Dissolved Gases in Boiler Water

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INTRODUCTION

Oxygen, nitrogen and carbon dioxide, being components of the atmosphere, are always found in appreciable amounts in boiler and feed water, and the decomposition of chemicals commonly added to remove oxygen and adjust *p*H may in turn give rise to ammonia and sulphur dioxide. All these gases can in certain conditions be harmful to boilers. This paper deals principally with dissolved oxygen and the other gases are discussed only briefly.

PERMITTED OXYGEN LEVELS

Experience suggests that there is a tolerance level for dissolved oxygen which varies according to the operating conditions of a particular plant; both theory and practice indicate that this tolerance level is lowered as working pressures and temperatures are raised. It is by no means certain that complete removal of dissolved oxygen is necessary although it is generally considered desirable. The practice of de-oxygenating boiler feed water has become an indispensable part of correct boiler operation, but in spite of its wide-spread application boilers still experience tube corrosion and, perhaps for this reason, permitted levels of dissolved oxygen in feed water have been gradually reduced. The following limits of oxygen concentration have been recommended[1]:

Working Pressure lb./sq. in.	Oxygen concentration p.p.m.
200-300	0·035 or less
300-500	0·015 or less
over 500	0·007 followed by chemical scavenging

A limitation of 0·007 p.p.m., for boiler pressures in the range 600-1,200lb./sq. in., was recently specified in a paper published in the TRANSACTIONS[2]. B.S.S. 1170[3] sets a limit of 0·03 p.p.m., without specifying pressure limits, but recommends that a de-aerator be installed "at the higher pressures" to cope with harbour and manœuvring conditions.

MEASUREMENT OF OXYGEN LEVELS

To determine typical dissolved oxygen levels in marine boiler systems the British Shipbuilding Research Association (now the British Ship Research Association) undertook a series of measurements with a continuous recording dissolved oxygen meter in a number of dry cargo and cross-channel vessels. A small selection of the many records obtained are presented later in the paper. Although the work was carried out some years ago the results have not previously received full publication and it is hoped that they will be of some interest.

At the time these measurements were begun, chemical methods of measurement on shipboard were very limited in accuracy with oxygen levels below about 0·02 p.p.m., besides which a minimum of 15 minutes was required to obtain a measurement and continuous recording was impossible. For the purpose of the trials, an instrument working on the electrochemical principle and having good sensitivity, quick response and reliability under shipboard conditions was required. Of the various instruments under development at that time one being developed and manufactured by Wallace and Tiernan, in collaboration with the Admiralty was selected.

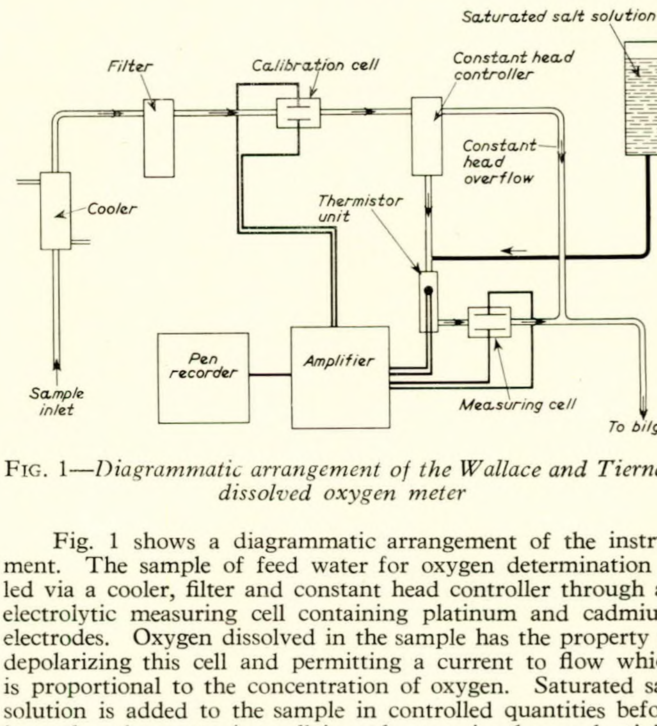

FIG. 1—*Diagrammatic arrangement of the Wallace and Tiernan dissolved oxygen meter*

Fig. 1 shows a diagrammatic arrangement of the instrument. The sample of feed water for oxygen determination is led via a cooler, filter and constant head controller through an electrolytic measuring cell containing platinum and cadmium electrodes. Oxygen dissolved in the sample has the property of depolarizing this cell and permitting a current to flow which is proportional to the concentration of oxygen. Saturated salt solution is added to the sample in controlled quantities before it reaches the measuring cell in order to raise the conductivity and hence increase the current output. This method of amplifying the response of the instrument greatly facilitates measurement and recording but contaminates the sample so that it cannot be returned to the main feed system; this may necessitate an extra 4 gal./hr. of make-up feed if the instrument is kept in continuous use.

Calibration is effected by injecting a known oxygen concentration into the sample flow from an electrolytic calibration cell located in the sample feed line and observing the resultant response on the pen recorder. The concentration of oxygen generated by the calibration cell is determined by measurement of the current passing through it and by knowledge of the total flow of sample feed.

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TABLE I.—DETAILS OF MACHINERY AND BOILERS.

Reference letter	A	B	C	D	E
Type	Cross-channel ferry	Cross-channel ferry	Dry cargo	Dry cargo	Cross-channel ferry
Normal s.h.p.	10,000	10,000	10,500	8,000	11,000
Main machinery	2 sets double-reduction geared steam turbines, twin screw	2 sets double-reduction geared steam turbines, twin screw	1 set Parsons turbines double-reduction geared to single screw	2 sets Parsons turbines double-reduction geared to twin screws	2 sets double-reduction geared steam turbines, twin screw
Main boilers	2 Foster Wheeler D-type 400lb./sq. in., 650 deg. F. (339 deg. C.)	2 Foster Wheeler D-type 490lb./sq. in. 750 deg. F. (394 deg. C.)	2 Babcock header type 450 lb./sq. in., 750 deg. F. (394 deg. C.)	2 Babcock header type 450 lb./sq. in., 750 deg. F. (394 deg. C.)	2 Babcock integral-furnace 350 lb./sq. in. 650 deg. F. (339 deg.C.)

Some Typical Records

Fig. 2 shows a typical record of dissolved oxygen concentration covering a cross-channel passage with Ship A (for details of ships see Table I). Oxygen concentration expressed in p.p.m. is shown plotted against time together with steam flow through the starboard turbine in lb./hr. Periods during which make-up feed water was being added to the main feed system are also shown.

It will be seen that the oxygen content was very high under standby conditions and also during manœuvring at the start of the voyage. Values varied very widely from well above 0·15 p.p.m. at standby down to approximately 0·10 p.p.m. during manœuvring, but they showed a general tendency to decrease. When steam flow was increased to that corresponding to normal service power, the general level of oxygen content fell gradually to a value of about 0·035 p.p.m. after two hours steady steaming. Superimposed on this general tendency for decreasing oxygen content there were very striking and sudden peaks occurring at intervals during the voyage. These peaks, in many cases three to four times the ambient level, coincided with the addition of make-up feed and it is reasonable to assume that they were in fact caused by oxygen in the make-up feed.

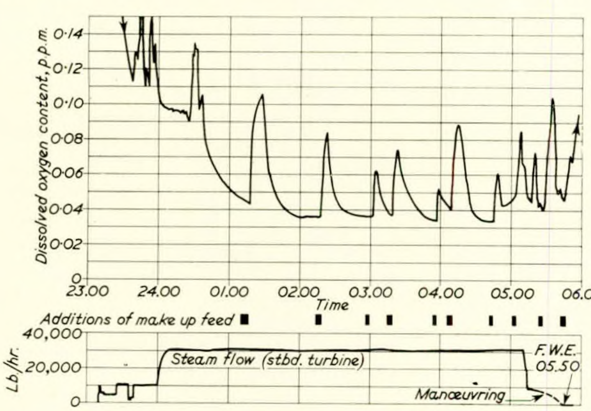


FIG. 2—*Variation of oxygen concentration during passage with make-up feed added from distilled water tank—Ship A*

Records for a total of seven voyages under similar conditions were obtained in addition to that shown in Fig. 2, all of which showed very similar patterns of oxygen concentration. Levels were always very high at the beginning of the voyages and fell to values of between 0·025 and 0·050 p.p.m. after 1½ to 2½ hours of steady steaming but tended to rise again during manœuvring at the end of the voyage. The sharp peaks of high oxygen content were a feature present in every record, coinciding with the addition of make-up feed in each case. During this series of voyages with Ship A, make-up feed was drawn into the main condensers from the distilled water tank which was open to atmosphere. Thus the feed make-up was at a relatively low temperature and air-saturated.

It is naturally desirable to reduce or, if possible, eliminate very high oxygen concentrations even if they are only maintained for short periods and, with this object in mind, it was decided to test the effect of adding make-up feed in the form of vapour direct from the evaporator output. In theory this vapour should have contained no dissolved oxygen, but only oxygen mixed with the steam which could be removed by the air ejectors on reaching the condenser. Good results were achieved; the peaks of high oxygen content were removed and the general level of oxygen under steady steaming conditions was reduced by 50 per cent. Owing to the risk of carry-over of salts with the steam, this system was obviously not one for normal use.

In a similar vessel, Ship B, it was normal practice to introduce make-up feed as a continuous flow of condensate from the distiller. Thus it had little opportunity to absorb oxygen before reaching the main feed system, which no doubt explains the absence of peaks in the records obtained. Fig. 3 is typical of this ship.

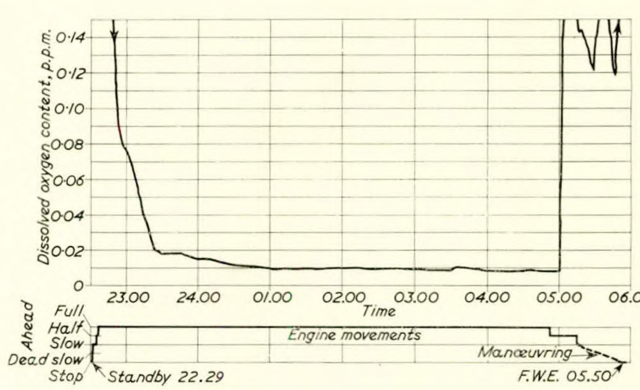


FIG. 3—*Variation in oxygen concentration during passage with make-up feed added direct from distiller during steady steaming —Ship B*

Fig. 4 shows oxygen levels recorded during the first coastal passage in Ship C. Between 05.00 and 09.00 hours, make-up feed was drawn into the main condenser from the double bottom tanks on three separate occasions. As with the previous ships, this method of adding make-up feed was seen to have a marked effect on oxygen levels, each addition of make-up causing a sharp rise in oxygen level from the steady value of 0·01 p.p.m. to above 0·10 p.p.m. The breaks in the record with vertical arrows indicate where the oxygen content exceeded full scale deflexion on the recorder, at different levels according to the various scale ranges employed.

