The
INSTITUTE of MARINE ENGINEERS
Founded 1889. Incorporated by Royal Charter, 1933.

Patron: HIS MAJESTY THE KING.

SESSION 1938

Vol. L. Part 7.

President: Sir E. JULIAN FOLEY, C.B.

*Marine Engineering Problems of To-day

By STERRY B. FREEMAN, C.B.E., M.Eng. (Vice-President).

Synopsis.

THE author points out that while in general marine engineering progress has been considerable, there are quite a number of problems that have come to light during that progress which have not been satisfactorily settled; most of the solutions have entailed additional expense; the experiences are touched upon which have been gained with turbines, water-tube boilers, the reciprocating steam engine, Scotch boilers, and mechanized firing of boilers. From that he compares some of the characteristics of the turbines and the oil engine and of course brings in the question of liner wear. Electric transmission of steam engine and oil engine power is dealt with and the question of standardization of machinery is considered. Propeller research is touched upon and the question of bossing. The grounds for deciding upon the correct fuel, oil or coal, are looked at and gas is suggested as another fuel for coastal work. Finally, the contribution of metallurgy to marine engineering problems is acknowledged. Throughout the whole paper the emphasis is on the matters we do not know and for which we should be grateful to have the answers.

It is a great honour to be allowed to present a paper to an international gathering such as this. Meeting as it does in London with so many attractions elsewhere, it is hard to find a subject which will be of equal interest to each of my hearers and which may compensate you for spending time here rather than in the open. Should we deal with the broad question of the relative merits of different types of marine machinery, or the narrower question of some specific system of construction or operating practice, or the still narrower field of an examination of the cause of the success or failure of some machinery part?

There have been many papers read recently on the present-day development of marine engineering and on the possible future which lies before our industry. In most of these papers there has been an air of congratulation that we have travelled so fast and so far, and a general atmosphere of optimism as regards our future progress. It might therefore be timely to suggest that while we admit that we engineers are wonderful people, and that the children of our brains are wonderful also, still there remain quite a number of points where we must confess to a certain degree of frustration, if not failure, and in order to add to the pleasure of this meeting I propose to dwell for a short time

* Read at the International Conference of Naval Architects and Marine Engineers, London, June, 1938.

on some of these questions, and to invite you to produce some solutions to the problems involved. It is probable that some weak spots have been left unmentioned, and your assistance is invited in adding these to the list.

There is, of course, a theoretical limit of efficiency which can never be quite attained in practice, which Nature has imposed for every type of prime mover. It is not suggested that any complaint is levelled against Nature. What is emphasized is that research and experiment in fundamental matters should be carried on continuously as experience has shown that in this way we make progress in practical technical details which may at first seem to have no connection with fundamental research. While admitting these limitations, engineers should not be satisfied with an ideal efficiency for a steam engine of, say, less than 35 per cent., or for an oil engine of, say, less than 39 per cent. In the efforts made to raise the standard of performance there has been a general elaboration of design and construction in all classes of marine machinery, which is contrary to the old order of things when simplification was the aim and economy of first cost was a very serious matter. The amount of money which must be spent to achieve the lowest possible consumption of fuel may be a good investment, but there is always a danger that more may be spent in first cost than is saved in subsequent economy. The modern high-pressure, high-temperature steam turbine and boiler and the later oil engines are equally under suspicion in this matter. It should be emphasized that the eternal search for efficiency is always right and to the good—it is the cost of achieving it that is the important qualification.

The present output of power per unit weight from various types of marine machinery is very different, and of approximately the following order, on a basis of weight per shaft horse power :—

1	2	3	4	5	6
Low pressure steam and reciprocating engines with Scotch boilers.	High pressure steam and geared turbines with W.T. boilers.	High pressure steam and electric transmission with W.T. boilers.	Oil engines, direct drive, S.A. 2 S.C. or 4 S.C. supercharged.	Oil engines, direct drive, 2 S.C.S.A. or D.A.	Oil engines and electric or mechanical gearing and clutch transmission of power.
500lb.	250lb.	230lb.	400lb.	350lb.	300lb.

It is suggested that in all these systems, except the second and third, there is a long way to go before we should be satisfied with the power/weight ratio.

Steam Reciprocating Engines.—These are now supplied with high-pressure superheated steam, and perhaps preheated l.p. steam; weight is reduced by the adoption of higher speeds, steel columns, single collar thrusts, and the power is increased by exhaust steam turbines interposed between the l.p. cylinder and the condensers, which drive on the propelling shaft mechanically or electrically, or the power is used to heat and dry the steam between the stages of the main engine. All these refinements have been adopted to reduce weight and running costs at the expense of first cost.

Are these systems too complicated for outputs below 1,000 s.h.p. and would a turbine alone for powers above 6,000 b.h.p. be preferable?

For these steam reciprocating engines, pressures within the compass of the Scotch boiler are usual, and if high superheat is adopted there is a danger of passing lubricating oil from the cylinders to the condensers and ultimately to the boilers. Is there any effective way of filtering an emulsion of oil and feed-water in such a case? All sorts of towelling, fibre and coke, or charcoal devices have been tried, and also an electrical plant, but in the space which can be given in a normal engine-room it is hard to get rid of oil from an emulsion. And how about the cost of such plant?

Turbines.—The characteristics of the turbine have given us a propelling plant of low contour, free from troublesome vibration, occupying small floor space, and of comparatively high efficiency and low steam consumption. Unfortunately, for its best performance high-temperature high-pressure steam is a necessity. The metallurgist has not yet given us the metals that will unfailingly resist these temperatures and pressures.

When the turbine was first introduced many of us thought that as there was no contact between rotor and stator, there would be, apart from some small wear in the bearings, no repairs and no maintenance charges to face. Probably the bearing wear has been the least troublesome item in the turbine. It was not anticipated that casings would distort, crack, and erode, that shafts would bend, discs become loose, axial and radial packings leak, that blades would break, erode, and pit, and that binding wire would fail. But all these have occurred.

To prevent these happenings there has been a flood of ingenious invention, and the materials and the processes they go through have been much improved at greatly enhanced cost.

In spite of all precautions, however, there are cases where the engineer is baffled, as when, for example, a certain row of blades will fail repeatedly although renewed in modified and improved material. The erosion of turbine casings at the later stages can, by alteration of the pressure in the stages, be transferred from one stage to another as the mischief goes on, but no means of completely preventing this damage has yet been discovered. Another common failure is that of the later stages of l.p. blading, where probably the blades strike water, for which condition we have as yet no remedy. From experience of turbines which have had various rows of blades removed, it seems that turbine design has not reached finality.

It is desired to go on towards pressures of 1,500lb. per sq. in., and temperatures of 450° C. In view of the troubles we have at lower pressures and temperatures, is it safe to do so? And if we do, then it seems certain that some practicable scheme of reheating the steam between stages must be adopted, but how is this to be done in the limited space of a ship's engine-room? Will the method employed originally by Ferranti of transferring heat from highly superheated steam between the boiler and the first stage of the engine, to steam exhausted from a further stage in the plant, be applicable?

Condenser.—No satisfactory method has yet been devised to conserve the heat which is imparted to the circulating water by the steam which has been condensed. The method adopted in the mercury boiler system achieves this object to some degree, but not in a way which would be practicable in marine work.

In the same way the technique of gear-cutting has been studied, and those tests, checks, and methods of calibration with which you are familiar have been evolved, so that now the gear-cutting machine in its glass case is performing miracles of accuracy, also at a commensurate cost.

It is regrettable that so far no means of running test-bed trials of large steam plant are available to ascertain with certainty the relative economy of, for example, mechanical and electrical transmisison of power. They are needed.

Electric transmission of power has been adopted in a number of important steamships where there have been some special reasons for its employment, such as to avoid the risk of broken teeth in mechanical gearing, to lessen vibration, and to reduce noise. It would be interesting to know if the above qualities are noticeably exhibited in comparison with other ships where the electric system is not used. It is generally understood that the consumption of fuel oil in those of our large ships which are fitted with turbo-electric propelling machinery is from 0·72 to 0·78lb. of oil per s.h.p. hour in comparison with a consumption of 0·57 to 0·6lb. per s.h.p. hour in geared turbine plant. Our friends in the electrical industry will agree that these figures call for improvement. As regards the Diesel electric system, the rate of fuel consumption will be on the same lines, and the Diesel engine at 250 r.p.m. is not so suitable as a fast-running turbine for the generation of electrical power. Means are needed to bring the losses of electrical gearing more closely into line with mechanical gearing with a corresponding reduction in fuel consumption per b.h.p. hour, and to reduce the weight and space required for electrical gear. Although electric, mechanical and hydraulic gearing of all kinds have been successful, they must be paid for in capital cost, maintenance, and repair. Are we better without them?

It should be noted that the measurements of mechanical performance lag behind those of electrical performance, and an accurate and reliable meter is another long-felt want.

Oil Engines.—We have been promised the advent of a gas turbine, but it has not yet appeared. The advantage of a rotary type of oil engine seems probable. What is the difficulty which has arrested this development?

Like everything else in this world, there are always compensations. The old four-stroke cycle single-acting engine, with its cooling stroke between each power stroke, was very comfortable, but had a very high weight/power ratio. The two-stroke single-acting engine had a better weight/power ratio, and was going into the lead until the two-stroke double-acting engine arrived. Double-acting engines having a piston-rod through their lower combustion chamber must have a lower cover and stuffing-boxes. It may be urged that the top and bottom covers are weak spots in these engines, and that the opposed piston engine avoids the danger by having no cover at all. The stresses in this engine are concentrated in the crankshaft. Is it better to have a cylinder cover fail from time to time, or an occasional crankshaft? The desirable answer is "Neither", but if there are to be no failures many of us will be out of our present employment, which is unlikely.

At any meeting of engineers to deal with oil engines, it will be found that liner and piston-ring wear cannot be kept long out of the discussion.

In the four-stroke single-acting engine the liner is a simple proposition, the pearlitic cast iron of which will last for, say, 50,000 hours. Some two-stroke and some double-acting engines have liners of comparatively complicated construction, and the cast iron for such is now alloyed with, for example, nickel, chromium, molybdenum, or vanadium and titanium, and even so these liners do not seem to give general satisfaction. What hope is there under these circumstances of increasing the life of the two-stroke cycle double-acting engine to compare with that of the four-stroke cycle single-acting engine, and further of using successfully so-called "boiler oil" in our engines, which is one of the objectives which should be kept in view? Is the remedy going to be the adoption of harder liners or the electroplating of liners, or must the shipowner continue to pay for the lighter oils? And should the piston ring be softer or harder than the liner, or of the same metal and characteristics? Although much has been written about the wear of cylinder liners and piston rings in the internal-combustion engine, no solution has yet been reached which finds general acceptance. Probably the correct solution of the problem is to make these of the same material, and as hard as possible so long as the hardness is due to the closeness of the texture of the material, and to make sure of effective lubrication of the upper part of the cylinder liner. As already said, the simple liner of the old 4 S.C.S.A. engine is not expensive, and lasts fifty thousand hours, say, ten years; the liner for the modern 2 S.C.S.A. or D.A. engine costs about six times as much, and lasts less than half the time. We cannot sit down contentedly with that state of affairs.

It is also suggested that the question of piston rings, whether for steam or oil-engine pistons, is not finally decided. If a ring is used which is unrestricted in its expansion on to the cylinder wall, the pressure of the working fluid will get behind the ring and may increase the wear of both ring and liner. If, on the other hand, a ring of the restricted type is used in a cylinder which is not absolutely true in bore from end to end of the stroke, it obviously would either be held off the liner wall at points, or would not actually be restricted in its operation.

The transmission of heat is of course bound up with the size of the cylinder and the amount of oil necessary to be burned to develop the power required. When pressure charging in the four-stroke cycle single-acting engine was adopted, it was found that the additional heat released in the cylinder by the burning of additional fuel was removed by the additional air supplied for scavenging and for subsequent compression and combustion. Something of the same practice is wanted in the double-acting engine so that higher pressures and output can be achieved without incurring higher heat stresses.

As regards the running of modern machinery, one of the effects of forced lubrication is to conceal overheating and wear by carrying off the surplus heat unnoticed, and a simple and cheap means of warning the operator of such overheating is wanted.

