to oil a bearing on a pinch, but rather that an engineer who had entire charge of engines and boilers had other and more important duties to perform. It is altogether beside the question to insinuate that the modern engineer is above his work. Mr. ADAMSON, the honorary secretary, rightly pointed out that the engineer who is "hail fellow, well met," with an oil can, will probably neglect the duties more especially pertaining to his position. He quoted from an absent member one steamship with engines indicating over 1,000 horse power, in which no greasers were employed on one voyage, and the expenditure of oil was very heavy. When greasers were on board during a subsequent voyage there was a marked decrease in the oil consumption, and the engineers were enabled to attend to their own duties in a proper manner. As a matter of fact, Mr. Ross advocated the employment of greasers on the ground of economy; and it is idle to twist his words into any other meaning.

Mr. A. W. ANDERSON said, during the discussion, that he would not allow any engineer to have charge of a watch until he could use an oil can with good effect. He had been compelled to teach many young engineers how to oil, and found that as a rule they poured more oil into the crank pit than on to the bearings. We infer from this that Mr. ANDERSON would have every sea-going engineer commence life as a greaser. Well, in days gone by, engineers no doubt did go through the various subordinate grades; but the modern marine engineer must not infrequently find himself sadly to seek if his chief claim to perfection lies in the direction of the oil can. It does not at all follow that a good greaser will make a good engineer. Far from it. Engineers of the Royal Navy pass one of the stiffest possible examinations, and by this educational lever have attained to a relative rank beyond the highest hopes of those sterling mechanics who first carried on the duties of engineers in warships. As with deck officers, so with engine-room officers. They must take care that theory and practice go hand in hand. Otherwise they will continue to be but hewers of wood and drawers of water. Of course, in small vessels, with only two engineers and three firemen, the former must of necessity act also as greasers. Nevertheless this system should be kept within the narrowest limits; and apparently Mr. Ross had no desire to disturb existing arrangements. We are every day coming nearer to mastless twin-screw steamships of enormous horse power, and the engine-room needs the very best men for the position, and these must not be merely greasers but highly trained engineers. A certain amount of mathematical knowledge, a fair share of natural philosophy and chemistry, must be found in the engine room staff of the future if they wish to keep pace with the times. And these necessaries are easier for them to obtain than for the deck officers, inasmuch as the former do not leave the shore so early as the latter, and are thus able to avail themselves of the inestimable blessings of free libraries and the first-class education afforded by evening classes all over our islands at a merely nominal charge. There is every

excuse for neglected education to the deck officer, who perchance left home at the tender age of fourteen years to serve an apprenticeship on board a sailing ship making long voyages, under a master who looks upon him merely as another rope-puller for a short-handed ship. An engineer can scarcely urge so forcible a plea. The time may come when the shipmaster and seagoing engineer will be one and the same person. There will then be a survival of the fittest ; and it behoves both engineer and deck officer to prepare for the event. Many more impossible things than this combination have come to pass in the world's history.

MR. W. M. ROSS.

I have received the detailed discussion on the paper Mr. J. H. Thomson read for me, and I would here take the opportunity of thanking him for kindly undertaking this service on my behalf. I am pleased to see the subject matter has received so much attention. The ideas, perhaps, might have been more ably and more fully detailed ; still from the remarks of the various members, who have entered into the discussion, I think my ideas have been generally understood, and from the general tone of the discussion my impression is confirmed, to the effect that some advancement is, of a certainty, required in this special matter. That there are many good and useful patents in the market I know, but very few are in every day use, and, until they are, I thought it of little moment speaking of them at all in the paper. The clause which appears to have brought out the strongest expressions is that "No Marine Engineer should be asked to oil the engines unaided." It was very far from my thoughts when writing this, that the engineer of

to-day required a footman or a flunkey to assist him in his duties, on the standing that it was something so much beneath him as to seriously interfere with the social duties of his life, and I regret a few of the members should have read it in this light; it is an interpretation of my meaning which I did not count upon, and it has somewhat astonished me, for no true engineer, whether he has one or more assistants, is ever afraid to use the oil can or yet the hose if required: but while the present oil feeder system is so much in use an assistant is necessary, not for the engineer's comfort, but for the well working of the machinery in his charge, and therefore to his employer's benefit. It has been said the engineer of to-day is the same as he was 20 years ago, he *may* be so, but the machinery is not, and while the present system is carried on many important details must be neglected, which if properly looked after at the proper time would be the means of saving many pounds in repairs afterwards. In speaking of the bearing surface equal to the diameter of the shaft, I do not mean the length of the bearing but the circumferential length in each brass. I most sincerely thank the Institute for receiving the paper and the members who have taken part in its discussion.