This ship was fitted with a hand valve and a pipe connexion to a double bottom tank which enabled make-up feed to be added direct to the main condenser. This arrangement is, of course, not usual in a closed feed system. Normal procedure was to open the valve and allow cold air-saturated water to be drawn into the condenser. This raised the condensate level, operated the control valve and filled the main feed tank

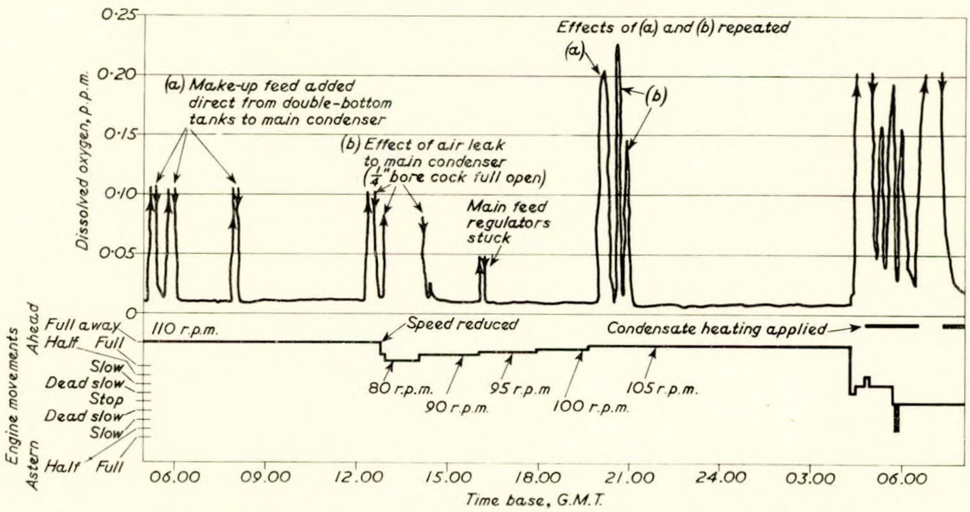


FIG. 4—*Variation of dissolved oxygen content during a coastal passage—Ship C*

via the main condenser and extraction pump. The inlet pipe from the double bottom discharged below the surface of the condensate in the condenser well and thus the make-up entered the feed system without de-aeration.

Because of these high concentrations it was decided to change the method of adding make-up feed by pumping it direct to the main feed tank. This ensured that the feed water entered the system in a small continuous flow, via the feed control valve and the sprayer at the top of the condenser. This technique was employed throughout the remaining trials with this vessel and no further high oxygen concentrations due to the addition of make-up feed occurred.

The section of record between 04.00 hours in Fig. 4 and the end of the passage (shown in Fig. 5) is a good illustration of the effects of prolonged manœuvring and standby conditions and it also shows the result of operating the condensate heater fitted in this vessel. It is particularly interesting to compare the two periods of manœuvring and reduced speed running between 10.30 to 13.50 hours and 17.10 to 19.30 hours shown in Fig. 5. During the first period no heating was applied and the oxygen level reached a peak of 0·33 p.p.m. Full vacuum was maintained throughout and the condensate was under-cooled by approximately 10 deg. F. At 17.00 hours, just before entering port, the condensate heating was turned on and kept on until finished with engines at 19.30 hours. It will be seen from Fig. 5 that the maximum oxygen peak during this second period of manœuvring was 0·15 p.p.m. and that the effect of the condensate heater was to reduce the maximum oxygen level by approximately 50 per cent. The record between 04.00 and 08.00 hours (see Fig. 4) shows that under standby conditions at anchor there was a fall in oxygen concentration from 0·20 p.p.m. (heating off) to 0·02 p.p.m. (heating on). The beneficial effects of condensate heating are of course related to the quantity of steam supplied to the heater and will only be significant when the flow of main exhaust steam is relatively small. In this case heating steam was supplied at the rate of 2,000lb./hr. at 100lb./sq. in.

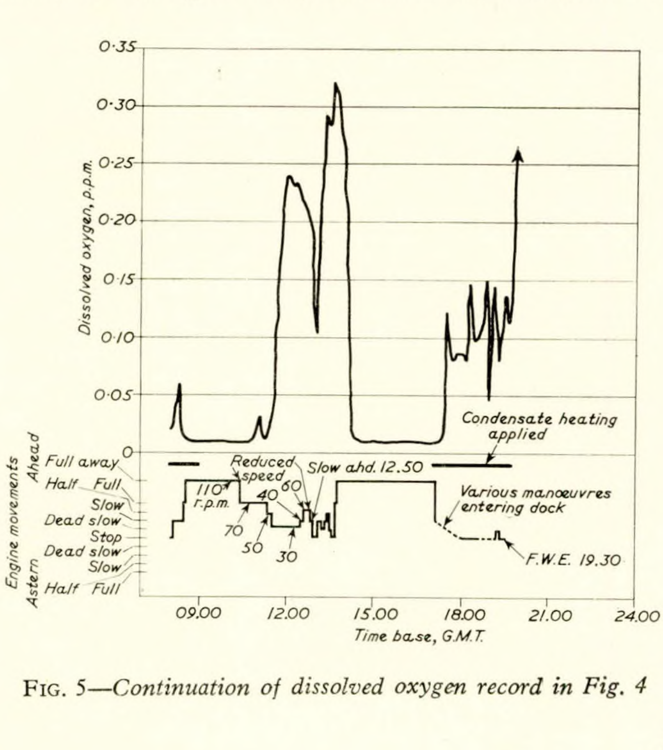


FIG. 5—*Continuation of dissolved oxygen record in Fig. 4*

Ship D was of special interest since serious boiler corrosion, believed to be caused by dissolved oxygen, had been experienced. After some five years of service, trouble developed in both boilers and it had been necessary to renew a large number of tubes, particularly in the port boiler where over half of the tubes were affected. Efforts to trace the cause revealed a substantial loss of vacuum in the port condenser which had previously been masked because the machinery had been run with the condensers coupled. The port condenser vacuum loss was up to 2in. of mercury under steady steaming at full power and considerably worse (3 or 4in.) under manœuvring conditions. Attempts to locate air leakage in the system had not been successful and the vacuum loss still existed when the present measurements were started.

Fig. 6 shows the first record obtained from Ship D, during a coastal passage which consisted entirely of manœuvring or reduced speed running in fog. Levels from the starboard condenser were normal under these conditions, varying between 0·05 and 0·25 p.p.m. but the level on the port side failed to come within the range of the recorder, remaining above 0·70 p.p.m. The corresponding vacuum readings were: starboard between 29·1 and 29·4in. of mercury, port between 25·4 and 26·3in. of mercury. The effect of coupling the condenser steam spaces was tested (between 09.20 and 09.45 hrs. in Fig. 6), when oxygen levels measured at the starboard extraction pump rose to approximately 0·60 p.p.m. and the vacuum equalized at 28·2in. of mercury.

The records in general confirmed the presence of a serious air leak somewhere in the port condenser or L.P. turbine which would allow highly aerated feed to reach the boilers. Further efforts to locate the leak were made and at the first opportunity the faces of the flanged joint between port condenser and L.P.

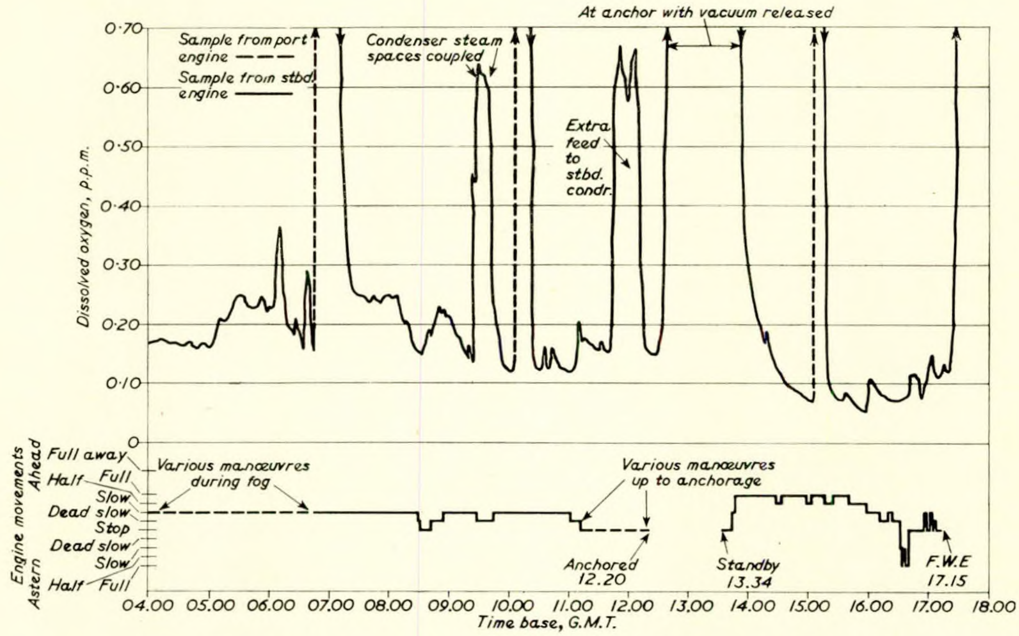


FIG. 6—*Dissolved oxygen record from Ship D during a coastal passage*

turbine were coated with an epoxy resin to provide a temporary seal on any leakage there.

The effectiveness of this treatment was indicated by the oxygen measurements taken during the next voyage. Manœuvring at the start of the voyage produced no significant change in either oxygen or vacuum, but after several hours at full power the port oxygen level had fallen to about 0·02 p.p.m. The vacuum also improved to 28·9in. of mercury. Corresponding starboard readings were 0·01 p.p.m. and 29·0in. On manœuvring at the end of the passage the port oxygen level did not go above 0·07 p.p.m. Thus it appeared that a faulty joint between the L.P. turbine and condenser accounted for a large part of the air leakage, although high oxygen levels and a poor vacuum were still present at the start of the voyage.

Effect of Manœuvring

The regenerative condenser becomes inefficient as a de-aerator, when the main steam flow is reduced, since the condensate temperature will fall unless the main cooling water flow is also reduced. Air leakage through glands is also likely to be greater under manœuvring conditions. The effect of very high short term oxygen levels on boiler tube corrosion is not really known although it is generally felt that they are of importance where the service of the ship demands frequent shutdowns of the main machinery.

To investigate the effectiveness of a separate de-aerator oxygen measurements were made on a cross-channel vessel fitted with a direct-contact spray-type de-aerator. For this trial two oxygen meters were used, one taking a sample from the air ejector condenser and the other from the de-aerator extraction pump.

The vessel, Ship E, was engaged in a cross-channel service consisting of a single round trip per day of 1½ hours steaming each way, including manœuvring. Fig. 7 is a typical record

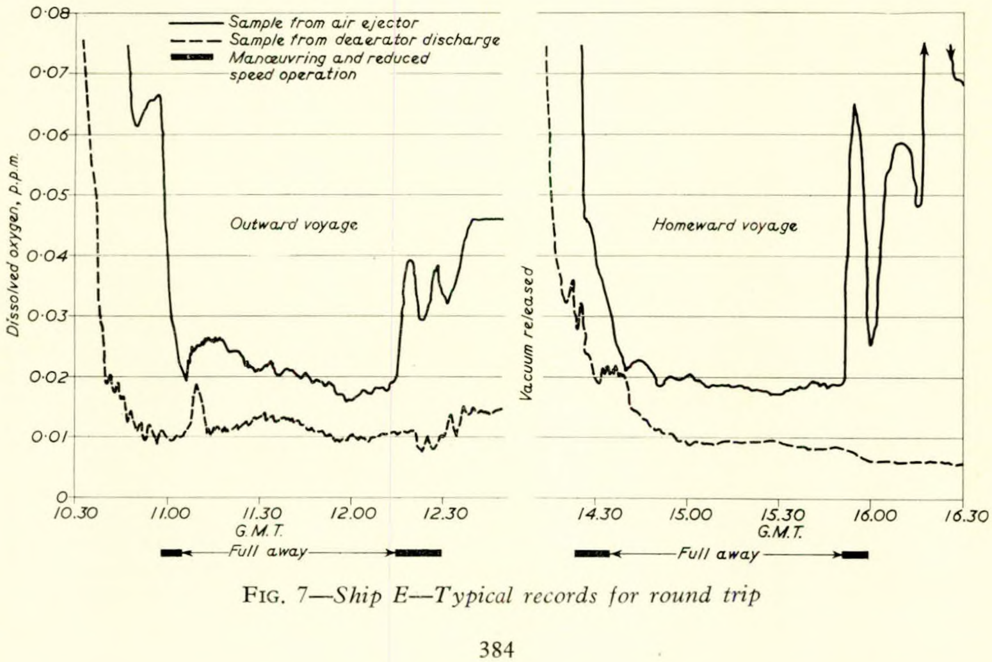


FIG. 7—*Ship E—Typical records for round trip*

from this vessel showing simultaneous readings of dissolved oxygen at the air ejector and after the de-aerator. It will be noticed that the oxygen level in the sample from the air ejector remained high from the time of raising the vacuum to the commencement of manœuvring, but fell rapidly to the low level of 0·02 p.p.m. at or just after full away. This level was maintained until the first speed reduction; whereupon a rapid increase in level occurred due to the automatic admission of make-up feed to the condenser. After a short period of manœuvring the level rose to 0·04-0·05 p.p.m. and the vacuum was released. The record for the homeward run was similar except that the first peak was greater. The second and third peaks occurring at the end of the homeward passage were caused by extra feed introduced into the system to raise the water level in each of the two main boilers prior to shut-down for the night.