A ship's structure is not rigid, chocks wear into the tank top, riveting slackens, and nothing but constant vigilance keeps bearings in line. That there is still much work to be done on the problem of shaft alignment is evidenced by the fact that at the time of writing these notes there are some six ships in the Tyne with broken crankshafts and fractured bedplates.

The oil engine is tied to a fairly narrow range of oil for efficient running and maintenance, and every effort should be made by designers and users to discover how the heavier grades of oil can be used. The larger the oil engine the greater its heat problems and other difficulties, and the metallurgist and the engineer have to determine how far sizes and outputs can go.

Considering that Dr. Diesel originally designed his engine to burn coal, it seems that the advent of an efficient and trouble-free coal dust engine is overdue. This might help our coasting vessels to obtain cheap power. The question of obtaining a licence to manufacture a successful engine is perhaps a more difficult one than it should be if the industry is to advance by co-operation. If one firm has a monopoly of the manufacture of a successful engine, then all other firms are tempted to decry that firm's engine; which does not help co-operation.

Some years ago—in 1926—the author's firm issued a specification for the construction of a marine oil engine which should combine all the then known desirable features of a pressure-charged four-stroke cycle single-acting engine. Four such engines were built by two firms in collaboration, and have been running now for eight years with practically no major renewals or repairs. The engine fitted in m.v. "Polyphemus" was tested by the Marine Oil Engine Trials Committee and showed a high efficiency. That sort of co-operation and standardization appears to be useful and might be extended.

Boilers.—Present-day boilers are equally or more developed than the turbines which they supply. At one time a boiler was a kettle in which water was boiled. Now it has become a machine for the rapid production of steam. For many years the older types of water-tube boilers for use in the Mercantile Marine were rated so lightly that there was no particular advantage, from the weight and space point of view, in adopting these in lieu of the Scotch boiler. The difficulty of keeping up the brickwork of water-tube boilers, of firing coal by hand in their large grates, of keeping condenser tubes tight, and the inadequate quality of workmanship and material in them made the Scotch boiler preferable. With the competition of modern boilers, such as the Johnson in this country, and the Wagner, Loeffler, La Mont, and Velox types abroad, the rating and output of these standard water-tube boilers have been greatly increased. This, however, results in the boiler, and in particular the steam reservoir capacity, being reduced in proportion to the output obtained. Are the best results to be obtained by natural, guided, or forced circulation?

To deal with our oldest friend, the tank or Scotch boiler. This has latterly come back into the picture, thanks to the improvements in steam engines, but an old problem still remains, viz. why a boiler of this type should be built with such high factors of safety that its weight is a severe penalty on its use. It may be that the advance in the quality of workmanship and of steel has not been given its full weight. It is safe to say that these boilers would suffer less from the inevitable movement which goes on, due to expansion and contraction, if the shell and furnace plate thickness and also the stay diameters were reduced. Consider, for example, the boiler shell. This is formed by bending the plate beyond the elastic limit, and it is not subsequently annealed. It is obvious that the thinner the plate, the less the internal stresses set up in the plate. The allowance of an additional thickness for wastage is unnecessary as the plate thickness is 15 per cent. more than is required, the strength of the seam being only 85 per cent. of the strength of the full plate. As regards stays, no water-space stay fails through excessive corrosion at the centre of the stay. Stays almost invariably fail at the plating where the movement of the combustion chamber in relation to the shell plating or to another chamber has been most severe, and very little nicking is enough to cause failure.

The defect of many boilers of this type is that they tend to prime with the consequent damage to piston rings, piston-rod packing, turbine glands, nozzles, and blades, etc. The production of really dry steam is a matter of first-class importance, and although little is positively known of the cause and prevention of foaming and priming in marine boilers, it is believed that the reservoir capacity and the height of the steam outlet orifices above the water-level and the purity of the water are all important. The latter is probably the biggest factor in the case. In the Admiralty type of water-tube boiler with its guided circulation, priming is no longer a worry.

Fuel.—Much study and experimental work has been done on the burning of fuel oil in boilers, and progressively better results have been obtained in consequence. On the other hand, coal burning has not advanced in the same way. What has been done in marine work since Howden arranged valve control of air into boiler furnaces under forced draught?

From the shipowner's point of view, the questions of reliability, cost, space, and weight are of importance in the order named. Whatever machinery is used must be taken in conjunction with the bunkers necessary for its performance, and in this connection for an equivalent weight coal occupies about 17 per cent. more space than oil, and the transport of the same number of heat units in coal entails moving about 50 per cent. more weight than in oil. Cannot these figures be improved upon? Coal might always be washed and then properly freed from water and graded. It should be burnt in pulverized form, but no scheme has yet been evolved whereby coal can be cheaply and effectively powdered in the stokehold, or powdered in bulk ashore and safely carried in ships' bunkers without risk of coal-dust explosion when at sea. What is wanted, perhaps, is some combination of duct keel, serving, by means of a suction hose, bunkers arranged in the cellular double bottom, so that it may be possible to send a ship to sea with powdered coal stored in the double bottom. Mechanical grates work well, but when a suitable coal is found for use with these, the price of that coal promptly tends to go up. Mechanical means of bunkering ships are wanted which will not break the coal up into smalls and dust.

Mechanized firing is constantly under consideration for marine boilers, but this question is bound up with the considerations of first cost, of the supply of fuel at the right price, and of bunker space and weight. If the very low grade coal which can be used with mechanical grates, or with powdered fuel plant, be selected, how much more bunker space will be needed to store the requisite number of heat units required? It is a transport as well as an engineering question, and the answer will differ with the service.

The present position of coal for bunkers has become in this country involved with political considerations to an extent that makes it impossible to deal with it on the lines of straightforward engineering economics, and a return is wanted to a basis competitive with other coal-producing countries.

At a recent meeting of the Institution of Naval Architects this question of the choice of fuel, coal or oil, was debated. On technical grounds it was demonstrated that oil gave a ship such range of action, speed, and other strategic advantages that coal could not successfully compete with it. All these arguments apply to the international commercial rivalry that is unceasingly going on, and no shipowner can avoid the necessity of equipping himself with the best ships with which to carry on the struggle if he is to survive. On political grounds, it was urged that because Britain has no indigenous oil, we should burn coal lest we could not obtain it from oil-producing countries. None of the speakers mentioned the fact that Germany, Italy, Japan, France, Spain, and the Scandinavian nations have no oil either!

What is most obviously needed is an economical process whereby our coal could be converted into liquid fuel, so that a ship might bunker the valuable heat units without the residues which add weight and bulk to the ship's fuel supply.

For vessels burning oil in oil engines a centrifugal oil-cleaning plant, fully large enough to pass all the fuel intended for the day's use through it in, say, six hours' time, is an invaluable asset. A static type would do as well perhaps if it would take out water. Can such be devised?

There is a rumour that "boiler" oil is to displace "Diesel" oil. Perhaps these are differences in names and prices only. Given a clean oil of approximately the same viscosity, specific gravity, percentages of hard asphalt and sulphur as the "Diesel" oil in common use, and it can be burnt in an oil-engine even if it is labelled "boiler" oil.

While many people are very indignant with the marine engineer who uses oil instead of coal, they quietly ignore the fact that even in the sheltered home market, where international competition is not so acute as in shipping, many of our engine builders are making a comfortable living out of the manufacture of oil engines. They ought, of course, to be building gas engines. They used to do so, but the cost of coal, even at their doors, is prohibitive, and the taxed foreign oil, being cheaper, has driven gas engines off the market. Some means is wanted of putting gas engines on smaller ships in the home waters of those countries which produce no oil, these ships bunkering gas instead of coal. The experiment of using gas engines was tried in the "Holzapfel" on the Tyne in 1910 (?), but it should be re-examined.

Another path of progress which needs clearing is that of invention. In the past century, the Industrial Revolution and our consequent comforts were the outcome and reward of the inventive genius that gave us the power of steam in our factories and for transport, the enormous addition to our resources which electrical power and light confer, and latterly the transmission of power to great distances. But to-day the inventor's way is usually a hard one. He has to pay for the monopoly which the patent confers upon him and further fees to keep up the protection of his idea. As a matter of practice very few busy people will trouble to sit down to invent something specifically to meet the difficulty they may be in, because they realize that, from the financial point of view, the inventor is very largely wasting his time. The exception to this generalization is that of an invention protected by the firm who can manufacture it, which is not in the same category.

Inventions are an addition to the riches of the country in which they are made and should be encouraged as much as practicable by the State.

Standardization is another matter where we have not yet in many cases arrived at clear decisions.

Most engine works standardize their units—bolts, nuts, certain fittings, and so on—as one might standardize bricks but not a house. For steam installations of, say, 4,000 s.h.p. and upwards, turbines are usually employed; below that power reciprocating engines with or without an exhaust turbine. The question arises, can steam practice be standardized in the same way in view of the great divergence of pressures, temperatures, and types and layout of boilers and machinery involved? With the advent of the oil engine, standard sizes of cylinder pistons and piston rods, etc., have become possible, and a complete engine can be built up for varying powers out of standard units on mass-production lines. But the ideal that there would be one standard type of oil engine, in the same way that there was for years a standard type of steam reciprocating engine, is as far off or farther off than ever.

As standardization will tend to lessen the capital cost of the manufacturer's plant, shorten the time of delivery of machinery, and reduce the amount of spare gear necessary to be carried, it is obviously a desirable end if it can be compassed and more of it is wanted.

It is only fair to add that the firm that standardizes an engine is in danger of being overtaken and passed by a competitor with a new engine, and that the shipowner may find his ships obsolete if he carries standardization too far. How far can standardization of parts be carried to assist manufacture and use without checking progress?

Looking backwards it appears that the advance which has been made since the inventions of the steam engine, the steam turbine, and the oil engine has been bound up very closely with the advance in workmanship, including of course accurate machining, and with metallurgy, and it is probably on the future progress of metallurgy that the rate of development will depend. We are still in need of cheap, standardized material capable of withstanding high pressures and temperatures, and resistant to such evils as creep, brittleness, and corrosion. That there is much to be learnt is evident. Physicians do not know the cause and cure of the common cold. In the same way metallurgists cannot tell us why common wrought iron resists the ravages of time so much better than steel.

Cast iron has travelled on through pearlitic cast iron to be alloyed with chromium, copper, vanadium, titanium, molybdenum, and nickel. Are we on the eve of something definitely so superior to our past practice that we can standardize it?

Steel has been similarly alloyed, and has been tempered, quenched, and/or annealed in all these forms. Will there be a simplification of these processes, e.g. can tempering be omitted for gear pinions? In the eyes of marine engineers brass, in the form of condenser tube, is one of the outstanding triumphs of metallurgy since the discovery of aluminium brass, 76 C, 22 Zn, 2 Al. What is now wanted is the similar discovery and development of a metal to stand up to the temperature of burning oil, say a modest 1,500° C. (It sounds more reasonable in Centigrade!). And an oil that will lubricate at that temperature. And nuts and bolts that will not be at or above their annealing point under these conditions.

Further research is needed into the use and relative value of protective coatings, to guard our low-pressure turbine casings from corrosion and our oil-engine cylinder liners from wear.

More light is needed on the question of the propeller and the conditions under which it works; for example, in determination of the actual pitch of the propeller, taking into account the aerofoil sections of the blades, the effect of appendages, and particularly the bossing. On comparing the results of model naked hull trials, it is obvious that no such differences exist in the hulls alone as are exhibited between these hulls when fitted with those bossings which are considered to be the most suitable for their purpose. Are the bossings now fitted almost as a matter of course in multiple screw ships really necessary and advantageous? Should we not do as well or better with bare shafts and A brackets as in much naval practice? Can bare shafts be adequately protected from corrosion? Is it certain that to fit propellers amidships, as suggested by John de Meo, is not practicable and of advantage?

Someone has pointed out that if we are ever inclined to think that we have arrived and there is no more to be done, it is a good thing to make out a brief balance sheet, putting on one side the things we know, and on the other side the things we don't know. It should have an invigorating effect. This paper is intended in some small way to fill such a want, and is presented to you in the earnest hope that it may be welcome.

Discussion.

