Notes on the Management of Marine Diesel Engines.

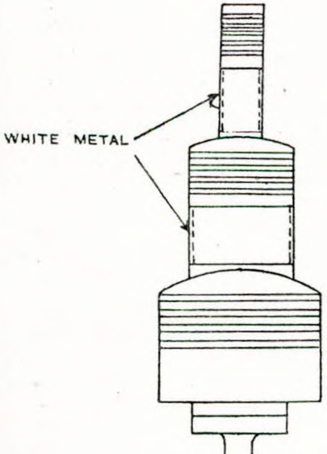
REPLY BY THE AUTHOR, HOMER McCRIRICK
(MEMBER AT SINGAPORE).

In reply to the discussion which followed the reading by Mr. Adamson, of my paper on "The Maintenance of Marine Diesel Engine Installations," I wish to thank the members present for the interest taken in the paper, and for the vote of thanks so cordially expressed. A number of points were raised during the discussion which I think can stand for a few further remarks. A great deal of interest seems to have settled round my comments regarding safety valves on compressor inter-coolers, and the damage that can be caused by their failure to act when required.

I had the experience some time ago of an explosion taking place inside the L.P. air casing of a two-stage air compressor, happily I may say without any disastrous effects. The engine was a four-stroke Diesel, with a two-stage air compressor direct driven from the end of the crank shaft for supplying blast air. I had just started up the engine when there was a loud report, a flash and then smoke, and on examining the air compressor the safety valve on the L.P. air casing was found to be leaking continuously. The engine was stopped, and the valve taken out for examination, when it was found that the spring had lost its compression in the first three coils and from their colour they appeared to have been greatly overheated by the passage of hot gases over them.

The conclusion arrived at was that through an accumulation of oil in this casing, an explosion had occurred; whether this oil was a lower flash-point variety than should have been found there, could not be ascertained. The intensity of the explosion could not be judged, but from the heat imparted by the gases when passing the spring, it must have been considerable, and had the safety valve not been in a condition to release the force of the explosion, considerable damage might have been caused to the casing.

Whilst on the subject of safety valves, I think it will be interesting if I relate an accident that came to my notice a short time ago. The vessel, which has been in service since 1911 is one of the pioneers of the present day motor ship, and, so far, has had a very successful career. The machinery consists of a four-stroke directly reversible Diesel engine with a three-stage air compressor direct driven from the main shaft. The piston for this three-stage air compressor is fitted with white metal, as shown in sketch No. 1, for the purpose of reducing friction between the walls and piston. During this particular voyage, overheating of the air compressor piston occurred to such an extent that the white metal became partially melted. The engine was therefore stopped and the piston taken out and replaced with the spare one. When things were all coupled up,



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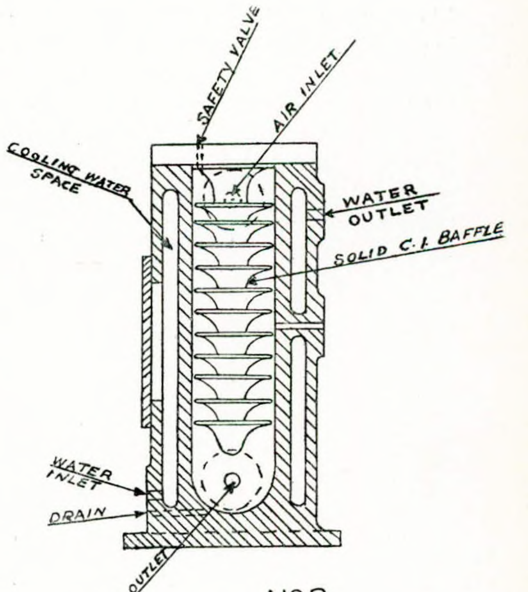

Nº2

the engine was again started and everything seemed to be in order. In less than an hour a loud report was heard in the engine room and on examination being made it was found that the I.P. intercooler had burst and scattered in all directions; water service and oil service pipes in the vicinity of the same were crushed and fractured, and a bulkhead three feet away had a hole pierced in it three inches long by two inches wide.