In the sample from the de-aerator, the dissolved oxygen level fell very soon after start-up, so rapidly in fact that the level could be reduced to about 0·02 p.p.m. before the main feed pump was started. Generally, the oxygen concentrations recorded at the de-aerator discharge remained in the range 0·006 to 0·015 p.p.m. irrespective of the fluctuations in oxygen content in the condensate system.

In certain other records from this ship the levels at the air ejector during steady steaming were somewhat higher, sometimes 0·03 to 0·04 p.p.m. but the same general pattern recurred repeatedly. Nearly all records showed the oxygen concentration at the de-aerator discharge to be in the range noted above, namely 0·006 to 0·015 p.p.m. under all conditions. Thus, the de-aerator was especially effective during manœuvring and standby. An additional advantage was that prior to shut-down the boilers could be topped-up with de-aerated water, a feature of particular value in a vessel engaged in intermittent service.

CARBON DIOXIDE AND AMMONIA

A common mode of boiler tube failure is by overheating of the tube wall beneath a deposit of sludge or corrosion product having its origin at some place away from the point of failure. That tube failures can occur in this manner is well known and it is accepted that the bulk of the deposit is the product of corrosion in the condensate/feed water system. If the deposits are voluminous, overheating may occur through restriction of circulation, but the more likely cause in marine boilers, where large accumulations are not normally found, is the formation of hard, glass-like scales which, although very thin, have an extremely high thermal resistance. Analysis of such scales clearly indicates the origin of their main constituents as the ferrous and non-ferrous metals in the pre-boiler system.

When dissolved oxygen has been reduced to normal levels, dissolved carbon dioxide, or carbonic acid, is mainly responsible for corrosion in the condensate/feed water system.

Carbon dioxide can exist in water in three forms:

a) Chemically combined in the form of bicarbonates and carbonates.
b) As the free carbon dioxide needed to keep these in solution.
c) Any excess.

It is the excess, known as the "aggressive" carbon dioxide, which is responsible for corrosion of ferrous and non-ferrous metals.

Although carbonic acid is a weak acid it nevertheless provides ample hydrogen ion concentration to promote acid corrosion and, as feed water consisting principally of condensate is an unbuffered solution, the *p*H value may be lowered appreciably by small amounts of CO_2. Conversely, the presence of small amounts of alkaline salts or ammonia, carried over with the steam, will neutralize the acidity caused by CO_2.

Sodium carbonate, when added to feed water as part of boiler water treatment, is an important source of CO_2. The decomposition of this compound is evinced by the appearance of caustic alkalinity in the boiler water, and by the acidity of the condensate. Another source of contamination is the make-up feed. Evaporated make-up feed contains dissolved carbon dioxide from decomposition of carbonates in the raw water, as well as oxygen. Sea and fresh water can contain appreciable amounts of calcium bicarbonate and the resulting effluent may contain several p.p.m. of carbon dioxide. If the carbon dioxide content of make-up feed is to be materially reduced, an ion-exchange plant must be used. In ships of moderate size it is probably more practical and economic to secure protection from aggressive make-up feed by neutralizing the carbonic acid within the feed system by chemical treatment.

Because of the uncertain corrosion potential of any CO_2 concentration under any given conditions, it is usual to assess the aggressiveness of condensate by measuring the *p*H value and to base remedial treatment, within the system, on *p*H control. Practical methods of safeguarding plant from attack by aggressive condensate aim, therefore, at maintaining an alkalinity of from 8 to 9 *p*H throughout the condensate/feed system. The desirability of providing this alkalinity at the point of initial condensation within the L.P. turbine suggests the use of a volatile neutralizing agent. Materials used for *p*H control are ammonia and the volatile amine cyclohexylamine.

The objections of boiler operators to the presence of ammonia in the feed system have mostly disappeared. These objections were based on the known corrosive effects on copper and copper alloys of ammonia concentrations well above the range normally encountered in boiler plant. In fact, in small amounts, ammonia inhibits the corrosion of metal by acid-bearing water.

Ammonia may result from decomposition of other treatment chemicals, such as hydrazine. Hydrazine, primarily a de-oxidant, can thus by means of its decomposition product, ammonia, perform the function of *p*H raiser. In addition, ammonia from decomposition provides a means of controlling hydrazine dosing as the rate of decomposition is, in general, dependent on the reserve of hydrazine in the system. Thus, if the feed rate of hydrazine is greater than the dissolved oxygen content of the feed water requires, the increased reserve will lead to increased decomposition, which can be detected by a *p*H meter at the condensate extraction pump. The rate of hydrazine feed can then be adjusted to obtain the desired reserve and, simultaneously, to maintain the condensate at a *p*H value of 8·5 to 9·0.

Dissolved sulphur dioxide, or sulphurous acid, from decomposition of the chemical de-oxidant sodium sulphite, can contribute to the corrosiveness of condensate. The degree of decomposition which occurs, depends on the sulphite concentration, the *p*H of the boiler water and the boiler pressure. There is no statement in the literature that sodium sulphite is unsatisfactory in this respect at pressures below 650lb./sq. in., so that little harm should result from its use in low and medium pressure boilers. Nevertheless, the sulphite dosage should be limited to as low a rate as possible consistent with removal of oxygen. Sodium sulphite in its role as oxygen scavenger has itself been subject to conflicting experience.

REFERENCES

1) "Corrosion of Iron and Steel by Industrial Waters and its Prevention". Iron and Steel Institute Special Report No. 41, 1949.

2) ARDEN, T. V. and BLIGHT, F. C. 1962. "The Treatment of Water for High Pressure Marine Boiler Feed". Trans. I.Mar.E., Vol. 74, p. 525.

3) "British Standard for Treatment of Water for Marine Boilers". British Standards Institution. B.S. 1170. 1947.

Correspondence on "Machinery Induced Vibrations"

Further contributions to the discussion on the paper by Dr. A. J. Johnson, B.Sc. (Eng.), A.C.G.I. and Mr. W. McClimont, B.Sc. (Member), published in the April 1963 issue of TRANSACTIONS *(Volume 75, page 121) have been received and are given below, together with a reply by the authors.*

MR. J. HOARE (Associate Member) wrote that his comments concerned the practical achievement of the requisite support and the control of wear at the stern tube as those were major factors in the reduction of vibration in the shaft system. The research and development section of the firm of engine builders with which he was associated, had been studying these matters for an appreciable time. The conclusions from their work were very much in line with the remarks on this aspect given by the authors on page 139 in the concluding paragraph of the section headed "Transverse Vibrations of Shafting Systems". Furthermore, a special design of stern tube bush, of the white metal lined, oil lubricated type had been proposed embodying the principle where the restraint of shaft freedom provided a reduction of vibratory movement of the shaft. As explained in Part I of the paper, such movement of the shaft was due largely to the torque fluctuations arising from the passage of the propeller blades through the disturbed wake trailing the stern post. Due to a comparatively rapid wear down characteristic, the supremacy of lignum vitæ stern tube linings had been challenged in recent years by the introduction of synthetic materials but even these were not resistant to the abrasive action of sand. When new, the clearance in such bearings was usually made about 0·060in. and shipowners were obliged to accept as inevitable the rapidly increasing clearance and tolerate the accompanying vibration until the wear down amounted to ¼in. when renewal was necessary. Depending on the trade of the vessel, wear down to a point of renewal was more or less rapid and there were many instances where re-wooding was a bi-annual event. All detrimental action of this kind was eliminated when a white metal lined, oil lubricated, stern tube bush was employed. There was also a substantial reduction in the coefficient of friction.

It was claimed that the new design provided both for improved support and longer service life free from the advent of undesirable vibrations caused by the rapid wear down associated with earlier designs using lignum vitæ or similar synthetics.

The design principle was based on the use of two separate stern tube bushes, forward and aft, each provided with eccentrically bored sections as shown in Figs. 54 and 55.

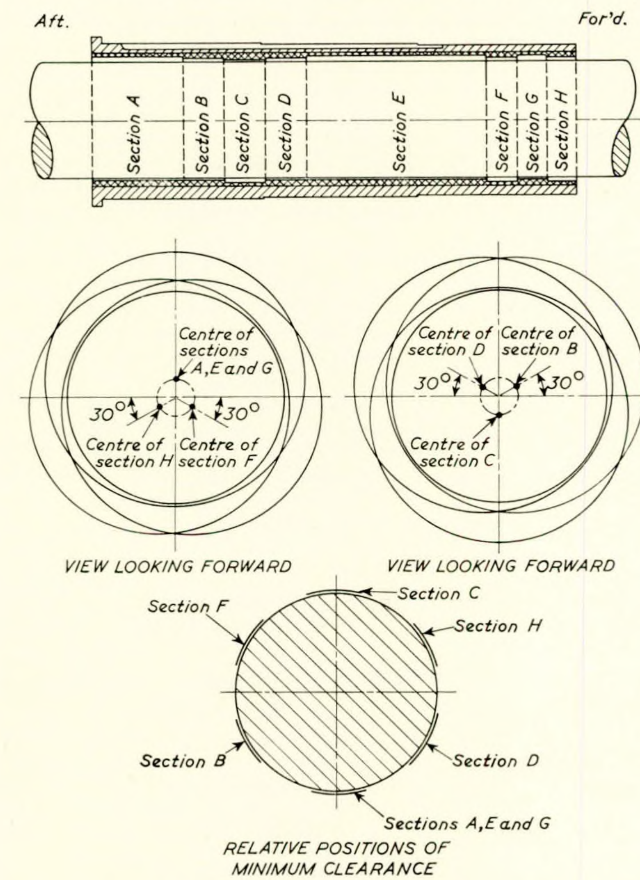


FIG. 54—*Camella stern tube—Aft bush*

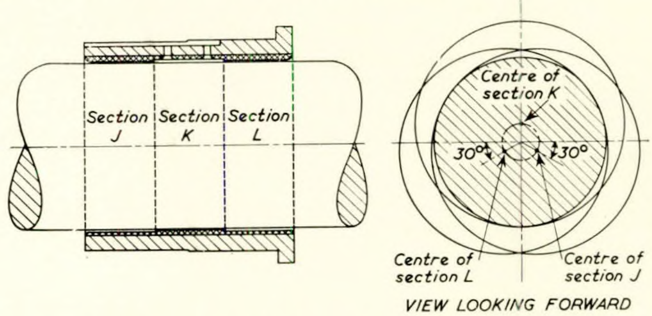


FIG. 55—*Camella stern tube—Forward bush*

The stern tube bush could have eight eccentric sections as shown in Fig. 54. The effective combined weight of the propeller and shaft was shared by sections A, E and G, which were placed eccentrically with respect to the axis of the shaft so that their positions of minimum clearance were on the bottom centre. There were three restraining sections at B, C and D spaced at 120 deg. to each other and arranged so that the minimum clearances of sections C were at the top centre of the shaft. Sections B and D were therefore effective at 60 deg. from the bottom centre on the port and starboard sides respectively and their purpose was to provide side restraint as close to the propeller as possible.