Mr. J. Hamilton Gibson, O.B.E., M.Eng. (Great Britain—Vice-President, I.Mar.E.): It is a serious matter to realize that there are so many engineering problems that to-day remain unsolved. At the same time it is encouraging to know that advances are being made, here a little and there a little, so that when we look back over one or two decades, the sum total of such advances amounts to something of which we have no need to be ashamed. In many ways marine engineers have made the very best use of materials and conditions that are at present available.

On page 151, the author says: "Some practical scheme of re-heating the steam between stages must be adopted, but how is this to be done in the limited space of a ship's engine-room?" Well, this has been done very effectively in some recent reciprocating steam jobs, according to the paper presented by Mr. Harry Hunter at the last Spring Meeting of the Institution of Naval Architects, and it would seem possible for some such scheme to be adopted in turbine machinery, although I must confess I do not quite see how. It was always considered that in the crowded space of an engine-room on board ship it would be impracticable to adopt re-heating such as we know it in land power stations, but it certainly has been done, and done very effectively in the reciprocating jobs to which I have referred, in which the partly expanded steam is re-heated, and does not start to condense until it has passed right through the low-pressure cylinder. On the same page the author says: "It is regrettable that so far no means of running test-bed trials of large steam plant are available. They are needed". That reminds me that some thirty years ago I saw a 10,000 shaft horse-power set of direct-drive steam turbines for a cruiser on a test-bed in a German engineering shop, the horse-power being measured by a large hydraulic brake of the Heenan and Froude type. It should be possible to couple up two or more such brakes in series for correspondingly larger powers and this may have been done for all I know. In any case, I do not think there would be any insuperable difficulty.

Then on page 151 we read: "Although electric, mechanical, and hydraulic gears of all kinds have been successful, they must be paid for in capital cost, maintenance, and repair. Are we better without them?" In other words, cannot we dispense with gears of all sorts, and revert to direct drive? The answer is that it is all a matter of propellers. If a propeller can be designed that will give maximum efficiency with natural steam turbine revolutions, then gears could be dispensed with altogether, and we should be better without them. The performances of such speed-boats as "Miss England II", in which the propellers were actually geared up, would appear to point to a solution of this problem.

In the next paragraph the author states: "An accurate and reliable meter is another long-felt want". If the author refers to torsion meters, I can only say that so far I have not seen anything to beat the simple direct-vision torsion meter that I used over thirty years ago, described in my I.N.A. paper of 1907. I would also point out that the longer the shaft, the more reliable the result. That, of course, is obvious. If thrust meters are included in the statement, then I would remark that the Michell apparatus as developed in this country is correct, within 1 per cent. At one time it was feared that the friction of the hydraulic leathers might vitiate the result, but some recent experiments have proved that such friction is almost negligible. That is probably due, as I have always thought, to the natural tremor of a shaft when transmitting power.

The only comment I would make on the oil-engine section of the paper is to record a recent experience that came within my own knowledge. We were asked to supply a thrust-block for a 15in. shaft. Then we were told to hold up the work as the shaft would have to be increased somewhat in diameter. It was eventually decided that 27in. was the minimum diameter for safety! This information is interesting (and I do not think I need add anything more) in view of the author's statement, viz.: "At the time of writing these notes, there are some six ships in the Tyne with broken crank-shafts and fractured bed-plates".

Finally, with regard to boilers, I am afraid I cannot agree entirely with the author's opening on that subject, when he says: "Present-day boilers are equally or more developed than the turbines which they supply". On the contrary, it seems to me that present-day boiler design is a complete mess. (Laughter). Mr. Burkhardt in his paper, perhaps a little more politely, calls it a state of flux, and I am willing to accept that amendment. Steam turbines, on the other hand, are as near perfection as permitted by present-day materials. There is quite a lot that can be done still further to improve the normal marine boiler, whether fire-tube or water-tube, before we need seriously consider any of those modern freaks having forced combustion, forced circulation, and so on.

I may mention one such improvement in which our American friends appear to have stolen a march on us, that is in the adoption, or re-adoption, of a marine economizer. Feed-water heaters were appreciated in the very early days, when the air-pumps delivered into a feed tank housed in the base of the funnel. The feed-water then descended by gravity to the boiler, which at that time was only loaded to about 5lb. per sq. in., no feed-pumps being required. In recent years the type of economizers now in universal use in land power stations has been adopted in many United States mercantile and naval steamers, and fuel economies of the order of 10 to 12 per cent. have been realized. In my opinion it is high time that something of the kind was tried in this country. Of course, it may not be necessary in all cases, but where funnel temperatures are above normal it would certainly be worth while. Then we could leave the boiler to perform its true function of merely generating steam, instead of having first to boil the water, to which our author has referred.

Mr. G. J. Lugt (Holland) : Mr. Freeman has told me in conversation that the purpose of his paper was to have a tilt at designers and marine engineers. He certainly has done so, and I for one am taking his remarks to heart. I do not want to speak about that part of Mr. Freeman's paper which deals with steam, because I know very little about steam, but I do want to make some remarks about the part concerning Diesel engines. Mr. Freeman develops quite a programme, but all he says is more or less in the shape of a query. Each sentence contains one or more, and in the notes which I scribbled down about Diesel engines there are fourteen definite queries, which Mr. Freeman wants answered. It can hardly be expected that we should go into all these points now. Just take the first one, which is perhaps the most difficult one of all : "Why do we not get a rotary internal-combustion engine?" Well, I do not think Mr. Freeman ever expected to get an answer to that question to-day. (Laughter). Then he asks : Is it better to have a cylinder cover fail or an occasional crankshaft? I cannot see the point of that very much. One may say : "A man must either drink *or* smoke", another man may say : "He can drink *and* smoke", but undoubtedly the best is neither to drink nor to smoke. Must it be either cylinder covers or crankshafts, to keep some of us in our present employment? I think the patients are not there for the doctor. but the doctor is there to cure the complaints. If the doctors succeed in doing away with the complaints, they will be out of their jobs, but the human race will be all the better for it. (Laughter).

Then there is a reference to the hope of increasing the life of liners and to the use of "boiler oil" in Diesel engines. Is it fair to use a kind of fuel for a purpose for which it was not made, and then to abuse the Diesel engine builders for their engines not standing up to it? Had not we better ask the oil people to improve a little on the fuel? Or is it the owners' own fault, because they want to get Diesel fuel and to pay for boiler oil? (Laughter.)

It is clear that it is impossible to go through all these points now, but I should like to say that when we go home after this very pleasant meeting, we designers shall have plenty of work to do, and that will be due to Mr. Freeman's efforts.

Mr. R. Jolly (Great Britain-A.M.I.Mar.E.) : Coming, as I do, from a large company where the marine engineering side is faced with the same problems as Mr. Freeman mentions in his paper, I thoroughly endorse his observations.

I would have liked the Author to have touched on what one may call the labour problem of the marine engineer at the present time. We marine engineers are now reaping the advantages of all the inventions of marine science and the hard and intelligent work of our research chemists, but what we are faced with is that we cannot get the human material to run ships satisfactorily from the engineering standpoint. I think the Author will agree with me in that. It is very difficult to-day to get intelligent junior engineers for service on board ship. This difficulty exists in many companies, and it affects the senior engineers, as they do not want to teach the younger men; they have not the time, and there is a lot of dissatisfaction about the position. There are, in my opinion, two reasons for that. First there is the immense amount of Government work in the shape of aeroplane work, armaments, and motor-cars, which is attracting the best mechanics or artisans in the engineering industry. They are getting such good wages that they will not go to sea. How can one expect the best men to go to sea with present wages ruling ashore, and the many opportunities to spend leisure? That is what we are suffering from. The other reason, to my mind, is the 8-hour day, which came in about nine years ago, about ten years too soon after the war. In the old days engineering apprentices worked from six in the morning to six at night, and more or less learned their trade. Nowadays they start at eight in the morning, after breakfast. They have welfare schemes and sports clubs, and they work eight hours a day. Do they learn their trade adequately? We are not getting the same material as in the past. Indeed, some of the best we get to-day are worse than many we rejected before the war. That is one of the problems on which I would have liked Mr. Freeman to touch.

I thoroughly agree with him that the results of tank trials and full scale results from ships are not always what might be expected. As long as the shipowner is mostly concerned with the amount of fuel required to drive a ship at a certain speed for a certain number of thousands of miles, reliable trial data is essential, otherwise the superintending engineer is going to be seriously handicapped. A ship may give excellent trial records at the start, but when it goes to sea and logs come in shipowners want to know why all this fuel expenditure, etc. A new cargo ship, when it is ready, should be loaded to its marks and run for a certain number of miles, and then the superintendent engineer would have reliable figures from which he could tell his ship's engineers what he will expect. This is affected, however, by the various national and international arrangements whereby ships are not allowed to take freights from certain people or from certain ports, but it is desirable that the marine engineer should have accurate facts to work on.

Speaking of invention, many a marine engineering inventor in the past has failed to market his invention because of his lack of commercial knowledge.

In the matter of boilers, as Mr. Freeman says, we have still the Scotch boiler with us, and we want to know why it is not giving better results. The Classification Societies have reduced the standard of test pressures for new material. That has perhaps added three or four years to the life of the boiler. There was no need to stress the material to double the working pressure. The application of superheat with Scotch boilers has become quite common, and with new ideas in the operation of slide valves on the ordinary reciprocating marine engine, and various new methods, such as exhaust turbines, for the more economical use of low-pressure steam in the engine, the Scotch boiler still has a very useful place in marine engineering.

Engineer Vice-Admiral Sir George Preece, K.C.B., Engineer-in-Chief of the Fleet (Great Britain—M.I.Mar.E.): I congratulate Mr. Freeman on being provocative, as he intended to be in this paper.

I was amused at the remark about machinery being a regrettable necessity. All engineers know that they are a nuisance to everybody, except perhaps in passenger ships, where they provide the amenities of life; but in general they are admittedly a nuisance because they have to be eternally striving for economy, and economy and comfort do not go together. I was rather taken with the suggestion that we must not make the ship an experimental station, but it was rather disturbing to hear the suggestion that if you want to experiment you ought to experiment in the Navy. I venture to suggest, however, that a naval ship is not really the best place to experiment in, for if the experiment goes wrong the results are likely to be very disastrous to people as well as to things. I would like to put it in this way. Speaking from my own experience of the past ten years, every ship we have built was an advance on the previous one, and to that extent every naval ship of every new class we build is an experiment. You never quite know how near you are to going "over the edge". Until the ship has not only done its trials, but has run for a matter of one or two years, you do not dare to write it off as perfect.

Incidentally, I think it probable that if naval ships had to run under the same conditions as liners there would be certain parts of them—I am not going to specify which—which we should want to renew about every two years. Over the last ten years I think it is fair to say that we have reduced the specific weights for horse-power of our naval machinery to about half of what they were ten years ago, which on the whole is not bad going.

With regard to the gas turbine, I am not so sure that it is so far away in the future as we are led to suppose. In this connection I might make just one remark from the naval point of view which is rather important. In the case of a gas-turbine plant, which consists of a turbine driving its own compressor, then burning fuel in that compressed air, and so raising its temperature, unless one is going to raise it to an impossible temperature one has to use a good deal of excess air. Now all you get to drive the ship is the difference between the power developed by the turbine and the power absorbed by the compressor. With the quantities of air dealt with in order to keep the temperature down to reasonable limits, the deck openings to pass that air have to be very large. In view of the menace from the air, the smaller the deck openings we have the better. That is rather an important point in connection with our objection to the gas turbine for naval purposes, but I am not so pessimistic as to think that I shall not live to see it.

With regard to the difficulties that Mr. Freeman refers to in connection with the priming of boilers, I do not know whether the controlled circulation in our boilers is really responsible for our freedom from it so much as our distilled feed-water. I think the latter is the main cause. At any rate, I can only say with joy that we do not suffer from priming. The superheaters are a great help, for even if a little priming does take place, water does not come over. But with our modern rates of boiler forcing, if the automatic feed regulator sticks open you can fill up boiler, superheater, as well as a few auxiliary engines before you know where you are. I would hardly class that as priming, however.

The author asks, can bare shafts be adequately protected from corrosion? The Corrosion Committee in this country is doing very good work on that point, and I think within reason that such shafts can be protected from corrosion. I can only say that we have extraordinarily little trouble from it ourselves. We use bare shafts in the Navy.