This particular intercooler was made of cast-iron, and a section of the same is shown in sketch No. 2. Various parts of the cast-iron were examined for deterioration that would have been likely to account for the bursting, but no extensive wasting could be found and therefore the cause of the accident had to be looked for in other places. The outlet pipe from the cooler although badly fractured and twisted, appeared to have been choked, so it is to be assumed that some of the white metal and carbonised oil from the piston found their way into the cooler, and after the engine had run for a little while the thin pieces of white metal must have become fixed in such a position as to choke the discharge pipe.

When this stoppage occurred, the pressure started to rise above normal, and as the safety valve failed to lift, it resulted in the cooler bursting. Had a thin disc been fitted in some place on this cooler the bursting would have been avoided; on the other hand also, had the safety valve been in working order the engineer would have had warning of an excessive rise of pressure and taken steps to remedy the same. Take the case of the explosion now, this I consider much more dangerous than a gradual rise of pressure, as the safety valve was able to release the sudden increase of pressure. Of course there is no reason why we should not have as many safety devices as possible, but I think if an engineer knows that all his safety valves are in working order he can go about with very little to worry him as far as bursting of air receptacles goes. Where I do think that pressure discs could be fitted to an advantage are at various places along the air starting and blast pipe lines, as should fuel oil find its way into them, there are chances of a violent explosion taking place.

Mr. Beckett raises the point about deterioration taking place on the steel shells of air vessels. I had the opportunity of examining internally the two starting air vessels on the ship I have just mentioned in connection with the bursting of the intercooler. These vessels carry air at 15 atmospheres, and considering they have been in use for almost 10 years they are in excellent condition, the only place where I found slight pitting was round the drain, and in no case were the recesses more than 1/16th inch deep.

As regards blast bottles, I have examined a few of them and in all cases the working bottles had a coat of oil adhering to the walls. The usual practice for cleaning these bottles is to put in soda and boil out the bottle with steam. I am not in a position to say to what extent pitting has been found in these small bottles as they are very difficult to examine at the bottom, and comparisons cannot readily be made between the working blast bottle having a coat of oil and the spare blast bottle with none.

The wastage of lubricating oil taken at about 1/14th of a ton per day for an installation of 3,000 I.H.P. is, I think, quite a fair figure, and there is no doubt that this will be improved upon as the sizes of engines increase and number of working parts decrease. Take the case of cylinder lubrication; in the older and smaller ships in which the pistons were not so efficiently cooled, the consumption of cylinder oil would average six gallons per 1,000 I.H.P. per day, whilst in the latest ships the cylinder oil consumption averages $1\frac{1}{4}$ gallons per 1,000 I.H.P. per day, which is quite a substantial reduction.

In reply to Mr. Hunter's remarks concerning the average temperature during the power stroke, it is assumed that the engine was working at a mean pressure of 95 lbs. per square inch. Varied opinion still exists as to the true temperature conditions found during the burning of the fuel in the power stroke of a Diesel engine, and as far as I am aware no general formulæ seems to be agreed upon for this. The temperature of 2,200° Far. was obtained from some experiments carried out on the Continent. In Fig. No. 2 in the paper, the temperature at C is stated to be about 2,200° Far. Under the paragraph of "Cylinder Heads" the 2,200° Far. is intended to be the average temperature during the burning of the fuel in the power stroke.

With reference to Mr. Adams' remarks regarding keeping record of the weights of the H.P. compressor coils so that any thinning of the same may be noticed and the coil condemned before it bursts. I heard of this coil weighing proposal some time ago, but seemed rather dubious of it. A certain quantity of compressor lubricating oil is bound to find its way into the coil and adhere firmly to the inner walls, so any record of weights may be misleading. I have not seen any H.P. coils opened up, but judging from the quantity of oil found in the tubes of the I.P. and L.P. intercoolers the weight of oil in the H.P. cooler coil must be considerable.