Forward of the main load carrying section the length of the bush was divided into three main sections F, G and H of equal length and arranged eccentrically making F and H positions of minimum clearance at 60 deg. from the top centre on the port and starboard sides while section G provided the third position giving additional support to the shaft on the bottom centre.

A typical design of forward bush was shown in Fig. 55. Three equal sections J, K and L were arranged so that the centre was supporting the shaft.

These stern tube bearings were designed to allow a decrease in the temperature of the stern tube by at least 80 deg. F. without approaching seizure.

The effect of these provisions was to provide a restricted clearance for a shaft of 24-in. diameter of about 0·013in. whereas in contemporary white metal lined bushes this would be about 0·030in. In vessels built for coastal and harbour services where the risk of shrinking the stern tube on the shaft was absent the clearances might be reduced considerably with absolute safety.

The stern tube bushes were of gunmetal lined with high grade white metal and in order to provide the maximum area for adhesion the bore of the gunmetal bush was machined in the form of a coarse right and left hand thread of circular form as shown somewhat exaggerated in Fig. 56. The shaft did not normally have a liner.

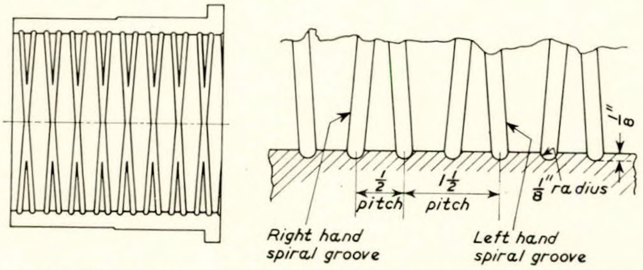


FIG. 56—*Internal grooving of stern tube bushes prior to white metalling for Camella bearing*

Oil seals were fitted at each end of the stern tube and the supply of lubricating oil was from a gravity tank having sufficient head to ensure that the pressure in the stern tube always exceeded the pressure of the external water. Oil was admitted to the stern tube through a connexion in the after peak and conveyed along a groove cut in the back of the bush to an entrance position close to the after end of the load carrying section of white metal. The oil groove could be bifurcated just before the oil inlets so as to provide a duplicate channel as a safeguard against obstruction. The oil inlets could be duplicated for the same reason. This feature was shown in Fig. 57. There was an oil leak-off connexion at the forward end of the stern tube, leading to the drain tank, the working level of which was maintained constant by a pump discharging to the gravity tank. The pump might be either independently driven by an electric motor or driven directly from the main shaft. This was shown in the general arrangement, Fig. 58.

Stern tube bushes did not have the limitation of length that was frequently the case with either types of bearings and consequently there was scope for a selective subdivision of length into eccentric sections to ensure that the shaft was provided with adequate support and restraint at optimum positions circumferentially and along its length. In addition the bushes could be slope bored to conform to the deflected

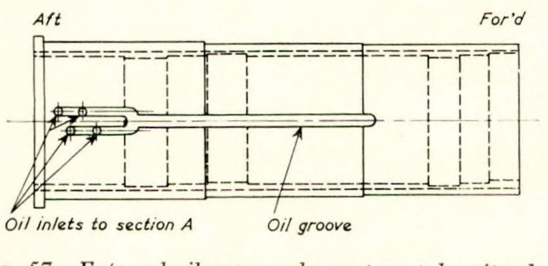


FIG. 57—*External oil groove along stern tube after bush*

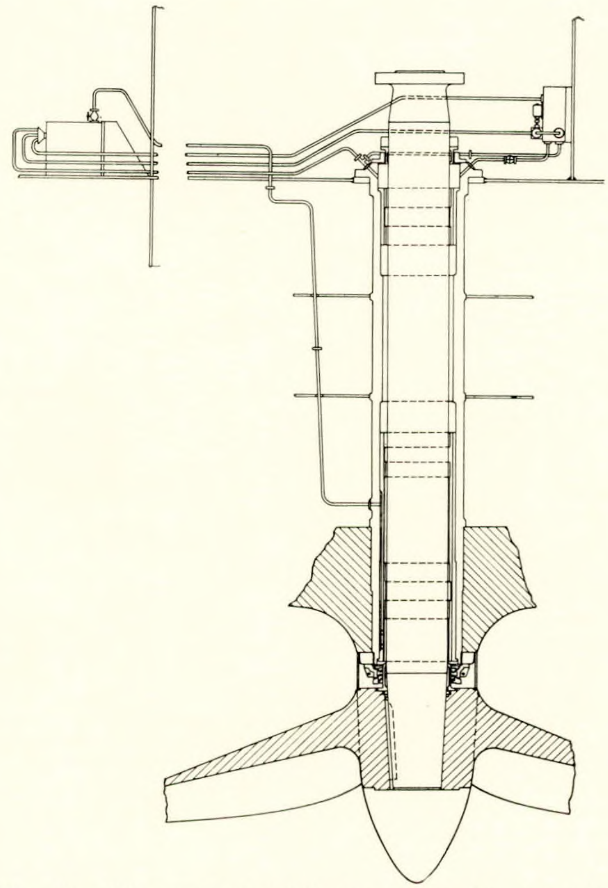


FIG. 58—*Diagrammatic lubrication system for stern tubes*

axis of the shaft which made no difference to the incorporation of the eccentric bores in achieving the above advantages.

To sum up, therefore, this design of stern tube arrangement was capable of reducing vibrations and frictional losses, of providing adequate support and restraint and together these meant a smooth running shaft system with the expenditure of slightly less power accompanied by a proportional saving in fuel costs without the rapid rate of wear down formed with wooded or similar types.

This development had several promising characteristics when considered in the context of the very able and understandable paper, to the authors of which he was most indebted.

MR. A. HILL wrote that he had found the paper extremely interesting and useful, also outstanding for the amount of factual information given. The authors had taken considerable pains to set out the information in accessible form which deserved the gratitude of all busy engineers.

Unfortunately he had missed the opportunity of being present for the discussion but ventured to write now with one or two comments.

Having been very much interested in thrust block design, and manufacture some years ago, he was most interested in the authors' remarks concerning axial vibrations.

In Fig. 24 was shown a typical thrust block and seating structure which by their design resulted in heavy bending moments and consequent large structural deflexions. He had long felt that builders gave quite insufficient attention to the design of thrust block seatings and even, in the case of certain wartime classes, to the building.

The usual seatings tended to be too short in a fore and aft direction and the seating shown in Fig. 24 had this defect. Admittedly the provision of long fore and aft girders was difficult in the days of riveted seatings due to the usual bulkhead, but there should be no problem in these days of allwelded structures. Whilst it might not be possible to extend the seating at the forward end due to the gearcase, there was no reason why it could not be extended over many frame spaces aft and indeed it could be combined with the forward tunnel bearing seat as indicated in Fig. 59.

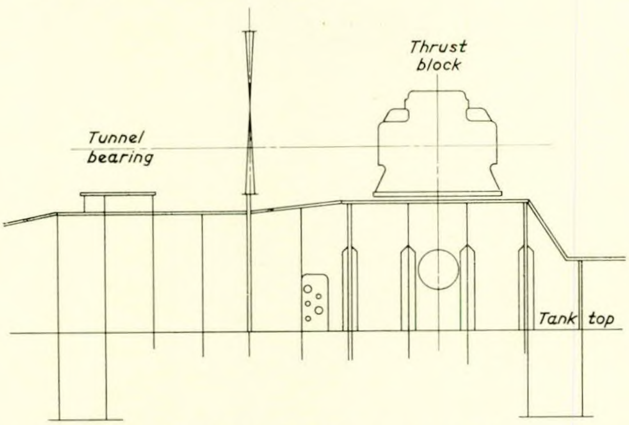


FIG. 59—*Suggested stiffening of seating*

Whatever was done to improve the seating, there remained considerable bending moment and consequent deflexion due to the design of thrust block. Although with a stiffer seating the total deflexion would be less, a somewhat higher resonant frequency would result and this itself might prove awkward.

A side effect of the deflexion occurring with thrust blocks having rigidly mounted thrust pads was that the load was not shared evenly between the pads. Deflexion of the block seating resulted in a transfer of load from the upper pads to the lower, so that instead of the load being shared uniformly, the lower pads carried almost the entire load and the upper were virtually unloaded. This was not likely to have any ill effects upon the pads themselves, since the lower pads would still have ample margin of safety, even if carrying almost twice the expected unit loading. But it did result in eccentric loading of the shaft which would tend to deflect in a vertical plane, increasing the load on the aft gearcase bearing and reducing it on the forward tunnel bearing.

These deflexions would probably be of a small magnitude but might well prove of importance under resonant conditions.

He considered that a much better design was for the thrust block to be supported at, or near the centreline and if this was done, then the seat could be designed as a relatively light girder structure where the top flange was practically under pure tension. This arrangement was illustrated in Fig. 60.

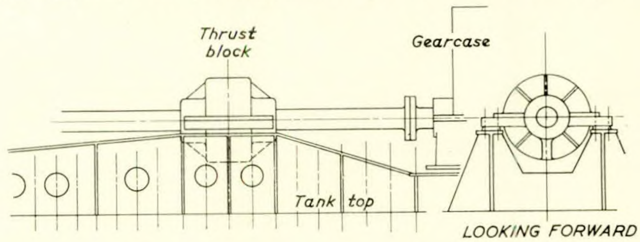


FIG. 60—*Arrangement of centre line*

This design not only tended to limit axial deflexion and vibration but also resulted in a better distribution of load on the thrust pads. He remembered being impressed by the design of the German Z Class destroyers during the war. These vessels had thrust blocks of this type, and the whole design of block and seating was extremely compact and much lighter than equivalent British vessels.

Incidentally it was probably most advantageous to place the thrust blocks further aft than was usually done at present, since not only was the length of shafting affected by axial vibration thereby reduced and therefore the resonant frequency raised, but there was improved flexibility between the thrust block and gearcase so that the latter was less likely to be influenced by any seating distortions.

He had often heard it reported that vessels ran more smoothly when the hydraulic type thrust meter was in operation. This could be due to the change in "stiffness" of the thrust block, or could be due to the load being shared evenly between the pads, removing any tendency to eccentric loading of the shaft. He would like to know if the authors had experienced this in their various trials. This was quite distinct from the case where a specially designed hydraulic resonance changer was used.

He wished to state that the foregoing remarks were entirely his own and not associated with any company.