As to things wanted, there are one or two things that we could do with very well. One is a simple and robust detector of poisonous or inflammable gas. A ship is a maze of small compartments which have to be entered and examined, and we do really want a reliable detector. At present I know of none. One wants something that can be used easily, not an elaborate chemical outfit. Human nature being what it is, a man will put in a safety lamp and see it go out, but still take no notice of it —a case, I think, of familiarity breeding contempt.

Mr. J. H. Narbeth, C.B., C.B.E., M.V.O. (Great Britain)* : The members are fortunate in having a paper put before them by an engineer who has taken an active part in so much engineering progress, and who also has a wide experience in the progress of ship design, and in the production and management of ships.

Mr. Freeman has done well to record that in all kinds of progress there are difficulties. A pooling of experience is a very great help to naval architects and marine engineers; experience which merely records the great successes is not sufficient. The greatest value can be obtained from experience *only* when manufacturers and builders are willing to record their failures as well as their successes; otherwise as new inventions come along each manufacturer has to follow the same rocky path, treading down the same difficulties. The history of the development of the Diesel engine in this country is, perhaps, a special example of the losses sustained by the lack of such a policy.

Mr. Freeman's paper will be especially appreciated by naval architects, because they have a two-fold interest. They are keenly interested in the progress of propelling machinery in order to secure machinery of the highest efficiency, but they are concerned also with the effect of variations of machinery upon the structure and the dimensions of the ship. It is, perhaps, not always fully appreciated how far-reaching the effect of changes in machinery may be upon the design of the ship. As an instance of this, when the design for H.M.S. "Dreadnought" was being prepared, it was suggested for consideration that Parsons turbines should be adopted for her propelling machinery. The Admiralty Committee considering the design immediately wanted to know what effect this would have on the design. The reply was that the change from reciprocating engines to Parsons turbines would mean a reduction of 1,000 tons in the displacement, and £100,000 in the cost of the ship. The Committee accepted the idea of Parsons turbines, and the results forecast were obtained. I was much interested when listening to Admiral Sir George Preece, to hear him touch on the other aspect of the matter, where we are now visualizing an increase of space and weight due to advances in marine engineering, which are not so welcome as the advance I have just mentioned.

Naval architects were fascinated with the development of the Parsons turbine, because it provided a prime mover running at a uniform speed and without any reciprocating parts. Unfortunately, as Mr. Freeman says, the Diesel is still a reciprocating engine, and that means serious drawbacks for the higher powers. The drawbacks are, however, greatly mitigated in the opposed-piston engine, respecting which great progress has been made in recent years. An internal-combustion turbine, or a rotary engine without reciprocating parts, which would combine the advantages of the steam turbine and the Diesel, would be a wonderful achievement, but Nature seems to object. In each case the temperature losses by conduction would be greatly increased. It is sad to think that in a good Diesel engine the losses through conduction still carry off about one-third of the energy of the fuel. The compound Diesel is faced with a great falling off of efficiency for the same reason. In addition, as regards the gas turbine, a condensing fluid is called for, and in this respect experiences with Yarrow's naphtha engine using naphtha as fuel might be remembered.

From a national point of view a better utilization of coal is a matter of the utmost importance, and, if Diesel's dream could come true, viz., to utilize the coal direct in an explosive engine, that would be a great boon. The direct combustion of coal-dust in a cylinder would of necessity involve production of ash which would damage the cylinders and pistons sooner or later—probably sooner—but even if a coal were available which contained no ash, it seems more than possible that after being carried to a high temperature, imperfect combustion of the coal dust might still produce very damaging particles. It was my impression that Diesel with his coal engine reduced the coal to nuts, and gasified it before it entered the cylinder. An engine of this type was manufactured in this country many years ago. It was, I believe, about 54 h.p., and was in use at Keighley in Yorkshire for many years. A parallel process was carried out successfully for a long time in the utilization of refuse from sawmills for producing gas, which was consumed in gas engines.

But for the advent of the electric grid, and all that that means to the countryside, it is possible that the development of moderate-sized coal-consuming engines of such a type might have considerably progressed, and might even have developed into something which would have been suitable for the propulsion of ships.

Again, if perhaps I may touch once more on past history, Mr. Freeman refers to an experimental gas-engine built in 1910. It may be interesting to note that in 1911 the Admiralty gave its approval to fitting an experimental gas-engine as propelling machinery in the old second-class cruiser "Dido". One boiler-room was to be gutted and used for gas producers, etc., and one engine-room was to be gutted and used for the gas engines, utilizing the shafting and propeller on one side of the ship, the steam engines and shafting on the other side being retained as a stand-by arrangement, and for moving the ship as might be required during the trials. The gas-engine outfit was to be of the "Carel" type.

* Read by Mr. J. H. Narbeth, junr., B.Sc., R.C.N.C.

Alternative designs were prepared by Messrs. Vickers at Barrow, the late Sir Robert McKechnie taking a very great interest in the scheme. After considerable investigation, however, it was found inadvisable to proceed with the installation, because of technical difficulties.

Major W. Gregson, M.Sc. (Great Britain): I did not mean to speak on this paper, but I have got up on account of Mr. Hamilton Gibson's remarks relating to the use of economizers at sea.

We all know how effective the economizer is in land practice, but at sea the conditions for obtaining high overall thermal efficiency are somewhat different owing to the steady operating conditions which normally apply once a ship has put to sea, corresponding to unity load factor in land practice. Marine conditions are such that full advantage can be taken of stage-feed heating—and this source of economy is cut down if economizers are fitted. The way to obtain the best thermal balance on a marine installation appears to be stage-feed heating plus air preheaters, and the only case where economizers come into the economic picture is where we use pressures which mean (owing to the high saturated steam temperature) too high a boiler gas-leaving temperature for an air heater to give the requisite overall boiler efficiency. In such a case a comparatively small economizer to help out the air heater, together with suitable stage feed-heating seems to be called for.

Regarding the general question of economic steam pressures and temperatures, the majority of our modern British ships of size are running at about 450 lb. pressure, with a steam temperature of about 750° F., and I had hoped that some of our Continental friends would have given us some data from some of their latest ships running (I believe) at pressures and temperatures well above these figures. My own opinion is that—owing to turbine losses due to excessive wetness in the L.P. stages—little gain in *overall* efficiency is obtainable by increasing initial pressures much above the 450-lb. mark, until metallurgists will allow us readily to operate at much higher initial superheats than obtain at present, or alternatively, until we adopt a reheat cycle.

A reheat cycle—bringing the steam back to the boilers—is not so difficult to arrange as is commonly thought, as in such cases reheating will be carried out at reasonably high pressures, which in turn keeps down the sizes of the interconnecting pipework, and the area through the reheater sections.

It may appear to be rather stressing the obvious, but I would mention that what *really* matters in comparing the relative values of various machinery arrangements and designs is the measure of fuel used per s.h.p./hour *for all purposes,* and this calls for a well-balanced correlation of the whole design.

Have the few super-pressure installations at present at sea really bettered the performance put up by the British 450 lb./750° F. ships? Perhaps our Continental friends will give us some figures in this connection.

I think Mr. Freeman has erred on the conservative side with his weights per s.h.p./hour in dealing with modern steam installations, whether geared turbine or turbo-electric drive. The figures given apply to existing jobs where I think too much spare plant is carried, particularly boilers; this is undoubtedly due to executives wishing to prove for themselves that steam plant to the order of 450 lb/750° F. is as thoroughly reliable as low-pressure jobs. When, however, spare boiler plant is eliminated, individual boiler cleaning being effected at sea by running up the rating of the other units, then in both cases relating to modern steam, the weight per s.h.p./hour is well below the 200 lb. mark.

The Chairman: I should like you to carry by acclamation a vote of thanks to Mr. Freeman for the excellent and most interesting paper which he has contributed, and also to those members of the gathering who have dealt with the subject in discussion. (Loud applause.)

By Correspondence.

Mr. J. Hamilton Gibson, O.B.E., M.Eng.: If I may be permitted to add to my remarks on this paper, I would like to make a short reference to the Author's table of relative weights on page 150. In columns 2 and 3 the weights per s.h.p. for geared turbine machinery are given as 250 lb. and 230 lb. respectively. I suggest that these figures should be reversed. It is generally conceded that electric transmission is about 10 per cent. less efficient than mechanical gearing, therefore for the same total s.h.p. the boilers and turbines have to generate about 10 per cent. more power with a corresponding increase of weight. Some years ago, about 1932, Mr. T. E. Ferris, in a paper read before the American Society of Naval Architects and Marine Engineers, gave complete estimated weights of machinery for a 30-knot ocean liner wherein 20 boilers were required for electric transmission as against 18 for geared turbines, the increase of total weight being over 12 per cent. I rather expected that a subsequent speaker would raise this question during the discussion, but, as no one did so, that must be my excuse.

Mr. W. Hamilton Martin (Great Britain—M.I.Mar.E.): The author when referring to steam reciprocating engines asked whether the refinements he mentioned would not be too complicated for engines below 1,000 s.h.p., and whether turbines were not preferable over 6,000 s.h.p. In view of the reliability of the modern reciprocating engine, there would seem to be little difficulty in increasing its expansion stages to make the best use of high pressures and high superheats even if reheating is to be resorted to. A six-cylinder engine of the sextuple expansion type would seem to have much to recommend it over a combined reciprocator-cum-turbine type, there being no intermediate shafting and gearing. It should be easily attended to, and simply overhauled at low cost. It would lend itself to a wide range of sizes, say, from 250 to 6,000 s.h.p., and to standardizing of parts. Its upkeep should compare very favourably with the modern oil-engine, and in many ways it might prove preferable for all round marine service.

Oil in emulsion is not easily removed from feed-water. If the oil forming an emulsion exceeds three grains to the gallon, or about 1 part of oil in 20,000 parts of water, it is liable to cause serious damage to the boilers. Oil that floats can be easily entrapped; filtering removes only part of the oil emulsified, but every precaution is necessary to keep the oil content down to within 1 to $1\frac{1}{2}$ grains per gallon. Modern L.P. rod packings which keep the cylinders tight enable one nowadays to keep within these limits. To do so, however, a feedwater oil gauge becomes an absolute necessity, as it enables the operator to check at any instant, or preferably periodically, the amount of oil entering with the feed-water, while it also allows him to judge any alteration in the system, or adjustment of improvements he may effect in the working arrangements, the filtering system, the feed-water circuit, etc. It indicates to him just when the filters demand cleaning, changing, or recharging, depending on the system. Boiler and condenser efficiency, and working of the installation in general are bound to benefit thereby.

The author mentioned the use of engines run on gas in smaller ships in home waters as an alternative to oil or coal fuel. Light reinforced containers are becoming a practical proposition for the carriage of highly compressed gases. If, then, suitable high calorific value gas from indigenous fuels and of a non-dissociating nature can be made available at harbours, piers, or landing-stages, piped under pressure for recharging a ship's containers, this might prove an outlet for such home fuels, although it would be only for short hauls, such as ferries, shuttle services, pleasure craft in coastal watering-places, etc., at best a restricted field.

Breakdowns of crankshafts, shafting, gearing, turbo-rotors, etc., may be caused by insufficient static balance, to which reference is made in the discussion on the paper by Messrs. Lugt and Visser.

During the last ten years several attempts have been made here for the licensors of the coaldust-engine to get a stationary or marine type engine built in Great Britain. As such an engine would be the most economical consumer of coal for a given output, and our British and Empire coals (also the Chinese coals) are particularly suitable for it, steps in this direction are much overdue, and Government assistance might induce interested parties to carry out an investigation. One would have thought that by now the Fuel Research Station or the Admiralty Laboratory would have had such an engine under test. It ought to be of interest to some shipowner or those using cheap Chinese coal, and certainly our coalowners and the Coal Utilization Council might take some practical interest in its development.

Many stationary oil-engines could, and ought to, be made convertible to coaldust operation in times of stress, thereby releasing vital oil supplies for the fighting forces. In the 1937 Bulletin of the Diesel Engine Users Association the writer had occasion to indicate what is being done on coaldust engine development in Germany to-day. He also gave information on its development in his remarks on Captain Acworth's paper at the I.N.A. Spring Meeting, 1938. Opinions expressed by well-known British scientists and experts on its importance appear in an article entitled "Prime Movers for Indigenous Fuels", published by the writer in *Gas and Oil Power* of February, 1936.