One suggestion I have heard, which would enable engineers to know when a coil has become worn to any extent by the scouring effect of the air, is to sink the point of a drill a certain depth at various places along the coil. When the metal remaining between the drill point and the inside of the coil is worn away, a small air leak will commence and it may then be assumed that the coil has worn a thickness equal to the difference between the original thickness of metal and the depth to which the drill point has been sunk. Mr. Adams also points out the inadvisability of shutting off too many cylinders; I have mentioned the cutting out of cylinders in the paper, but it was not intended that when a valve in a cylinder cover gives out that the fuel and blast air are to be shut off and nothing more thought of it until port is reached.

Take the case of a fuel valve giving out; if it is very far gone the fuel and blast air must be shut off from the same immediately, or the engine stopped. The damaged valve can be taken out and replaced by a spare valve in half-an-hour, but it may be more convenient to keep the engine running on five cylinders for a short time until the spare valve has been examined and made ready.

The same holds good with a cracked piston; if the fuel and blast air are not shut off soon after it is discovered that the piston is not being circulated by cooling water, there are chances of the piston overheating and perhaps seizing in the cylinder liner.

The replacing of a piston may mean six hours work and there is no reason why the engine cannot carry on under reduced power until the spare piston has been cleaned and put in order ready for dropping in place.

Most engineers realise the extra strain set up in crank shafts through cylinders being cut out, and I do not think any of them would carry on with more than one cylinder out of action if a repair could be effected. Even with engines of the most reliable design and running under experienced engineers, there is still the possibility of a cylinder cover valve giving out, and I am sure allowance to take up the extra stresses caused by this on the crank shaft is made by the designers.

From the above remarks on the changing of cylinder cover valves and pistons, I hope members will not carry away the false impression that the failure of valves or pistons is a regular occurrence. Most of the larger motor ships are now covering distances from 4,000 to 8,000 miles without any involuntary stoppage, the valves being overhauled at regular intervals when the vessels are in port. Also when care is exercised in the lubrication of the pistons, they are able to remain in operation for distances from 60,000 to 70,000 miles without having to be drawn for cleaning the rings.

Cracked cylinder covers are certainly a source of worry, but so far, I have not heard of any serious breakdowns due to an accumulation of water in the cylinder of a large engine, where the compression clearance is usually about two inches.

If a cover is badly cracked it must be changed, but if the crack is small it is possible to avoid any large quantity of water finding its way into the cylinder when the engine is being manœuvred.

In conclusion, I wish to thank the Chairman, Mr. McConnell, for the interest he has taken in the paper and his endeavours to bring forth comments from others during the discussion, which without a doubt adds greatly to the value of the paper.

I am not in a position to say anything with regard to the opposed piston type of engine, but I can only endorse Mr. McConnell's remarks on the position of the Diesel engine being unassailable, and though the four-stroke is considered the reliable engine at present, I do not think the time is far distant when the two-stroke engine will come to the fore as being the more suitable engine for single screw vessels from 250 to 300ft. long.

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The Internal Combustion Engine—Fuel, Valves and Ignition.

BY MR. A. W. BRADBURY (Member).

READ

January 18, 1921.

Mr. R. Kingdom, member, calls attention to the following :—

In the discussion on the Paper "Fuel, Valves and Ignition" reported in the March Transactions, I notice on page 412 a question by a member in which it is assumed that the torque on the shaft of a four-cycle engine is more uniform than in the case of a two-cycle, and also that the Columns Shaft, etc., would be lighter for a four-cycle engine than corresponding parts for a two-cycle.

As these assumptions were not corrected in the report, some members who are not familiar with the two types may get some confused ideas. As a two-cycle engine has a working stroke in every two strokes, whereas a four-cycle engine has only one in every four, it is obvious that the turning effort in the case of the two-stroke must be more uniform than in the case of the four. A comparison is made in a booklet published by the "Sulzer Engine Co." between two 1,100 B.H.P. engines of the two types, and as this is nearly the size mentioned by the member, the figures given may be of interest. Diameter of shaft according to Lloyds requirements: Four-cycle 15 in., two-cycle 13½ in. Total weight of installation: Four-cycle about 530 tons; two-cycle 320 tons.