Authors' Reply

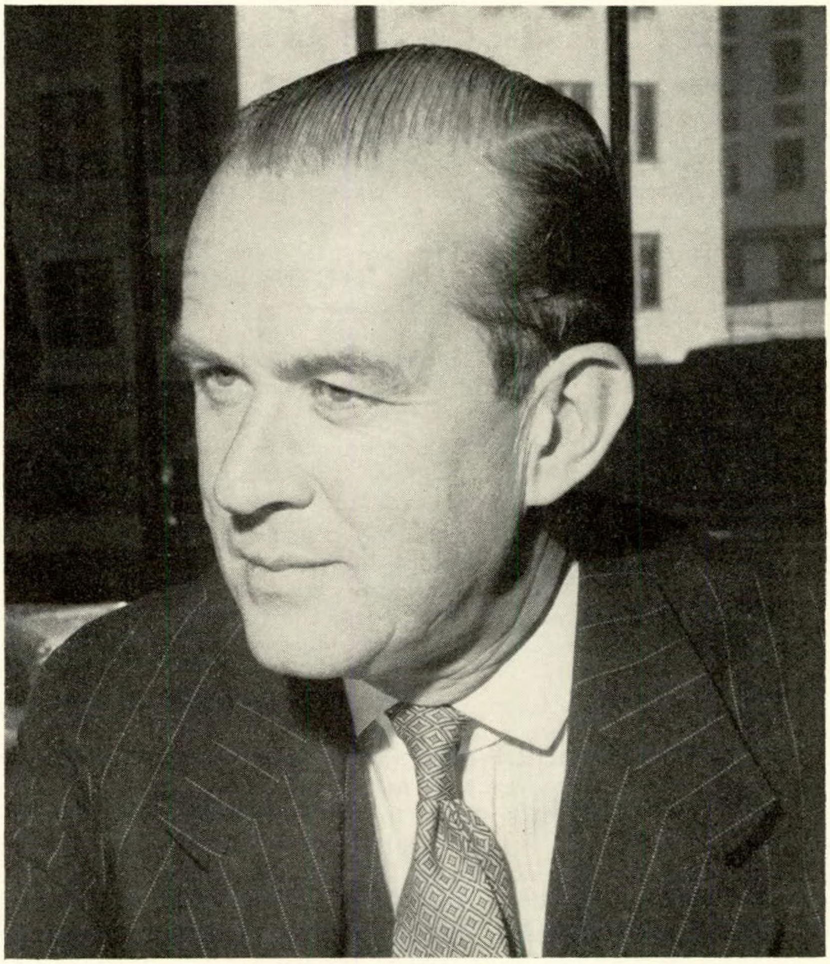
The use of lignum vitæ as a stern tube bearing material had disadvantages and these were not overcome by the use of synthetic materials such as resin-bonded asbestos pads. Clearances using these materials must be relatively large, a condition which was conducive to transverse vibration of the shaft and weardown was generally relatively rapid, thereby increasing the vibration problem. However, lignum vitæ had the great advantage of being water-lubricated, with consequently no sealing problems and it had been sealing problems which had retarded the use for so many years of oil-lubricated stern bearings in the larger sizes. This point appeared to have been overlooked in Mr. Hoare's observations.

If the decision was taken to use an oil-lubricated bearing, the employment of minimum diametral clearance was exceedingly desirable to ease the sealing problem. A by-product of the reduced clearance was the beneficial effect on tailshaft vibration characteristics. However, although bearing loadings were low and consequently eccentricity ratios were low, conditions which would normally permit the use of small diametral clearances, there were two conditions which limited the use of small clearances. The first was the potential temperature difference between shaft and bearing when cold sea conditions had to be considered and the second was the use of only a small gravity head to produce oil circulation in the bearing. It was to overcome the limitation imposed by this latter condition that the Camella arrangement appeared to have been designed, and it would probably be reasonably effective. However, it appeared to be an exceedingly complex way to achieve the objective.

The authors concurred with Mr. Hill's remarks concerning the deficiencies often encountered in the design of thrust block seatings; they would add that lightening holes might profitably be banned as they provided much more unwanted flexibility than was generally recognized.

Whether the arrangement shown in Fig. 60 would achieve the benefits for which it was designed was doubtful. So long as the thrust block/thrust seating structure was a cantilever built into the double bottom structure it would have the characteristic deflexion profile of a cantilever irrespective of the positions of the horizontal joints in the structure; inevitably, therefore, there would be uneven distribution of loading between the upper and lower pads.

The equal sharing of loads between pads which was achieved by the use of a hydraulic type thrust meter should have beneficial effects on the aft gearcase bearing and consequently on the meshing of the final reduction teeth. The authors had gained the impression that this could often be noted on a ship but had no data to substantiate this impression.



SIR NICHOLAS CAYZER, Bt.

SIR NICHOLAS CAYZER, Bt.

William Nicholas Cayzer was born in Ayrshire in 1910, the elder son of Sir August Cayzer, Bt., Chairman of Cayzer, Irvine and Co. Ltd. and the Clan Line Steamers Ltd. from 1918-1943. He was educated at Eton and Corpus Christi, Cambridge, and in 1935 married Elizabeth Catherine, daughter of the late Owain Williams, and has two daughters. On the death of his father in 1943 he succeeded to the baronetcy.

In January 1931, he entered the business and served in the London, Glasgow and Liverpool offices of Cayzer, Irvine and Co. Ltd. He became a Director of Clan Line Steamers Ltd. in April 1938, and a Director of Cayzer, Irvine and Co. Ltd. in January 1939. While serving in Liverpool he was a Director of Martins Bank Ltd. and the Sea Insurance Co. Ltd. He is a Director of the London Assurance which now incorporates the Sea Insurance Co. Ltd. He was Chairman of the Liverpool Steam Ship Owners' Association from 1944 to 1945.

In 1947 Sir Nicholas transferred to London, and on the death of Major Harold Cayzer he became Vice-Chairman of the Clan Line Group under the Chairmanship of the late Lord Rotherwick.

He took a leading part in the negotiations which led to the merger of Clan Line Steamers Ltd. and the Union-Castle Mail Steamship Co. Ltd. from which the British and Commonwealth Shipping Company came into being, and shortly afterwards became Deputy Chairman of that Company and the other principal Companies of the Group. He became Chairman on the death of his uncle, the late Lord Rotherwick, in March 1958.

Sir Nicholas has been a Council member of the Chamber of Shipping of the United Kingdom since 1947, and was a member of the National Dock Labour Board from 1947 to 1952. He has served on various Committees connected with the shipping industry and acted for ten years as Liaison Officer between the Admiralty and the shipping industry in regard to Defence for Merchant Shipping.

In 1959 Sir Nicholas was President of the Chamber of Shipping of the United Kingdom and Chairman of the General Council of British Shipping. He is Chairman of the British Liner Committee and of the Policy Committee of the General Council of British Shipping. He also sits on the Minister of Transport's Shipping Advisory Panel. Sir Nicholas is on the Committee of the training ship *Worcester*, and is a Director of the Commercial Bank of Scotland and other Companies.

PRESIDENTIAL ADDRESS

of

SIR NICHOLAS CAYZER, Bt.

As a shipowner I am, of course, very much interested in the work of the Institute of Marine Engineers. Shipowners have many problems today, and not the least of these are to see that they build the right ships and that in the technical sphere, as in other spheres, they are operated by the right personnel. In particular this evening I want to turn your attention to the engine room and to the engineers afloat and ashore who take the responsibility for the correct design and operation of the installation.

During this century we have seen considerable change in progress in ships' machinery; at the beginning of the century the compound steam engine was being superseded by the triple expansion engine, and this was shortly followed by the steam turbine. Between the wars we saw the Diesel engine taking its place alongside these other forms of propulsion. The present picture, as you are all well aware, is that with very few exceptions all new installations are either Diesel or steam turbine. Other prime movers, such as the gas turbine, have been tried but have not yet reached an economic stage of development. Fuel has also changed as time has passed. Before the late war coal had a place in ships other than as cargo. Today it has almost universally given way to oil, the use of boiler oil in Diesel engines being a considerable step forward in economy. Nuclear fuel is now in our sights, and while this fuel is not yet an economic proposition and is limited to special applications, I have no doubt that it will reach an economic stage and, of course, in the long term must do so, since while the known reserves of fossil fuels are very great and are still increasing, there must be a limit to these reserves.

Progress must continue. We in the shipping industry are subject to the same economic pressures as other industries and must continue to improve our productivity. There sometimes appears to be a feeling that productivity is something only the manufacturing industries are concerned with. This, of course, is fallacy. The service industries, which include the shipping industry, must continue to improve productivity by producing a better service with less use of man-power.

On the shipowning side, from my position, it appears that the areas in which progress is required are new and quicker methods of loading and discharging to increase the ship availability time; improved methods of preventing fouling and corrosion; improved reliability and improved systems of operation to reduce the man-power required. It is in these two latter fields in particular that this Institute has an important part to play. The layout, controls and instrumentation of the modern engine room are quite different from those of even ten years ago, and it is quite obvious from the discussions which arise that there is in these areas plenty of room for thought and development. Before the war I had never heard of Work Study; today it is commonplace, and particularly in regard to ships it has shown good results.

No matter how much care is taken in the original design of a machinery installation, how good the theoretical result achieved, and how good the shore organization may be, the practical result depends, and probably primarily depends, on the quality of the seagoing staff operating that installation, and I would like to say something on this aspect.

The twentieth century has seen many changes not least the growing standard of living for everyone. I hope this process will continue. This improved standard of living, the greater engineering opportunities ashore attracting men away from the sea, and the increasing complexity of modern installations have created serious problems with regard to the supply of Engineer Officers.

To my mind the problem can be broken down into three sections, first, attracting the right class of young man into the industry; second, seeing that he receives the proper training before and after going to sea; and third, retaining his services in the industry. The first and third aspects have many factors in common. To attract the right people into the industry we must project an image of a forward-looking industry which will provide adequate interest and full opportunity. We cannot project this image unless the industry and this Institute is forward-looking. It appears to me that we are in a quite exciting period in Marine Engineering development, and the most advantage must be taken of the opportunities with no nostalgic looking backwards. Similarly this Institute must in its organization and procedures not merely keep abreast, but must lead modern thought.

With regard to opportunity, the way to the Board Room should be open to those who serve afloat, whether on deck or in the engine room. We have done this in my own Company with conspicuous success. The technical and marine sides of a Shipping Company are vital, and to have these departments represented at top level is of the greatest assistance.

The general service conditions must be right, both on and off duty. I think one of the greatest steps forward has been the introduction of air conditioning. It has greatly added to the comfort and efficiency of ships' personnel, and it has now found its way into the engine room where it is possible to control the machinery from an air-conditioned control room.

With regard to training, the greater wealth and more time for leisure bring with them not only opportunities, but also pitfalls. It is no good creating a better paid and more leisured nation if this leads to a lowering of moral fibre. It is this attribute that has made Britain great, and if we lose it we shall be a small and probably impecunious island of no great consequence in the world. Each one of us, therefore, must be willing to give as well as to take, and our early training plays no small part in conditioning us. We must learn to play for the side and not just for ourselves. This requires a conscious effort to start with, for mankind is inherently selfish but nevertheless capable of rising to heights of considerable altruism if he is shown the way.

Now let us apply this thinking to a ship. If it is necessary to play for the side and work together ashore, if the best results for all are to be achieved it is ten times more necessary afloat if there is going to be a successful and happy ship. We teach those who choose the sea as their profession, whether deck or engineer officers, their job, but certainly in the case of the engineer little else. The cadets on the deck side have a number of pre-sea training establishments to choose from where they not only learn their profession but also work and play together and have inculcated into them a sense of team-spirit and *esprit de corps*. Young engineers lack this opportunity. I believe it would be an excellent thing, and a great step forward, if some of the pre-sea training establishments would start an engineering side. This would provide the opportunity for those who will have to work together to be trained together and have the same background experience. It seems to me that quite a lot has been done to get the right attitude and outlook into cadets who serve on deck—interim refresher courses that have a curriculum covering quite a wide field, opportunities of attending Outward Bound courses, and so on, but not enough has been done for the young engineer. Quite often cost is given as the reason for not going ahead with new schemes. This does not seem to me to bear inspection. Many of the accidents that happen, not only to machinery but also to personnel, stem from faulty outlook and training. I know in my own Company we have incurred heavy expenses and lost valuable time, and that serious injuries have occurred, on account of failure of the individual. It is time we gave the training of our young engineers serious thought from the moral as well as the technical aspect.