Much remains to be done on propellers, and especially the multi-bladed type deserves closer attention in the writer's opinion, as smoother vibrationless action would seem attainable with it, so vital to the passengers' and the crew's comfort and the efficient running of the machinery and the ship itself.

The de Meo system of central propulsion would seem to be well worth trying out in practice, and it would seem that either by means of a small self-propelled model, or by the use of two outboard motors fixed amidships in a small rowing-boat, some of its features could be quickly and inexpensively proved, after which a larger vessel could be so fitted. Its possibilities certainly seem very attractive.

The Author's Reply to the Discussion.

Mr. J. Hamilton Gibson has had a long and intimate acquaintance with that problem of putting a quart into a pint pot in which the marine engineering design office specializes, and it is noted that he does not quite see how reheating can be arranged in the limited space available. For the larger powers it certainly is a problem. As regards the testing of engines on the test bed, the point at issue was rather to determine the fuel consumption per horse power and not those other problems of reliability and wear that can only be answered after long experience under actual operating conditions. We are to-day testing oil engines of 12,000 b.h.p. on the test bed, but not steam engines of that output. As regards directly driven propellers, cavitation has led to such troubles with erosion of blades, as well as loss of efficiency, that it is reasonable to assume that propeller designers cannot give us maximum efficiency with natural steam turbine rate of revolutions of the propeller. Mr. Hamilton Gibson is right in claiming efficiency for his torsion-meter, but the cost of modern meters is a deterrent to the plainer class of ships. The broken crankshafts and the abnormally proportioned shaft are part of the early troubles of the oil engine. Those who remember the McIntyre tank top construction will realise that the steam engine in the days when such were fitted was not on sure foundations. The modern oil engine is put on adequate seatings just as the modern geared turbine is bedded on special seats, often of cast iron, and peculiar to the requirements of the engine. Present-day boilers are probably better when fitted with air preheaters and with stage feed heating rather than with economizers, which are more suitable to the conditions of land practice. As regards the question of weight per horse power, one is in the hands of various shipbuilders and engineers to obtain a wide range of data on this subject, and the figures given have been taken from different installations and are believed to be typical, if not absolutely correct, over the whole range of existing ships.

Mr. G. T. Lugt's contribution to the discussion was very welcome. He has got hold of the right idea when he says that the paper is a tilt at the designer, as it certainly has been written from the point of view of the operating engineer. The paper is a series of questions, and an old adage says that "A fool can ask more questions than a wise man can answer". But suppose that we ask ourselves these questions and also attempt the answers, how then? Shipowners appreciate the fact that the oil engine is burning residues from the petrol industry, and that if engines can be built to take advantage of the use of comparatively cheap residues, they will be able to operate their ships more economically. That is the reason for attempting to develop the oil engine to suit the oil.

Mr. R. Jolly has the sympathy of all of us who are trying to get the best use of our machinery with a class of engineers widely different from those who used to take up marine work. I can only suggest that the troubles to which he refers are temporary, and when the pressure of rearmament has lessened, we shall get back to our old conditions. I would suggest that although these newcomers are not highly-skilled craftsmen and have little knowledge of the technical side of the business, they can, in many cases, be trained to use their five senses as watchkeepers, and so be of use while the machinery is running, even if they are not of much value to repair the engine when it has stopped.

Eng. Vice-Admiral Sir George Preece has suggested an invention which would be of great value not only in the Navy but elsewhere in marine work, and many of us will be attempting to discover a simple and robust detector of poisonous or inflammable gas, which can be used easily and not be an elaborate chemical outfit. His aphorism that economy and comfort do not go together is perhaps specially true in its marine application. It is most interesting to hear that possibly the gas turbine is not so far away as is commonly supposed. Several schemes for gas turbines have been put forward lately, but Sir George's point that the very large quantity of air required will need large deck openings is one which is not commonly envisaged in this connection. His testimony that distilled feed water is probably responsible for the freedom from priming in naval boilers, and that bare shafts are used successfully in the Navy is of much value.

Mr. J. H. Narbuth's review of the connection between the type of machinery and naval construction is most interesting, and his very wide experience in this connection is most valuable.

Major Gregson's suggestion that our Continental friends should give us some figures in connection with the relative values of various machinery arrangements and designs using the fuel per s.h.p./hr. for all purposes as one of the criterions of value appeals to us very fully. The experience of Major Gregson's firm with water-tube boilers is of course second to none, and his remarks are most welcome.

Mr. Hamilton Martin has made a number of useful points in his contribution to the discussion which explain themselves. His suggestion of light reinforced containers for highly compressed gases as bunkers in coastwise craft looks a practicable suggestion which should be tried. The Coal Utilization Council might take action to help this development as he suggests.

Finally, the author would desire sincerely to thank those who have contributed to this discussion. The matters of which we are ignorant are as diverse and as interesting as those on which we imagine ourselves to be fully informed, and any addition to our knowledge as a result of our attempts to solve these problems is very welcome.

International Conference of Naval Architects and Marine Engineers.

By a happy coincidence the current presidential year, which will include the *fiftieth anniversary of the foundation of The Institute, has given occasion to record an event of exceptional interest and importance, and appropriate to such an outstanding session—the International Conference of Naval Architects and Marine Engineers, held in London on Thursday, 16th June to Saturday, 18th June, 1938, under the joint auspices of The Institution of Naval Architects and The Institute of Marine Engineers.

The International Meeting, initially convened by the Institution of Naval Architects in the spring of 1937, became a joint affair as a result of the Institute Council deciding, on the suggestion of Mr. A. Robertson, the Honorary Treasurer, at their meeting on 5th April, 1937, to ascertain the possibilities in regard to co-operation with the sister Institution in their offer of hospitality to the various kindred foreign societies to whom they (and in respect of the Society of Naval Architects and Marine Engineers, New York, we equally) were deeply indebted for similar courtesies at past conferences in their countries.

At their next meeting, on 3rd May, the Council deputed the Honorary Treasurer and the Secretary to interview the Secretary of the Institution of Naval Architects on the subject, with the result that a formal resolution passed by the Council at their meeting on 7th June, suggesting the abovementioned co-operation, was conveyed to the Council of the Institution of Naval Architects at their meeting on 17th June.

This preliminary suggestion was accorded warm approval, and after steps had been taken to ensure the necessary co-ordination with the impending International Engineering Congress at Glasgow, the Council decided, at their meeting on 5th July, to approach the Council of the Institution of Naval Architects with a formal request that the London Conference be arranged as jointly between the two institutions under the title of "International Conference of Naval Architects and Marine Engineers", The Institute undertaking to share equally with the Institution the expenditure involved and to contribute one or more papers on the engineering subjects of the Conference programme.

The Council of the Institution of Naval Architects whole-heartedly agreed to this request at their meeting on 15th July, this agreement being reported at the meeting of The Institute Council on 6th September, and the Institution having requested the appointment of a further representative of The Institute on the Conference Committee, i.e. in addition to the Honorary Treasurer and the Secretary, on Mr. Robertson's proposal Mr. J. M. Dewar was appointed in this capacity. The representatives of the Institution of Naval Architects on the Committee were Sir Charles J. O. Sanders, K.B.E. (Chairman), Mr. G. S. Baker, O.B.E., D.Sc., Mr. James Montgomerie, D.Sc., Mr. A. T. Wall, O.B.E., A.R.C.S., and Mr. J. L. Adam.

By November, in response to invitations from the promoting institutions, offers of financial support had been received from the leading shipbuilding and marine engineering firms in the country, and at The Institute Council meeting of 6th December the completion of the programme of main events was reported. In respect of one of the most important of these events, a reception by the Lord Mayor, Sheriffs and Court of Common Council of the City of London in the Guildhall, to which reference will be made later, the indebtedness of the two institutions to Mr. Alfred Robertson, C.C., for his valuable liaison services must be recorded. His unremitting activities in connection with the promotion and arrangement of this event were recognised in a vote of thanks accorded to him by the Conference Committee at their meeting on November 30th, and later, as Chairman of the Special Reception Committee of the City Corporation he earned and received the special thanks of The Institute Council at their first post-Conference meeting on 11th July, 1938.

In response to the general invitation issued to kindred foreign societies and naval representatives, the following acceptances were notified: *Argentine:* The Naval Attaché in London; *Belgium:* Societé Royale Belge des Ingenieurs et des Industriels; *Brazil:* Representatives of the Brazilian Navy; *Denmark:* Representatives of naval achitecture and shipbuilding; *Finland:* the Naval Attaché in London; *France:* Association Technique Maritime et Aeronautique, and the Assistant Naval Attaché in London; *Germany:* Schiffbautechnische Gesellschaft and the Naval Attaché in London; *Holland:* Koninklijk Instituut van Ingenieurs, Groep Nederlandsch—Indie van het Koninklijk Instituut van Ingenieurs, Nationaal—Technisch Instituut voor scheep-en Luchtvaart, and the Naval Attaché in London; *Italy:* The Italian Minister of Marine, Sindacato Nazionale Fascista Ingegneri, Vasca Nazionale per le Esperienze di Architettura Navale, and the Assistant Naval Attaché in London; *Japan:* Losen Kiokai; *Norway:* one delegate; *Poland:* Stowarzyszenie Polskich Inzyniero w Budownictwa Okretowego; *Sweden:* Svenska Teknologforeningen, Tekniska Samfundet, and the Naval Attaché in London; *United States of America:* Society of Naval Architects and Marine Engineers, and the Naval Attaché and Assistant Naval Attaché in London.

* 2nd February, 1939.

THE INAUGURAL LUNCHEON AT GROSVENOR HOUSE.

ANOTHER VIEW OF THE INAUGURAL LUNCHEON.

A full list of the delegates who eventually attended the Conference is given at the end of this report.

On Wednesday evening, 15th June, the eve of the opening of the official proceedings, the Chairman and Committee of Lloyd's Register of Shipping very kindly tendered a reception to the overseas delegates at the Society's headquarters in Fenchurch Street. The guests, who numbered between 600 and 700, were received on behalf of the Members of the Committee by the Chairman, Sir George Higgins (Past-President, Inst.Mar.Engineers) and Lady Higgins, and by the Deputy Chairman, Mr. Ernest L. Jacobs and Mrs. Jacobs. During the evening the string band of H.M. Grenadier Guards played selections of music. The occasion afforded opportunity for conversation between many British guests and friends from overseas.

On Thursday morning, 16th June, at 11.30 a.m., the inaugural reception took place at Grosvenor House, Park Lane, W.1, where the guests were welcomed by Lord Stonehaven, the President of The Institution of Naval Architects, and Lady Stonehaven, and Sir Julian Foley, the President of The Institute of Marine Engineers. Luncheon was then served, the guests being seated in intermingled groups of foreign delegates and British members at separate tables, an arrangement which helped greatly to develop the friendly atmosphere which prevailed. Lord Stonehaven presided, and, after the loyal toasts and those of the sovereigns and heads of the other countries represented had been drunk, made, in cordial and sincere terms, a short speech of welcome to the visitors from overseas, and received the unanimous assent of the company that a telegram should be sent from the Conference to H.M. The King of Sweden, signifying its greetings and congratulations on his attainment of his 80th birthday, the King having been an Honorary Member of the Institution of Naval Architects since 1911.

The response to Lord Stonehaven's welcome was made by Jonkheer O.C.A. Van Lidth de Jeude, President of the Koninklijk Instituut van Ingenieurs, this duty being delegated to him as representing the senior technical organisation officially represented, the Koninklijk Instituut having been founded in the year 1847. He said that the two institutions under whose auspices they were met gloried in a high standard in this country and abroad. All were aware of the predominance of Great Britain in naval architecture and marine engineering. A Conference like the present one was a most valuable stimulus to international co-operation. International co-operation, all knew, was a very complicated problem, which required careful manœuvring. It might be compared with hard steel, which had to be shaped and which engineers from all parts of the world had to rivet and weld to the welfare of mankind and to the benefit of the human race.