Mr. A. W. Bradbury: To put the matter perfectly plain and replying to Mr. Kingdom's question, I would say that members who are not familiar with the two types of internal combustion engines may be somewhat confused in a statement regarding the torque on the shaft and the weight of the reciprocating parts; and as a two-cycle engine has a working stroke in every two strokes, whereas the four-cycle engine has only one in every four, it should have been stated that the turning effort in the case of the two-stroke would be more uniform than in the case of the four, and that the connecting rods, shafts, etc., would also be lighter for the two-stroke type. A comparison is made in the Sulzer Engine's Company's booklet, and I cannot do better than repeat what Mr. Kingdom has said, that the comparison given between two 1,100 B.H.P. engines of the two types are of exceeding interest. They give a diameter of shaft according to Lloyds' requirements, four-cycle 15 in., two-cycle 13½ in.; total weight of installation: four-cycle about 530 tons and two-cycle 320 tons. I think that Sulzer comparisons may be taken as being correct, as they are absolutely reliable in data given of their engines, and know as much about two-stroke engines as any maker in the world.

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Notes.

The following note was received from one of our members, bearing on the subject of oils:—

INVINCIBLE OIL ENGINE (TWO-STROKE HOT BULB).

PARTICULARS OF TEST 25 B.H.P. SINGLE CYLINDER ENGINE ON PALM OIL.

The oil was heated to a temperature of 160°F. and at this temperature had a specific gravity of ·895.

The oil flowed at a temperature of 90°F. and flowed freely at 100°F. After a no load test the engine was put under load to run for a continuous test of six hours under full load, the horsepower developed during its trial was 22 B.H.P., a drop of 12½ below the power developed on fuel oil.

The consumption was ·63 of a lb. per B.H.P. per hour, this is slightly higher than fuel oil, the latter being ·56 of a lb. per B.H.P. per hour.

After the trial, the hot bulb and cylinder head were examined, and it was found that instead of a black carbon deposit there was a very slight deposit of brown powder, this deposit was not at all gritty and was not of such a nature to harm the engine.

A STEERING GEAR BREAKDOWN.—The bridge account of this breakdown is as follows:—

The wheel showed signs of stiffness, and was reported to the engine room, no sign of improvement followed; shortly after, according to the helmsman, the wheel took charge, going over of it's own accord to hard a starboard, there is jammed and could not be moved.

Fortunately this occurred in the open sea and so involved no risk to the ship, and beyond the loss of a little time had no serious consequences.

The engine room account is: A report was received from the bridge that the wheel was showing signs of stiffness, an examination was made, but no fault could be discovered, everything appearing to be working normally. They were first aware of something serious being wrong by the telegraph being put to "Slow ahead."

The wheel on the bridge was examined, and found to be as stated, it could not be moved under as heavy a strain as one dare put upon it; a careful examination was made of the control transmission gear and of the engine, rudder head, steering chains and rods, with no result.

Finally, a suggestion was made to try the small hand wheel on the control shaft at the engine; with the extra leverage of an ordinary 12 in. wheel wrench the wheel moved without undue force and the gear resumed it's normal functioning and the ship proceeded to her port without further incident. The engine is of the ordinary two-cylinder horizontal type, the control valve of the usual piston design with a steel spindle with tail end, thus having two stuffing boxes. Owing to the short travel of the spindle and the length of the glands, the spindle cannot be properly lubricated, though an attempt has been made to let oil get to the working part by boring oil holes and cutting gutters in the glands.

When the engine was opened up for examination, the fault was found to lie in the control valve spindle, this had a hard black polished rust scale at both the working positions in the stuffing boxes, this, despite the fact that it had been drawn only a month previous, when it was filed up parallel and the glands repacked. The gear had been in constant use since then, even including the stay at the terminal port where owing to abnormal conditions the ship had frequently to change moorings. The steel valve spindle was replaced by a bronze one, which should prevent the recurrence of such an accident; report has it that this is the usual practice in steering engines of foreign make.

J. H. T., Member.

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* It is with regret we record the death of W. V. Browne.

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