There is room for change for the better. If we are going to get the right response from those who serve afloat they must be given the opportunity of seeing what the Shipping Company they serve is doing. I am all in favour of bringing deck and engineer officers ashore for periods, not only to learn the shore administration of their particular section but also to get to know something of what goes on in the offices ashore and what are the problems and difficulties of administering a Shipping Company.

British shipping has still the largest active fleet afloat in the world. Whether this stage continues will depend on the quality of management in all its facets, and not least of these will be the alertness that we must lead and not follow in technical matters. We in this country have made the greatest progress when the pressure is on. Today British shipping is facing a great challenge. There is a danger living in these islands of being insular in outlook, and because of our past history and greatness being slow to change. We must accept change and turn it to good account. British shipping and shipbuilding have to face the fact that they must be more concentrated and must employ better management techniques than ever before. Both must look to bodies such as this Institute to supplement their own research, the practical and theoretical must work close together.

There are always the pessimists with us, but the future seems to me to hold a most exciting chapter for the shipowners. Certainly we British shipowners will have to put our best foot forward if we are going to keep in front, but meeting and overcoming difficulties is surely the spice of life.

The youth of this country is just as good as it ever was—perhaps better—but it does need inspiration and leadership. A great responsibility therefore rests on the shoulders of the older generation to see that this is not lacking. The position of Great Britain since the war has changed, and continues to change radically. We are more dependent today on our skills and inventiveness than for many generations. We cannot rest on our past greatness. Our future will depend on our ability to meet change in a changing world.

INSTITUTE ACTIVITIES

Minutes of Proceedings of the Ordinary Meeting Held at the Memorial Building on Tuesday, 1st October 1963

An Ordinary Meeting was held by the Institute on Tuesday, 1st October 1963, at 5.30 p.m. Commander F. M. Paskins, O.B.E., R.D., R.N.R. (Chairman of Council) was in the Chair supported by Mr. W. Young, C.B.E. (Vice-Chairman of Council), Mr. J. Calderwood, M.Sc. (Honorary Treasurer) and Mr. J. Stuart Robinson, M.A. (Secretary) and ninety-eight members were present.

The CHAIRMAN said it was a great pleasure and privilege to introduce the President, Sir Nicholas Cayzer. Sir Nicholas had been born into a great shipping family and he had lived his life for and in shipping. Initially his interests were in the Clan Line Steamers Ltd.—which was founded by his famous grandfather—and more recently in the firm of British and Commonwealth Shipping Co. Ltd., of which he had been its Vice-Chairman. Among other interests Sir Nicholas was now the Chairman of both the British and Commonwealth Shipping Co. Ltd., and the Clan Line Steamers Ltd. He was also a member of the Chamber of Shipping Council, and had been a President of the Chamber of Shipping.

He called on the President, Sir Nicholas Cayzer, to deliver his Address.

The PRESIDENT, Sir Nicholas Cayzer, Bt., then delivered his Address.

The CHAIRMAN said he was sure that it would be the wish of the meeting that he should thank the President for his most interesting and valuable speech. Sir Nicholas had made a great contribution to the efforts of furthering the interests of marine engineers. His words, and the knowledge of his backing, gave the Council tremendous encouragement to go forward in their efforts to carry out far reaching ideas.

He expressed appreciation at Sir Nicholas' words concerning the training of engineer cadets. If only the scheme outlined by Sir Nicholas for a Marine School or College with full residential facilities, which would specialize in the initial study and training of cadets and officers of all departments, could be developed, it would be of tremendous value. The results would be immensely valuable to all and would help form a much happier and efficient ship's company and, indeed, a happier shipping company. However, such a scheme would never be a success unless marine engineers co-operated whole-heartedly. The shipping industry was going through a difficult period, but now was the time to show the industry and the shipowners that the marine engineers would play their part. For so long they had been their own worst enemies. However, he was sure that they were men who were very loyal, conscious of their responsibilities and fully appreciative of all the advancements which had been made for their benefit. They would play their part whole-heartedly in the scheme which might be ahead.

He said it gave him the greatest of pleasure to propose a vote of thanks to the President for the valuable contribution he had made in the interests of marine engineers and the Institute of Marine Engineers.

The VICE-CHAIRMAN OF COUNCIL in seconding the vote of thanks said that it was more than forty years since he first went to sea, in a Clan Line steamer. He had been very pleased indeed to hear the degree of importance which the President had attached to the training of seagoing engineering staff. He was sure that everybody would agree that training was the most important subject to which they should address themselves. However, so far as he could see, there was no unanimity on how this should be accomplished. There was no doubt whatsoever that the views the President had expressed would be an excellent guide.

He had recently had the opportunity of visiting one of the newer units of the wonderful fleet which the Clan Line Steamers were building up, and had been tremendously impressed, not by the progress that had been made since he first went to sea on a Clan Line steamer forty years ago, but by the inspiration which the staff had from the President. All the work which had been accomplished had been, and would remain, an inspiration to every engineer.

One could not indulge in experimental work of this nature except at very considerable cost, and this was one of the important contributions which had been made by the President who was, after all, the man who had to foot the bill.

They were fortunate indeed that they had available to the Institute the energy and vision of such a person as the President. There were a great many problems facing the Institute, which he did not think he need enumerate, but having someone standing behind them with the wealth of experience which the President could bring to bear, would help them forward in dealing with all the manifold problems with which they were faced.

The President's Address had been a challenging one indeed, and he had no doubt that the challenge would be accepted to the great advantage of the Institute. He felt sure that the year of office of the President would be a stimulating one, and everyone looked forward to the help which they knew the President would give to the Institute.

The vote of thanks was carried by acclamation.

The PRESIDENT thanked the Chairman and the Vice-Chairman for the kind things they had said, and the meeting for the way the remarks had been received. The Vice-Chairman had said some flattering things about his (the President's) company, but he knew that in his own company any success they had had was because they had worked together as a team and because he had been backed up by very loyal and extremely efficient people. Without their help he did not think the company would have got very far at all. That, perhaps, was really what he was trying to say in his Address, that is, it was not only just a question of knowing how to do things; it was knowing how to do them together. It was co-operation, loyalty and understanding between man and man which made for progress. That was, he thought, what was needed today more than anything else in this country if there was going to be a future for it.

Autumn Golf Meeting

The Autumn Golf Meeting was held at The Berkshire Golf Club, Ascot, on the 3rd October 1963. Forty-six members took part in a Stableford Competition in the morning and a Stableford Greensome Competition in the afternoon.

The prize winners and leading scorers were as follows:

Morning Competition

1st Prize	Cdr. J. White, D.S.C., R.N.	36 points
	(better score over the last 9 holes)	
2nd Prize	J. F. Watson, B.Sc.	36 points
	J. G. Belsey, O.B.E., B.A.	35 points
	C. J. Probett	34 points
	G. E. Dunk	34 points
	Cdr. A. B. Dickie, R.N.	32 points
	T. L. Kendall	31 points
	R. R. Strachan	30 points

Afternoon Competition

1st Prize	D. G. Welton / G. M. McGavin	35 points
2nd Prize	P. S. Rosseter / P. C. Smith	34 points
	(better score over the last 9 holes)	
	W. J. S. Glass / Cdr. A. B. Dickie, R.N.	34 points
	A. Simpson / R. K. Craig, C.B.E.	31 points
	A. Walker, M.A. / Lt. Cdr. J. E. Bowell, R.N.	31 points
	Cdr. J. White, D.S.C., R.N. / A. Fowler	30 points
	G. E. Dunk / K. Grant	30 points
	J. G. Belsey / Cdr. R. G. Wood, R.N.	30 points

Mr. Stewart Hogg (Chairman of the Social Events Committee), distributed the prizes and thanked the Secretary and Committee of the Berkshire Golf Club for their hospitality in allowing the members the use of the club for the day. He announced that the next meeting would be at the New Zealand Golf Club, Woking, on the 3rd June 1964.

Section Meetings

Colombo

A meeting of the Section was held on Friday, 20th September 1963, at the Volunteer Naval Force Headquarters, Colombo, Ceylon at 9.00 a.m.

Forty-eight student/apprentices in marine and other allied engineering trades, were met by Committee Members at the above venue and were conducted to the workshops of Messrs. Walker Sons and Co. Mutwal, Colombo. The students, in two parties were taken round the workshops by representatives of the company.

The visit was arranged by kind permission of the management and the Assistant Works Manager, Mr. A. J. Hill (Associate Member), a member of the Section Committee.

On completion of this visit, by permission of the Chief Engineer, Colombo Port Commission, the student/apprentices were taken round on a conducted tour of the dry docks and the dock pump house. After this, they visited the s.s. *Malakand* which was berthed at the south oil fuel jetty. This visit was arranged by courtesy of the agents Messrs. Delmege Forsythe and Co. Ltd.

The party then returned to the venue where they were entertained to lunch by the Section. After a short interval two films of technical interest entitled "Basic Principles of Lubrication Part I and II" and "Nuclear Ship *Savannah*" were screened by courtesy of Esso Standard Inc. and the United Information Service respectively.

The students were further entertained to tea and the meeting terminated at 4.00 p.m.

The Committee expressed their gratitude to the Captain of the Navy, Royal Ceylon Navy, for the use of the Volunteer Naval Force Lecture Hall and also to the Committee Members for their assistance in providing transport to make the visit a success.

Kingston upon Hull

The first technical meeting of the 1963/64 session was held on Thursday, 10th October 1963, when a lecture entitled "The Selection of Machinery for Small Ships" was given by J. B. Griffith, B.A. (Member), deputy managing director of Richard Dunston (Hessle) Ltd.

Mr. Griffith first outlined the various factors which can influence the choice of machinery and then went on to suggest many different arrangements of machinery which could be used for a particular vessel. The lecture was illustrated throughout by lantern slides.

A lively discussion then followed and although it tended to dwell on automation, it nevertheless proved interesting to all concerned.

A vote of thanks proposed by Mr. F. N. Sutcliffe (Member) was seconded by Mr. R. Rawlings (Member).

Chairman of the Section, Mr. G. W. Hill, M.B.E., was in the Chair and the audience totalled sixty-five. All in all a good start to the session.

North East Coast

Autumn Meeting

The Autumn Meeting of the North East Coast Section Golfing Society was held on Wednesday, 18th September 1963, at the Hexham Golf Club, Northumberland.

A Singles Stableford played in the morning for a new trophy was won by Mr. J. Y. Loveridge with a total of 36 points; Mr. P. H. Arthur was second also with 36 points. In the third place was Mr. L. Brown with 34 points.

The afternoon competition was a Greensome Stableford for twin trophies and these were won by Mr. E. Dimmock and Mr. C. J. Probett with 30 points. Mr. P. W. Winter and Mr. L. Brown came second with 29 points.

The Spring Meeting of the Society is to be played at the Tyneside Golf Club in May, the date to be notified later.

Joint Golf Match

A twelve-a-side golf match between the North East Coast Section Golfing Society and the Tees-side Branch of the North East Coast Institution of Engineers and Shipbuilders was held at Brancepeth Castle Golf Club on Saturday, 28th September 1963.