After luncheon, the following papers were read and discussed at Grosvenor House, Lord Stonehaven presiding over the reading of the two first-named, and Sir Julian Foley over the two last-named, the two groups being dealt with concurrently in separate rooms:—"Trends in Shipbuilding", by Dr. James Montgomerie (Great Britain); "Effect of New Safety Regulations in Senate Report No. 184 on the Design of Merchant Ships", by Commander Howard L. Vickery (CC), U.S.N. (United States of America); "The present Trend in Marine Engineering in the United States of America", by Mr. John E. Burkhardt (United States of America); and "Marine Engineering Problems of To-day", by Mr. Sterry B. Freeman, C.B.E., M.Eng. (Great Britain).

Mr. Freeman's paper, with the discussion, is published in this issue of the Transactions. The remaining papers and discussions will be published with the Institution of Naval Architects' report of the Conference in the 1938 Volume of Proceedings of that Institution.

In the evening at 10.0 p.m. there followed a reception by H.M. Government at Lancaster House, St. James's, S.W.1, when the guests were received by the Right Hon. Alfred Duff Cooper, P.C., D.S.O., M.P., First Lord of the Admiralty, and Lady Diana Cooper.

On the morning of Friday, 17th June, the reading and discussion of papers was resumed at the Royal Society of Arts, John Street, Adelphi, W.C.2. The following contributions were dealt with, under the chairmanship of Dr. S. F. Dorey as regards the two first named, and of Sir Eustace Tennyson-D'Eyncourt as regards the two last named, the reading and discussion of the two groups proceeding simultaneously in separate rooms:—"Experimental Methods to Determine the Strength of Materials in Relation to Shipbuilding", by Monsieur H. de Leiris (France); "Whirl of Diesel Engine Crankshafts", by Messrs. G. J. Lugt and N. J. Visser (Holland); "Ocean Waves, Freeboard and Strength of Ships", by Professor Dr.-Ing. G. Schnadel (Germany); and "Some Contribution to the Theory of Rolling", by Professor Yoshihiro Watanabe (Japan).

On Friday morning, as an alternative to attending the technical session, many of the delegates took the opportunity of visiting the Royal Naval College and the National Maritime Museum at Greenwich, embarking at 11.15 a.m. in the paddle steamer "Thames Queen" from the Tower Pier. On disembarking at 12.0 noon at Greenwich Pier, the visitors entered the College grounds by the Royal Gate, and were received by Captain L. H. K. Hamilton, D.S.O., in the absence due to illness of the Admiral President. After visiting the College Buildings the party left the College grounds by the East Gate for the National Maritime Museum, where lunch was served, by the kind invitation of the Director, Professor Sir Geoffrey Callender, M.A., F.S.A., at which Lord Stonehaven presided. After visiting the Galleries, tea was served in the Museum, and the party re-embarked at Greenwich Pier at 4.15 p.m. for the Tower Pier, which was reached about 5.0 p.m.

The same afternoon other members visited the National Physical Laboratory at Teddington, and were received by the Director, Dr. W. L. Bragg, and Dr. G. S. Baker. Visits were paid to the William Froude Laboratory and the Engineering Department, and tea was served in the Laboratory canteen. On this trip the party was transported by motor coaches from the Royal Society of Arts to and from the Laboratory.

In the evening at 8.30 a reception was given in the historic Guildhall, London, E.C.2, by the kind invitation of the Right Hon. The Lord Mayor, Sir Harry E. A. Twyford, Alderman Colonel Richard William Eaton, Sheriff, Major William Henry Champness, Deputy Sheriff, and the Court of Common Council of the City of London.

The Right Hon. the Lord Mayor, the Lady Mayoress, Sheriffs and their ladies were received at the entrance to Guildhall by the Special Reception Committee and their Chairman, Mr. Alfred Robertson, who introduced Mrs. Robertson to the Lord Mayor and Lady Mayoress; Mrs. Robertson then presented a bouquet to the Lady Mayoress on behalf of the Special Reception Committee.

Mrs. Robertson had previously been presented with a bouquet by the members of the Committee.

The Lord Mayor, Lady Mayoress, Sheriffs and their ladies were then conducted by the Committee to the dais in the Library, after which the official reception proceeded.

The gathering numbered over 1,500, including members of the Corporation and their wives, delegates and guests. The members of the Corporation were very assiduous in conducting delegates over Guildhall and explaining items of interest which might otherwise have been overlooked.

The programme included dancing from 9 p.m. in the Guildhall to music by Dalton Marshall's Band; a Concert from 9.15 to 11.0 p.m. in the Council Chamber, the artistes being Mr. Webster Booth, Mr. Ernest Hastings, Mr. Jean Pougnet, Miss Gladys Ripley, Mr. and Miss Tree, and Mr. Thomas Best (accompanist); while in the Library

The Guildhall Reception. The Ceremony in the Library.

there was an exhibition of the ancient City Charters and manuscripts from the Corporation Record Office and the Guildhall Library. In the Art Gallery the Corporation's collection of works of art was on view, also a selection of the historic plate from the Guildhall and the Mansion House. Music was performed throughout the evening in the Art Gallery by the Orchestra from the Band of H.M. Royal Marines, Chatham Division (by kind permission of Brigadier A. L. Foster, D.S.O., and Officers) under the Director of Music, Lieut. Thomas Francis, L.R.A.M., A.R.C.M., R.M. Buffet refreshments were served from 9.15 p.m. in the Crypt under the Council Chamber, the Library Newspaper Room and in the ancient crypt adjoining the Museum. The Court of Aldermen Room and the Council Chamber were open throughout the evening, as was also the Museum, where the City's Collection of Antiquities was on view.

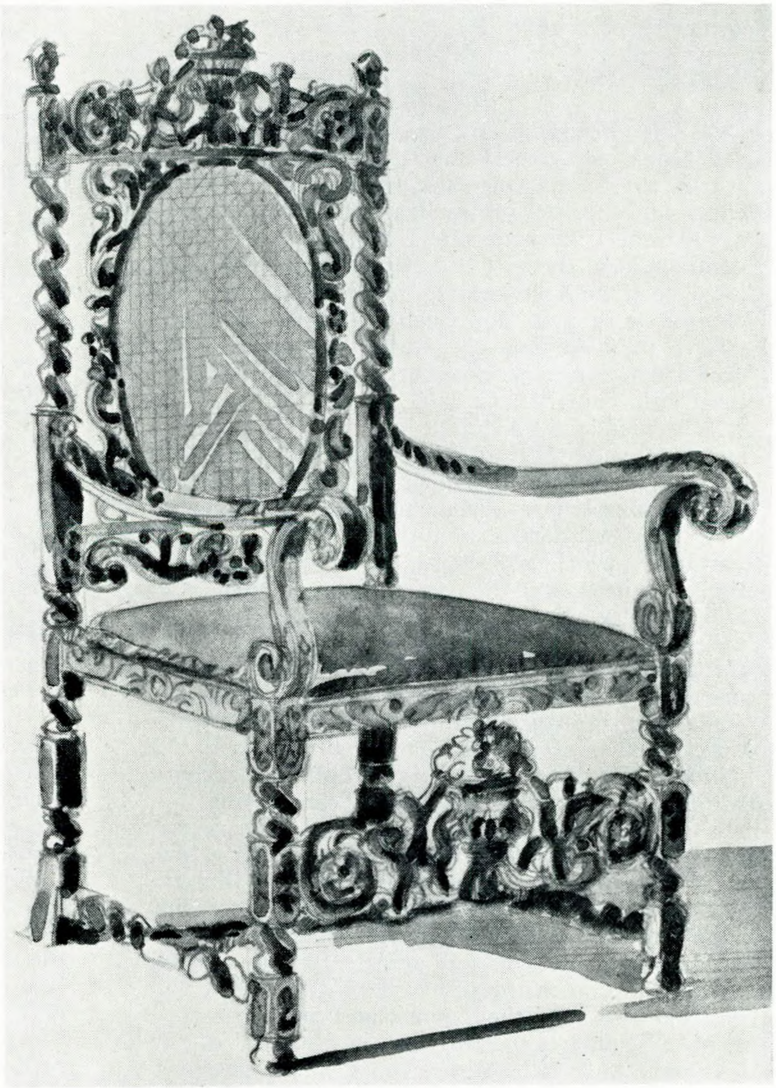
The Guildhall Reception was the outstanding event of the Conference, not alone for the overseas visitors, but for many members of the organising institutions, who saw the Guildhall and its rich treasures for the first time.

On Saturday, 18th June, some 350 delegates and ladies took part in an all-day up-river excursion to Windsor and Henley. The fine weather which had prevailed from the beginning of the Conference held throughout the day, enabling the Thames to be seen under ideal conditions.

Leaving Paddington at 10.0 a.m. by special train, the party arrived at Windsor at 10.30, and proceeded on a conducted tour of Windsor Castle, during which the Henry VIII Gateway, St. George's Chapel, the Castle Precincts, Terraces and Cloisters were visited, to the accompaniment of running commentaries by official guides.

Lunch was served at 12.15 p.m. at the Castle Hotel, and at 1.30 p.m. the party embarked on three river steamers for Bray, Maidenhead, Boulter's Lock, Cliveden Woods, Cookham, Bourne End, Quarry Woods, Marlow, Medmenham and Henley, tea being served on board. An enjoyable diversion was provided as the steamers traversed the lovely stretch of the river where Marlow Regatta was in progress. Disembarking at Henley at 7.0 p.m., the party returned by special train to Paddington, arriving at 7.50.

A farewell dinner was given the same night by the American delegates to the councils of the two British institutions at Grosvenor House. Mr. Joseph Powell, President of the American Society of Naval Architects and Marine Engineers, presided. In a felicitous speech at the close of the proceedings, Mr. Powell, on behalf of the American delegation, presented two chairs to Lord Stonehaven, President of the Institution of Naval Architects, and Sir Julian Foley, President of the Institute, in appreciation of the hospitality and cordiality extended to the guests. These handsome gifts were gratefully acknowledged in speeches by the two Presidents, who voiced, on behalf of their Councils, their surprise and pleasure on receiving such beautiful and permanent expressions of the goodwill which so obviously accompanied these gifts. The chairs, they said, would be used by the Presidents or Chairmen at institution meetings and functions,



Presidential Chair presented to The Institute by the American Society of Naval Architects and Marine Engineers.

where they would be constant reminders of the mutual friendships which the Conference just ended had renewed and sealed.

An artist's sketch of the chair presented to The Institute, which is of carved oak and bears an inscription recording the circumstances of the presentation, is here reproduced. The chair was used for the first time by the Chairman at the Council meeting on 11th July, at which meeting it was unanimously resolved that the Secretary send a letter to the American Society conveying the purport of the Council's resolution recording their appreciation of this gift. The letter sent was as follows :—

13th July, 1938.

"Mr. J. W. Powell,
President,
The Society of Naval Architects and
Marine Engineers,
29, West 39th Street,
New York,
U.S.A.

"Dear Mr. Powell,

"On Monday the Council of this Institute met "for the first time since the International Confer- "ence, and before proceeding with the ordinary "agenda the Chairman referred to the new Presi- "dential Chair, the gift of your Society, which you "have been kind enough to present as a tangible "expression of your appreciation of this Institute's "efforts to make you thoroughly welcome on the "occasion of your recent visit and participation in "the Conference.

"It would be difficult to find words to convey "adequately the warmth of the Council's gratitude "for this beautiful gift, which has been enthusiasti- "cally admired by every member who has seen it. "It is a most graceful and useful addition to our "furniture, which will be as much appreciated by "the Presidents and Chairmen of the Council who "will be privileged to use it as by the members "assembled at our meetings who will have the "pleasure of admiring it in its proper setting. The "inscribed plate on the back of the chair records "for all time the origin and date of this gift, while "the circumstances of the presentation will be "minuted in our archives, in addition to the account "which will be published in our Transactions.

"The last-named report will include a repro- "duction of the artist's drawing of the chair which "you handed to Sir Julian Foley; from this illustra- "tion our members who are, for various reasons, "unable to visit the premises will obtain an idea of "its beautiful design and craftsmanship, which "enhances so much the pleasure which the gift will "continue to afford the Council and members.

"At Monday's meeting, on the proposal of the "Chairman, Mr. R. Rainie, the Council passed a "unanimous resolution recording their gratitude to "your Society for the gift of this chair, and their "best wishes for your Society's future prosperity, "and I have the utmost pleasure in conveying this "resolution to you as directed.

"Yours sincerely,
"B. C. CURLING,
"Secretary."

On Monday, 20th June, many of the delegates travelled from Euston to Glasgow by a special train to attend the International Engineering Congress which was being held there during the ensuing four days in connection with the Empire Exhibition. A report of the Congress is published later in this issue.

Since the close of the Conference the following communications have been received :—

(From the President of the Society of Naval Architects and Marine Engineers, New York, to the President and Chairman of Council of The Institute of Marine Engineers) :

"Gentlemen,

For the Members of the Society of Naval Architects and Marine Engineers who were privileged to attend The International Conference of Naval Architects and Marine Engineers in London from June 16th to 18th, I wish to express our hearty thanks for a most delightful visit, to which even the pleasant weather added the last touch to make it a memory that will remain with us always. Nothing was left undone to make the Conference a great success and I can speak for all of those who were present in voicing our deep appreciation of the many courtesies, the thoughtfulness and the hospitality with which we found ourselves surrounded.

With best wishes, believe me, I am
Yours very truly,
J. W. POWELL,
July 5th, 1938. President."

(From the President of the Association Technique Maritime et Aeronautique, Paris, to the President of The Institute of Marine Engineers) :

"Cher Sir Julian,

J'ai attendu, après mon retour à Paris, que ceux de nos membres qui ont été de Londres à Glasgow soient eux-mêmes revenus en France, pour vous adresser à la fois nos félicitations et nos remerciements au sujet de l'International Conference of Naval Architects and Marine Engineers.

Je me fais, en effet, un devoir de vous complimenter pour la parfaite organisation de toutes les belles réunions auxquelles nos membres ont eu le plaisir d'assister. La Conférence de Londres a été un grand succès.

Mais je veux aussi vous exprimer notre profonde reconnaissance pour l'accueil si cordial et si hospitalier que vous avez bien voulu, réserver aux membres de notre Association. Ils ont hautement apprécié toutes les attentions dont ils n'ont cessé d'être l'objet, et ils ont été charmés par les magnifiques réceptions qui leur ont été offertes.

La Conférence de Londres aura, en outre, rendu à de nombreux ingénieurs de tous pays le service de se mieux connaitre; elle aura ainsi contribué efficacement au rapprochement des peuples, pour le plus grand bien de la science navale et plus généralement de la paix.

Je vous prie, Cher Sir Julian, de bien vouloir agréer l'expression de mes meilleurs sentiments.

Le President,
le 5 juillet 1938. MAX DAHON".

(From the President of the Societé Belge des Ingenieurs et des Industriels, Brussels, to the President of The Institute of Marine Engineers):

"Mon Cher Président,

La délégation belge a l'International Conference of Naval Architects & Marine Engineers, est rentrée de Londres, enchantee de la visite qu'elle a eu le plaisir de vous faire.

Nous avons tous pu apprécier le haut intérêt des communications qui ont été faites et nous avons été profondément touchés par toutes les amabilités dont vous nous avez combles.

Aussi, je tiens à vous exprimer les très sincères remerciements de la délégation belge en même temps que mes remerciements personnels.

Je vous prie d'agréer, Mon Cher Président, l'expression de mes sentiments de haute estime et confraternels.

le 25 juin 1928. MAURICE BERGER".

(From the President of the Vasca Nationale par le Esperienze di Architettura Navale, Rome, to the President of The Institute of Marine Engineers):

"Dear Sir Julian Foley,

I wish to thank you very much for the cordial reception and hospitality displayed towards myself, my daughters and the Italian Members attending at the International Conference of Naval Architects and Marine Engineers, promoted by the Institution of Naval Architects and by the Institute of Marine Engineers.

The Conference was really very important, its success will last, and every one will retain a vivid impression of the meeting. Believe me

Yours faithfully,
July 6th, 1938. GIUSEPPE ROTA".

LIST OF DELEGATES.

Argentine

FINCATI, REAR-ADMIRAL M., A. N. Naval attaché in London.
FINCATI, MME.
FINCATI, MLLE. M.
FINCATI, MLLE E.
FINCATI, MLLE. D.

Belgium

SOCIETE ROYALE BELGE DES INGENIEURS ET DES INDUSTRIELS

BELIARD, H. J. P., D.S.O., LT.-COL., Chairman and Managing Director, Béliard, Crighton & Co., Ltd.
BELIARD, MME.
SHERMAN, MME.
BELIARD, M. F., MLLE.
GEURTS, MLLE.
BERGER, MAURICE, President of the Society.
BERGER, MME. M.
BERGER-HAINAUT, MAURICE, Ingénieur Civil.
BERGER-HAINAUT, MME.
CROMBE, G., Ingénieur Civil Electricien.
CROMBE, MLLE.
DE BIEVRE, CYRILLE, Director, The Mercantile Engineering & Graving Dock Co.
DE BIEVRE, C. MME.
GHILAIN, JEAN, Ingénieur Commercial.
GHILAIN, MME. J.
*GRANDCHAMPS, M., Ingénieur Métallurgiste.
*GRANDCHAMPS, MME. M.
*GRAUX, LUCIEN, Past-President of the Society.
*GRAUX, MME. L.
GUILLAUME, JULES, Ingénieur Civil des Mines.
GUILLAUME, MME. J.
HEUSKIN, P., Industriel.
HEUSKIN, MME. P.
JONET, CH., Industriel.
JONET, MME. CH.
*KAESMACHER, C., Ingénieur des Mines.
MEULENBERGH, Ingénieur Civil des Mines.
MEULENBERGH, MME. C.
*MEUWISSEN, J., Professor of Naval Architecture, University of Ghent.
*MEUWISSEN, MME. J.
RYCKERE, P. DE, Ingénieur Civil Electricien.
RYCKERE, MME. P. DE.
UME, COLONEL F., Professor, Ecole Royale Militaire.
UME, MME.

DUFOUR, G., Superintendent Engineer, Cie Maritime, Belge, S.A.
DUFOUR, MME.
URBIN, G., Naval Architect.
URBIN, MME.

Brazil

ABRIEU, ENGINEER-COMMANDER S. W. DE, B.N.
ABRIEU, MME. DE.
NEIVA, J. M., Capt., B.N.
NEIVA, MRS.

* Also attending International Engineering Congress, Glasgow.

Denmark

*Berg, H. P., Managing Director, Nakskov Skibsvaerft.
*Berg, Mrs. H. P.
Löndberg-Holm, A., B.Sc., Naval Architect.
Löndberg-Holm, Mrs. A.
*Ringsted, E., Managing Director, Odense Staalskibvaerft.
*Ringsted, Mrs. E.

Finland

*Gröndahl, Commander H., Naval Attaché in London.

France

Bedin, Lieut. de Vaisseau, Assistant Naval Attaché in London.
Bedin, Mme.

ASSOCIATION TECHNIQUE MARITIME ET AERONAUTIQUE

*Augustin-Normand, A., Member of Council of the Association.
*Augustin-Normand, Mme.
Bahon, Max, K.B.E., President of the Association.
Bahon, Mme.
*Bogaert, P. W.
*Bogaert, Mme.
*Bonis, Gaston, Capitaine de Corvette de réserve.
Bourges, Georges, Secretary of the Association.
Bourges, Mme.
*Brillie, Henri, Former Chief Engineer of the C.G.T.
De Leiris, Henri, Ingénieur Principal du Génie Maritime.
Delaeter, Frederic, Secrétaire-Général, Ateliers et Chantiers de France.
Delaeter, Mme.
François, Charles, Inspecteur Général du Génie Maritime.
François, Mme.
Gaston-Breton, Former Managing Director of the Cie. des Chargeurs Réunis.
Gaston-Breton, Mme.
Janet, A., Engineer, Cie. des Messageries Maritimes.
Janet, Mme. A.
*Kahn, Louis, Ingénieur en Chef du Génie Maritime.
*Kahn, Mme.
Kerchove, R. de Baron, Expert Maritime.
Kerchove, Baroness R. de.
Latty, Jean, Ingénieur en Chef, Chantiers et Ateliers de la Loire.
Latty, Mme.
Lefol, Lucien, Directeur Général, Ateliers et Chantiers de France.
Lefol, Mme.
*Le Las, Maurice, Ingénieur.
*Le Las, Mlle.
Levy, Andre, Member of Council of the Association.
Levy, Mme. A.
Milne, J. A., Ingénieur en Chef, Ateliers et Chantiers de France.
Pernot, L. C., Union Industrielle et Financiére.
*Petersen, Anton, Ingénieur.
*Petersen, Mme.
Procacci, Gianni, Ingénieur du Génie Maritime Italien.
Rougeron, Camille, Ingénieur en Chef du Génie Maritime.
Salmon-Legagneur, M., Ingénieur en Chef du Génie Maritime.
Salmon-Legagneur, Mme.
See, Andre, Ingénieur en Chef, Société des Chantiers et Ateliers de St. Nazaire.
*Teissier du Cros, J., Ingénieur du Génie Maritime.
Teissier du Cros, Mme. J.

Germany

Siemens, Captain Leopold, G.N., Naval Attaché in London.
Siemens, Frau.

SCHIFFBAUTECHNISCHE GESELLSCHAFT

*Buchsbaum, Georg, Direktor des Germanischen Lloyd.
*Chi, Hsi J., Dipl. Ing.
Daasch, Oskar, Director der See-Berufsgenossenschaft.
*Ebert, Werner, Dipl.-Ing.
Engehausen, Wilhelm, Oberingenieur.
Engehausen, Frau.
Engehausen, Frl.
Erbach, Professor Dr. Ing.
Erbach, Frau.
*Fausel, Karl, Baurat a.D. und Wirtschaftsprüfer.
*Forkel, Otto, Dr. Ing.
*Gechter, Hans.
*Gloth, Friedrich, Dipl. Ing.
*Gloth, Fritz, Torpedo-Ingenieur.
Grube, Diedrich, Zivil-Ing.
Grube, Frau.
*Grundt, Erich, Geh. Baurat.
*Grundt, Frau.
*Grundt, Frl.
*Grunert, Kurt, Betriebsingenieur.
Heuser, Paul, Direktor der Demag. A.G., London.
*Höfling, L., Baurat.
Kanis, Paul, Dipl.-Ing., Inhaber der Turbinenfabrik Brückner, Kanis & Co.
Kanis, Frau P.
*Kleynmans, F. T.
Köhler, Albert, Ministerialrat a.D.
Kort, Ludwig, Dipl.-Ing.
*Lindenau, Paul, Ingenieur und Schiffbau.

* Also attending International Engineering Congress, Glasgow.

MELLER, KARL, Direktor der Siemens-Schuckert-Werke A.G.
MELLER, FRAU.
*MÖTTING, EMIL B., Zivil-Ing.
*NOLTENIUS, F. H. KONSUL, Direktor der Atlaswerke A.G.
ROSCHER, E. K., Dipl. Ing.
*SCHNADEL, GEORG, Dr. Ing. Professor a.d. Technischen Hochschule Berlin.
*SCHMIDT, REINOLD, Dr. Ing.
*SCHOWALTER, S., Dipl. Ing. Oberreg. Rat.
*SCHOWALTER, FRAU.
SCHULZ, CARL, Oberingenieur der Wilton-Fyeenord N.V. Schiedam (Holland).
SOHST, H.
STURM, KARL, Direktor der See-Berufsgenossenschaft.
*SÜCHTING, WILHELM, Dipl.-Ing., Stellv. Direktor der Kom. Ges. Blohm & Voss.
*SÜCHTING, FRAU.
WEICHARDT, RUDOLF, Marinebaurat.
WEICHARDT, FRAU.
WEINBLUM, G., Dr. Ing.
*WITT, FRIEDRICH, Oberingenieur.

Holland

DE BOOY, COMMANDER A., Naval Attaché in London.