This was a successful event all round and the match result was a win for the Institute of Marine Engineers.

Joint Meeting

A joint meeting with the North East Branch of the Institution of Mechanical Engineers was held on Thursday, 10th October 1963 at the University of Newcastle upon Tyne, Stephenson Building, Newcastle upon Tyne, at 6.15 p.m. The audience numbered 112.

Mr. G. Yellowley (Chairman of the Section) was in the Chair and asked for approval of the Minutes of the previous meeting held on 4th April 1963, which was given unanimously. He then invited Dr. T. A. Bowden, B.Sc., (Member) Chairman of the North East Branch of the Institution of Mechanical Engineers, to take the Chair.

Dr. Bowden introduced the speakers, Mr. C. W. Herbert, M.I.Mech.E. (Member) and Mr. G. F. Milne, B.Sc., A.M.I. Mech.E. (Associate Member), who presented their paper entitled "The Application of Free-piston Gas Turbine Machinery to Marine Propulsion" in a brisk and clear manner. After the presentation Dr. Bowden called for contributors to the discussion and asked the authors to deal with questions seriatim in accordance with N.E. Coast custom.

The following contributors took part in the discussion: Mr. G. Yellowley (Member), Mr. A. Moiroux, Mr. S. M. Butler (Associate Member), Mr. E. Beale, Rear-Admiral J. G. C. Given, C.B., C.B.E. (Member) and Mr. M. Henderson.

In conclusion, Dr. Bowden proposed a vote of thanks in which his remarks included sincere appreciation to the Chairman and the Section for arranging the meeting and a tribute to the authors. Dr. Bowden thought that discussions on the sort of paper read that evening, were never better than when held in the North East and that the work of the authors was proof of the contribution which the North East Coast was making in engineering. He felt sure that the French colleagues present would agree. Dr. Bowden considered that the paper would become a classic.

The meeting closed at 8.25 p.m.

Scottish Section

General Meeting

A meeting was held on Wednesday, 9th October 1963 in the Weir Hall of the Institution of Engineers and Shipbuilders in Scotland, at 7.30 p.m.

Mr. L. D. Trenchard (Chairman of the Section) presided at the meeting and extended a warm welcome to the members and visitors present at the opening meeting of the session.

The Chairman introduced the speaker Mr. E. Holmes, A.M.I.Mech.E., F.R.S.A., who presented his paper entitled "Use of Models in Engineering Design".

The paper and the models shown, proved of great interest and a lengthy discussion followed which was ably dealt with by the author.

A vote of thanks to the speaker was aptly proposed by Mr. J. Laing.

The meeting terminated at 9.20 p.m. after which light refreshments were served.

Junior Meeting

A junior meeting was held on Wednesday, 30th October 1963, in the Weir Hall of the Institution of Engineers and Shipbuilders in Scotland, at 7.30 p.m.

Mr. L. D. Trenchard (Chairman of the Section) presided at the meeting and extended a warm welcome to the thirty-six members, students and guests present.

The Chairman introduced Mr. A. C. Bailey, B.Sc., who ably presented his paper entitled " Marine Electrical Engineering ". The paper gave an interesting picture of present day installations and an instructive discussion followed.

A vote of thanks, to Mr. Bailey for covering such a vast subject so well, was proposed by Mr. Hughes and carried with acclamation.

The meeting terminated at 9.10 p.m. after which light refreshments were served.

South East England

A general meeting was held on Tuesday, 15th October 1963, at the Clarendon Royal Hotel, Gravesend, at 7.30 p.m.

Mr. G. F. Forsdike (Chairman of the Section) was in the Chair and forty members and guests were present to hear Mr. C. C. Pounder (Past President) give a very informative lecture on "Present Marine Machinery Trends and other Cognate Matters"; the subject matter ranged from the earliest marine engines, through the development of steam and oil machinery, to the present day situation.

The audience was given a brief insight into related problems of machinery design and some of the means by which the designer of engine rooms, as complete entities, could manage to satisfy the specific requirements laid down by a shipowner.

The "Cognate Matters" dealt not only with the men who serve in the engine rooms, but with the progress of these men in their subsequent careers which lead them into so many different walks of life. Mr. Pounder stressed the point that it was not enough to be a good engineer but that one must also be a complete person, with interests not restricted or confined to matters solely connected with one's career.

Professional qualifications, integrity and ability were essentials, but equally so was the responsibility to oneself and the community, to take an active part in other spheres of interest.

After a brief interval, a series of related questions were put to Mr. Pounder and his replies, some brief, some at length, were full of the wealth of knowledge which he had accumulated during his many years in the marine engineering industry.

The Chairman proposed a vote of thanks to Mr. Pounder, which evoked the customary applause from an appreciative audience.

The meeting closed at 9.45 p.m.

South Wales

General Meeting

A meeting was held on Monday, 7th October 1963, at the South Wales Institute of Engineers, Cardiff, when a lecture entitled "Air Cushioned Vehicles" was presented by Mr. G. C. Keen.

Chairman of the Section, Mr. R. A. Simpson (Corresponding Member, Swansea), presided at the meeting which was attended by 105 members and guests.

Members of the Institute of Transport were the guests of the Section for the evening and the number present was supplemented by a coach load of engineer students who had travelled from Swansea.

The lecture, illustrated by slides and sound film, covered a new and topical subject and was well received by members of both Institutes. The several stages of development and the future possibilities of this mode of propulsion, both overland and sea, occasioned a very interesting discussion and the many questions were ably answered by Mr. Keen.

On behalf of the Institute of Transport, Mr. Sydney Evans thanked the Section for the opportunity of attending the lecture.

A vote of thanks to Mr. Keen for his interesting lecture was proposed by Mr. A. W. G. Long (Associate Member) and Mr. F. F. Richardson (Member) proposed a vote of thanks to the Chairman for presiding at the meeting.

Junior Meeting

A Junior meeting was held on Friday, 25th October 1963 in the Technical College, Swansea, at 7.00 p.m. when a lecture entitled "Marine Boilers" was given by Mr. W. Wilson.

Chairman of the Section, Mr. R. A. Simpson (Corresponding Member, Swansea) was in the Chair and fifty members and students were present.

The lecture, which lasted for one hour, was well illustrated by slides and the interest aroused was shown in the enthusiastic session of questions and answers which followed.

The appreciation of those present was expressed in a vote of thanks to Mr. Wilson, which was proposed by Mr. F. F. Richardson (Member).

Following a vote of thanks to the Chairman, proposed by Mr. J. E. Smith, a BP Tanker apprentice, the meeting terminated at 8.30 p.m.

West of England

Annual Dinner and Dance

The Fourth Annual Dinner and Dance of the Section was held on Friday, 11th October 1963, at the Grand Hotel, Bristol.

The 160 members and guests were received by the Chairman of the Section, Captain A. C. W. Wilson, R.N., and Mrs. Wilson, at a reception given prior to the dinner. The principal guests were the President of the Institute, Sir Nicholas Cayzer, Bt., and Lady Cayzer.

Following the Loyal Toasts, the Chairman extended a warm welcome to the guests and said that it was indeed an honour to have the President of the Institute, and Lady Cayzer present on that evening, but he was sorry that Captain R. G. Raper (Past Chairman of the Section), and Mrs. Raper were unable to be present. He went on to say that Sir Nicholas belonged to a remarkable family which had done much for the shipping industry, and his father, and a cousin, had both been Presidents of the Institute before him.

Captain Wilson then made reference to the difference between engineers and scientists. This, he said, was an immediate problem since boys now leaving school mostly wanted to become scientists and not engineers. He said how pleased he was to see that the Minister for Science had apparently recently appreciated the problem and was currently embarking on a campaign to "glamorize engineers". In this connexion the Institute was doing a great deal to help in bringing about new and proper recognition of the position of the engineer today.

shipping company in Bristol, Messrs. Charles Hill and Sons.

It was apparent that the tradition of the sea lay in Bristol, a port that had always been known for venturing into the unknown, indeed the Merchant Venturers of Bristol had always been in the forefront in this way.

Speaking of Institute affairs, Sir Nicholas said that it was very fitting that a Royal Naval Officer, especially one with so distinguished a Naval career as Captain Wilson, should be Chairman of the West of England Section; very high qualifications were needed in the Engineering Department of the Royal Navy, and in the Royal Navy and the Merchant Navy was a partnership of greatness. The Merchant Navy's greatness came about with the introduction of steam. He went on to say that the quality of machinery was brought about to a large extent by the efforts of the Institute of Marine Engineers and that the training of marine engineers was very important because men meant more than machines—a sentiment which should not be forgotten in this modern age.

West of England Section

At the Annual Dinner and Dance at the Grand Hotel, Bristol. The President of the Institute, Sir Nicholas Cayzer, Bt. (right) with Captain A. C. W. Wilson, R.N. (Chairman of the Section), and Mrs. Wilson

Dealing with the work of the Section, Captain Wilson wished to thank all the members for their co-operation in the past, and especially Commander Inches, R.N., and Mr. D. V. Hyde, both of whom as Chairman and Secretary of the Social Committee respectively, had put in much work with the help of that Committee, and had made this function an outstanding success. He also thanked Mr. M. R. Goodacre (Honorary Secretary), for the work he had done for the Section generally, and he extended a warm welcome to Mr. F. C. Tottle, M.B.E., the newly elected Local Vice-President for Bristol, whom, it was hoped, would keep a fatherly eye on the Section's activities and guide it accordingly.

The Chairman then proposed the toast—" The Ladies and Guests".

In replying to this toast, Sir Nicholas Cayzer said how nice it was to be in Bristol once again and spoke of the great tradition of the port. He then spoke of Brunel who had many wonderful engineering feats to his credit, both civil and marine. He mentioned Samuel Plimsoll of load line fame, who was a Bristol man, and also mentioned the oldest

In concluding his speech, Sir Nicholas congratulated the Section on having a membership of 350, and he wished it all success in the future.

Dancing to the orchestra of Arthur Alexander followed the dinner and a number of novelty dances were included.

The dance ended at 1.00 a.m.

General Meeting

A general meeting of the Section was held on Monday, 14th October 1963 in Smith's Assembly Rooms, Westgate Buildings, Bath, at 7.30 p.m. Captain A. C. W. Wilson, R.N. (Chairman of the Section) was in the Chair and also present was Mr. F. C. Tottle, M.B.E. (Local Vice-President, Bristol).

After a speech of welcome by the Chairman the paper entitled "Progress in Automation" by R. Munton, B.Sc. (Vice-President), J. McNaught (Member) and J. N. Mackenzie

(Member) was read by Mr. Munton and proved to be a most interesting and instructive paper which stimulated much questioning.

Mr. Munton gave a definition of the word "automation" with a few simple examples. He also spoke of the benefits economically, and said that it was essential for an efficient plant to be fitted with controls of 100 per cent reliability and that the ruthless selection for the application of controls was of paramount importance. Apart from each control, safety devices were necessary, but had to be separate from the automatic control. This meant that two things had to fail before anything went wrong, i.e. controller and warning.

Mr. Munton said that one of the biggest headaches with which he had to contend was that too little attention was paid by the shipbuilders to the pipe work connexions; a very high standard was required so that leaks along the line were non-existent.

At the conclusion of the lecture, no less than fourteen members of the audience of thirty-eight, put questions to Mr. Munton, which were answered in a very lucid manner. Had time allowed, an immensely interesting discussion on this subject could well have followed.

A vote of thanks to Mr. Munton was proposed by the Chairman and the meeting ended at approximately 9.30 p.m.

Student Meeting

A Meeting of the Student Section was held at The Memorial Building, 76 Mark Lane, London, E.C.3, on Monday, 4th November 1963, at 6.30 p.m.

A short film preceded the lecture on " The First Principles of the Diesel Engine and its Development for Use in Marine Work " which was given by Mr. G. S. Mole, B.Sc. (Associate Member).

A vote of thanks to the speaker was proposed by the Chairman, Mr. V. G. Bridge, and was carried by acclamation.

There were 58 members and visitors present, and the meeting ended at 8.10 p.m.

Election of Members

Elected on 21st October 1963

MEMBERS

Gerald Cecil Collins, Eng. Lt. Cdr., R.N.
Joseph Dooling
T. S. Govindarajulu
Samuel Holt
Jason Harold Ingham, B.Eng. (McGill)
Melville Thompson Leatherdale
Henry Alexander McGregor
Alexander Kelman Maitland
Jasper John William Mellows
Benjamin Wilfrid Oxford
Norman James Pollock
Armindo Alves Rodrigues, Lt. Cdr. (E), Port. N.
D. E. A. Rowland
Roland Cecil Selman, Cdr., R.N.
Martin Edward O'Keeffe Trowbridge, B.Sc.

ASSOCIATE MEMBERS

Gordon Middleton Alexander
Otto Altherr
Laurence Henry Barnes
Demetrios C. Bouras, B.E. (McGill)
Derek Bowman
Norman Cockill
Geoffrey Gordon Cosgrave
William Ernest Dandy
Jatindra Chandra Das
Victor de Eraso y Arcaraxo
Peter Thomas Duesbery
John C. Fleck
Giancarlo Franco
Homi Cowasji Gandevia
John Goodenough
Gerald Hardy Haggar, B.Sc.
Nripendra Nath Halder
Glyn William Holme
John Wilson Lowis, Lieut., R.N.
Maurice Francis McBride
Maxwell McLean
Patrick Moran Peden
Ronald Patrick Aquinas Phelan
Nawal Kishore Raichand, Lieut., I.N.
Joshua John Reid
Thomas Robison
Joseph Royce Speight
Lucas Remedios Vaz

ASSOCIATES

Raymond Victor Benda
Burchell Soley Fulmore
Bimal Kanti Gupta
Douglas George Thomas Myatt
Albert Smith

GRADUATES

Rowland Elleray Dobson
Noel Christopher Fleming, Lieut., R.N.
Ian Munro Mathieson
Neil Stuart Patrick
Qaiser Mirza Rizqi
Alan Malcolm Rushton
Ian Alexander Smart

STUDENTS

John Isaac Azuka Attah
Ralph James Bell
Peter Antony Bloomfield
John Christopher Cornford
Martin William Gowdridge
David John Howard
Stephen David Irvine-Fynn
Liang Hong Koh
Timothy Christopher O'Sullivan
Colvyn Quaggin
Stephen Howard Rogers
Nicholas Sole
James Henry Stoppa

PROBATIONER STUDENTS

Barry Michael Abbott
Malcolm Arnold
John Stewart Brackenboro'
David Edwin Clayton
Michael John Covington
Graham John Dadd
Richard George Fernie
Henry Jeremy Meadows
Robert John Gordon Smith
Andrew Douglas Willis
T. V. Venkateswaran

TRANSFERRED FROM ASSOCIATE MEMBER TO MEMBER

Ian Clark
Peter Guy Edwards, B.Sc.(Durham)
Estanis Gallo
Alexander McMillan
William John Savage
Louis Strauss

TRANSFERRED FROM ASSOCIATE TO ASSOCIATE MEMBER

Mordechai Paul Katriel
K. N. Ramanathan
Albert Richard Sillito

TRANSFERRED FROM GRADUATE TO MEMBER

James Rowland Herd

TRANSFERRED FROM GRADUATE TO ASSOCIATE MEMBER

Dennis Brunton
Richard John Christie-Gammie
Michael Joseph Close
Barry Owen Field
Vinod Kumar
Peter Langford-Jones, B.Sc.
Samuel Leith, B.Sc.
William Dennis Moss
Albert Rose, B.Sc.
Ronald Henry Shaw

TRANSFERRED FROM STUDENT TO ASSOCIATE MEMBER

Denis W. Baker
Hugh Martin Charles Syrett

TRANSFERRED FROM STUDENT TO GRADUATE

Michael John Schilling

TRANSFERRED FROM PROBATIONER STUDENT TO STUDENT

David Gordon Conolly
Derek William Hodge
John Barry McCabe
Howard Jeremy Rhodes

OBITUARY

JAMES CAMPBELL (Member 10849) died earlier this year. He had been a Member of the Institute since 4th June 1946.

Mr. Campbell was apprenticed to the North Eastern Marine Engineering Co. Ltd. from 1915-1920. During this apprenticeship, which was interrupted by a year's service with the Royal Air Force towards the end of the First World War, he studied engineering at the Wallsend Technical College. He commenced his seagoing career as seventh engineer with Shaw, Savill and Albion Co. Ltd. and some years later transferred to the China Navigation Co., to whom he was eventually appointed assistant superintendent engineer. Mr. Campbell held a First Class Board of Trade Certificate and, during the Second World War, was at one time an assistant superintendent engineer with the War Department.

WILLIAM GLADSTONE DAVIES (Member 10173), a Member of the Institute since 2nd January 1945, died some months ago.

Mr. Davies was born on 14th August 1895 and entered the marine engineering profession by way of a five-year apprenticeship with Chapman and Co. Ltd. of Sydney, N.S.W., after which he spent several years as a seagoing engineer. He gained a First Class Steam Certificate in 1920 and a Motor Endorsement three years later. He left the sea in 1924 and eventually set up in business on his own account as a consulting engineer. He also acted for many years as a surveyor to Lloyd's Register in Fremantle and would be known to many marine engineers who had called into that port. During the war years he was responsible for many outstanding repairs to damaged ships. Mr. Davies was probably one of the best known men in shipping circles in Weestern Australia. After Lloyd's Register opened their own office in Fremantle, his main activities became centred around his own practice as a consultant.

In addition to his membership of this Institute, Mr. Davies was a Member of the Institute of Marine and Power Engineers (Australia) and a Foundation Member of the Mechanical Engineers Association (Australia).

THE RT. HON. LORD LEIGHTON OF ST. MELLONS, C.B.E., V.L., J.P. (Companion 14602) died suddenly on 17th October 1963. He had been a Companion of this Institute since 21st September 1953.

George Leighton Seager was born on 11th January 1896, the younger son of the late Sir William Seager, and was educated at Queen's College, Taunton. During the First World War he served with the Artist Rifles and also, on being invalided out, in an honorary capacity on the Secretariat of the late Lord Rhondda, at the Ministry of Food. He was honorary adviser to the Lord Privy Seal on his Trade Mission to Canada in 1929 and was a member of the British Delegation to the International Maritime Conferences at Geneva in 1935 and 1936. Lord Leighton was a director of many companies, including W. H. Seager and Co. Ltd., Mountstuart Dry Docks Ltd., Cardiff Channel Dry Docks and Pontoon Co. Ltd., Barry Graving Dock and Engineering Co. Ltd., Atlantic Shipping and Trading Co. Ltd., and the London Steam-ship Owners' Mutual Insurance Co. Ltd. He was also a director of the South Wales Electricity Board and of the British Sailors' Society; late president of the Chamber of Shipping of the United Kingdom; a member of the Council of British Shipping, of the Baltic Exchange and of the General Committee of Lloyd's Register of Shipping. He was an underwriter at Lloyd's and had been chairman of the Cardiff and Bristol Channel Shipowners' Association.

Lord Leighton was made a C.B.E. in 1932, was knighted in 1938, created a baronet in 1952 and was raised to the peerage in the New Year Honours List for 1962. He was nominated High Sheriff of Monmouthshire in 1938 and became H.M. Vice-Lieutenant, Monmouthshire in 1957. He was a director and treasurer of the Royal Merchant Navy School, a governor of the University College, Cardiff, and a member of the Milford Haven Conservancy Board. He was a Prime Warden of the Worshipful Company of Shipwrights and a Freeman of the City of London.

In 1921 he married Marjorie, daughter of W. H. Gimson, Esq., of Breconshire; there are two sons and two daughters. Lady Leighton survives her husband, whose heir is Mr. John Leighton Seager.

COMMANDER HUGH GASKELL PATRICK TAYLOR, R.N. (Member 11362) died suddenly on 25th July 1963.

Commander Taylor was born on 4th September 1904 and was educated at St. Bees School. His engineering apprenticeship was served with the London, Midland and Scottish Railway at their Horwich Locomotive Works and he also attended evening classes at the Horwich Railway Technical Institute.

In 1927 he was commissioned Engineer Sub-Lieutenant in the Royal Indian Marine and, for the next thirteen years, served at sea with the R.I.M. and the Royal Indian Navy. In 1940 he was appointed Base Engineer Officer at Madras and, in 1941, Engineer and Harbour Master at Port Blair, Andaman Islands. In 1942 he joined the Staff at Naval Headquarters, New Delhi, later being appointed Deputy Director of Engineering, there. He came to the United Kingdom in 1944 on a two-year tour of duty as Deputy R.I.N. Liaison Officer to the Admiralty at Bath, after which he returned to India as Training Commander, H.M.I.S. *Shivaji*. He was promoted Commander, R.I.N. in 1947 and also received the rank of Commander, R.N. After his retirement from naval service, Commander Taylor joined the Aluminium Development Association, in 1950, where he became marine engineer responsible for the development of aluminium for marine uses.

Commander Taylor was elected a Member of this Institute on 9th June 1947 and was also a Member of the Royal Institution of Naval Architects. He leaves a widow.

CORNELIS VAN DIJK (Member 25707), formerly joint general manager of Verolme Cork Dockyard Ltd., died on 26th March 1963.

Born on 23rd January 1922, he was educated in Rotterdam and, concurrently with his apprenticeship, served with the marine engineering department of Wilton-Fijenoord N.V., he took a marine engineering course at the Rotterdam Technical Institute.

He completed his indentured time in 1944, remaining with Wilton-Fijenoord as an assistant estimator and, two years later, became chief draughtsman at the company's engineering works at Doesburg. In 1952 he joined the Dockyard Co. at Tandjong

Priok in Indonesia as assistant repair manager, a position he held until 1956 when he returned to Holland to become the manager of the repair department of the Verolme Dock and Shipbuilding Co., Rotterdam. He became joint general manager at Cobh two years later, and left the company's service at the end of 1962 to take up a new appointment in Holland.

Mr. Van Dijk was elected a Member of the Institute on 14th January 1963.

JOHN Y. WILLIAMSON, B.Sc. (Associate Member 7313) died suddenly on 5th August 1963, aged 56 years.

He was educated at Greenock Academy and Glasgow University, gaining a Bachelor of Science degree with honours. He also served an engineering apprenticeship with Scott's Shipbuilding and Engineering Co. Ltd., with whom he was afterwards engaged as an engineering draughtsman. For a period, during the 1930's, he was Assistant Editor to *The Shipbuilding and Shipping Record*. In 1938 he joined the Factory Department of the Home Office as an inspector, stationed in Birmingham. He has remained in the service of the department, now administered by the Ministry of Labour, ever since, being appointed District Inspector for Fife in 1946, for Lanarkshire in 1950, for Stirling in 1954, and for Rotherham in 1959. He was transferred to Carmarthen in March of this year.

Mr. Williamson, who was elected an Associate Member of the Institute on 3rd July 1933, has maintained a great interest in marine matters throughout his career. He leaves a widow, and a son who is in the Merchant Navy.