KONINKLIJK INSTITUUT VAN INGENIEURS

*DEMMENIE, P., Director Technical Office P. Demmenie.
*DEMMENIE-BRIDEL, MRS. M. V.
GEHLEN, J. H., Chief Engineer, Hollandsche Stoomboot Maatschappij.
GEHLEN-POUW, MRS. E. R.
*GILJAM, B., Mechanical Engineer.
GROOTENHUIS, W. C., Director Technical Company W. C. Grootenhuis.
GROOTENHUIS, MRS.
LUGT, G. J., Chief Engineer, N.V. Werkspoor.
LUGT-VAN TYEN, MRS. M. J.
METZELAAR, A. C., Director, Nederlandsche Scheepsbouw-Maatschappij.
*MULLER, W. J., Member of Council of the Institution, President of Section for Mechanical Engineering and Naval Architecture.
*MULLER, MRS. J. A.
SALBERG, J. H. C., Director, Nederlandsche Dok-Maatschappij.
SALBERG, MRS.
VAN LIDTH DE JEUDE, JHR. O. C. A., President of the Institution.
VAN LIDTH DE JEUDE, MRS.
VERVAT, P., former Director Burgerhout's Machinefabriek & Scheepswerf.
VISSER, N. J., Engineer, N.V. Werkspoor.

GROEP NEDERLANDSCH-INDIE VAN HET KONINKLIJK INSTITUUT VAN INGENIEURS

*KORVING, A., Engineer, State Postal Service.
*KORVING, MRS.

NATIONAAL-TECHNISCH INSTITUUT VOOR SCHEEP-EN LUCHTVAART

*ARNTZENIUS, R. H., Captain R.N.N., Director Pilot Service.
*ARNTZENIUS, MRS.
BAST, L. W., Superintendent, Rotterdam Lloyd S.S. Co.
BAST, MRS. L. W.
*BOSSCHART, L., Consulting Engineer.
*BOSSCHART, MRS.
CANKRIEN, B. E., Assistant Director of the Institute.
CANKRIEN, MRS. B. E.
*CROLL, D., Director, Tandjong Priok Dry Dock Co.
*CROLL, MRS.
*DE KANTER, A., Director, Wilton-Fijenoord Yard.
*DE KANTER, MRS.
DE MEESTER, T. H., Director of Zeeland Steamship Co. (ret.)
DE MEESTER, MRS. T. H.
HOOYKAAS, J. C., Admiral, Director of Hydrographic Service.
HOOYKAAS, MRS. J. C.
*MEES, DR. PH. A. J., Hon. Secretary of the Institute.
*MEES, MRS. A. J.
PHILIPSE, M. C., Member, Tank Association.
PHILIPSE, MRS.
*PRINS, H. N., Director of Shipbuilding Dept., Netherlands S.S. Co.
*PRINS, MRS. H. N.
RUYS, D. T., Chief Engineer, Rotterdam Lloyd S.S. Co.
VAN EENDENBURG, L. C. M., Director, United Steamship Co.
BANSZKY, MRS. H.
*VAN HAERSOLTE, BARON, Director of the Institute.
*WALEN, MISS JANNETTE.
VAN HOBOKEN, A., Junr., Member of Council of the Institute.
VAN HOBOKEN, MRS.
VAN OMMEREN, B. C., Director, De Mass S.S. Co.
VAN OUWERKERK, L., Mechanical Engineer.
WESSELING, H. C., Director of De Schelde Yard.
*WILTON, W., Director Wilton-Fijenoord Yard.
*WILTON, MRS. W.

Italy

*DONDONA, MAGGIOR GENERALE DEL G. N. FILIBERTO, R.I.N., Ministero della Marina.
*TRENCHI, CAPTAIN E., R.I.N., Assistant Naval Attaché in London.
TRENCHI, MRS.

* Also attending International Engineering Congress, Glasgow.

SINDACATO NAZIONALE FASCISTA INGEGNERI AND VASCA NAZIONALE PER LE ESPERIENZE DI ARCHITETTURA NAVALE

*ROTA, GENERALE DEL G. N. GIUSEPPE, R.I.N., Senatore del Regno, President of the Vasca Nazionale.
*ROTA, SIGNORINA VITTORIA.
*ROTA, SIGNORINA ELVIRA.
*ROTA, SIGNORINA FELICINA.

SINDACATO NAZIONALE FASCISTA INGEGNERI

*GOBBI, ERNESTO, Dr. Ing., Naval Architect.
*GOBBI, SIGNORA.

VASCA NAZIONALE PER LE ESPERIENZE DI ARCHITETTURA NAVALE

*SANTIS, RENATO DE, Dr. Ing, Chief Engineer of the Vasca Nazionale.

OTHER DELEGATES

BOZZONI, GENERALE DEL G. N. GUSTAVO, Dr. Ing., Cantieri "Ansaldo".
*COSTANTINI, M., Lloyd's Register of Shipping.
*COSTANTINI, SIGNORA.
*COSULICH, AUGUSTO, Dr. Ing., Soc. Cantieri Riuniti dell' Adriatico.
*LAYET, ROMOLO, Dr. Ing., Naval and Mechanical Engineer.
*MONETTI, LUIGI, Dr. Ing., Soc. di Navigazione "Italia".
*MONETTI, MRS. L.
MONTECORBOLI, G., Dr. Ing. Cantieri "Ansalao".
*ORLANDO, MARCELLO, Cantieri F. lli Orlando.

Japan

ZOSEN KIOKAI

TOYAMA KOICHI, CONSTRUCTOR-LIEUTENANT I.J.N.
*NAGANO RIHEY, ENGINEER-LIEUTENANT I.J.N.

Norway

*AAMUNDSEN, C. N. R., B.Sc., Managing Director, Akers Mek Verksted A/S.
*AAMUNDSEN, MRS.

Poland

STOWARZYSZENIE POLSKICH INZYNIEROW BUDOWNICTWA OKRETOWEGO

BIELAWSKI, B., Lloyd's Register of Shipping.
GIELDZIK, H.
*NIEMIEC, G., Dipl. Ing., Chairman of the Society.
WITOWSKI, B., Lloyd's Register of Shipping.

Sweden

*BOLDT-CHRISTMAS, Captain G. F., R.Sw.N., Naval Attaché in London.
BOLLDT-CHRISTMAS, Mrs.

SVENSKA TEKNOLOGFORENINGEN

*SCHOERNER, COMMODORE YNGVE, Director of Naval Construction and Engineer in Chief, R.Sw.N.
*HOLMBERG, ENGINEER-CAPTAIN GUSTAF, Assistant Director of Naval Construction, R.Sw.N.
*CARLSON, SVEN, Civ. Ing.
SCHILLER, MISS K.

TEKNISKA SAMFUNDET

*ÅBERG, H.
HEDEN, E. A., Vice-Chairman of the Society, Director of A. B. Götaverken A/B.
HEDEN, MRS. TULLAN.
HEDEN, MISS GRETA.
HEDEN, MISS BERIT.
*INGELF, SVEN, Civil Engineer.
*LINDBLAD, PROFESSOR A., Sc.D., Chairman of the Society, Chalmers Technical University, Gothenburg.
*LINDBLAD, MRS. A.

FORSTER, S., Assistant Managing Director, Eriksbergs Mekaniska Verkstads.
HEMLIN, E., DR., Director of the Library, Chalmers Technical University, Gothenburg.
HEMLIN, MRS. C.

United States of America

WILLSON, CAPTAIN RUSSELL, U.S.N., Naval Attaché in London.
WILLSON, MISS E. R.
NELSON, COMMANDER G. W., M.Sc. (C.C.), U.S.N., Assistant Naval Attaché in London.
NELSON, MRS. G. W.

AMERICAN SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

*ARNOTT, DAVID, Council Member of the Society. Vice-President and Chief Surveyor, American Bureau of Shipping.
*ARNOTT, MRS.
*BALLARD, PROFESSOR L. J., Professor of Engineering, Webb Institute of Naval Architecture.
*BALLARD, MRS.
*THOMPSON, MISS H.
*DAVIES, J. A., Engineer, Marine Dept., Westinghouse Electric and Manufacturing Company.
*DAVIES, MRS.
*FIRMAN, HARRY, Vice-President and General Manager, Red Hand Composition Company, Inc.
*FIRMAN, MRS.
*GAWNE, CAPTAIN J. O. (C.C.), U.S.N., Bureau of Construction and Repair, Navy Department.
*GAWNE, MRS. J. O.
*GAWNE, J. O., Junr.
*GAWNE, MISS CHRISTINE.
*GERHAUSER, WILLIAM H., President, American Ship Building Company.
*GERHAUSER, MRS.
*GREGORY, HENDERSON B., Principal Engineer, Bureau of Engineering, Navy Department.
*HAFF, A. DUDLEY.

---

* Also attending International Engineering Congress. Glasgow.

*Herbert, Frederick D., Council Member of the Society, President, Kearfott Engineering Company.
*Herbert, Mrs.
*Hunnewell, Commander Frederick A., Chief Constructor, U.S. Coast Guard.
*Hunnewell, Mrs.
*Hunter, James B., Charge Hull Technical Division, Bethlehem Shipbuilding Corporation, Ltd.
*Hunter, Mrs.
*Jack, Professor J. R., Professor Emeritus, Department of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology.
*Jack, Mrs. J. R.
*King, J. H., Council Member of the Society, Manager, Marine Department, Babcock & Wilcox Co.
*King, Mrs.
Klitgaard, C. E., Superintendent of Construction and Repair Division, Standard Oil Company of New Jersey.
*Livingston, John, Vice-President and Chief Engineer, Th. Goldschmidt Corporation.
*Luckenbach, J. Lewis, Vice-President of the Society, President, American Bureau of Shipping.
*Luckenbach, Mrs.
*Main, A. M., Vice-President, Bath Iron Works Corporation.
*Main, A. M., Junr.
*Manzi, Julius C., Sales Engineer, Sperry Gyroscope Company.
Metten, John F., President, New York Shipbuilding Company.
Middleton, C. W., Council Member of the Society, Vice-President, Babcock & Wilcox Company.
Middleton, Mrs.
*Owen, Professor W. Selkirk, Professor of Naval Architecture, Webb Institute of Naval Architecture.
*Owen, Mrs.
*Powell, Joseph W., President of the Society and President of United Shipyards, Inc.
*Powell, Mrs.
*Robertson, A. J. C., Naval Architect, Fairbanks, Morse Company.
*Robertson, Mrs.
*Rock, Rear-Admiral George H. (C.C.), U.S.N., Ret., Past-President of the Society, Head of Webb Institute of Naval Architecture.
*Sauter, William V., President, American Engineering Company.
*Sauter, Mrs.
*Seward, Professor H. L., Council Member of the Society, Maritime Assistant to Secretary of Commerce.
*Seward, Mrs.
*Wilcox, Miss Florence.
*Sharp, George G., Council Member of the Society, Consulting Naval Architect.
*Sharp, Mrs.
*Sharp, Miss Jane.
*Smith, H. Gerrish, Vice-President and Secretary-Treasurer of the Society, and President of National Council of American Shipbuilders.
*Smith, Mrs. Gerrish.
*Smith, Townsend J., Assistant Manager, Construction and Repair Divn., Socony-Vacuum Oil Company.
*Smith, Mrs. Townsend.
Stanley, Thomas L., Consulting Engineer.
Stanley, Mrs. T. L.
*Swan, James, Council Member of the Society, Principal Marine Engineer, Bureau of Marine Inspection and Navigation.
*Tawresey, Rear-Admiral J. G. (C.C.), U.S.N. (ret.), Council Member of the Society.
*Tawresey, Mrs. J. G.
*Tode, A. M., Consulting Marine Engineer.
*Tode, Mrs. A. M.
*Vickery, Commander H. L. (C.C.), U.S.N., Assistant to Chairman of U.S. Maritime Commission.
*Vickery, Mrs. H. L.
*Walker, R. S., Chief Engineer, M.A. Hanna Company.
*Walker, Mrs.
*Wetherbee, C. P., Hon. Vice-President of the Society, Consulting Marine Engineer.
*Wetherbee, G. B., Engineering Design Divn., Bethlehem Shipbuilding Corporation, Ltd.
*Wetherbee, Mrs. G. B.
*Whitaker, Omar B., Manager, Marine Department, Sperry Gyroscope Company.
*Whitaker, Mrs.

Great Britain.

† Member of Institution of Naval Architects.
‡ Member of Institute of Marine Engineers.

‡Adam, H. D., Eng. Lieut.-Comm. R.N.((ret.).
Adam, Mrs. H. D.
†Adam, J. L. (Member of Council, I.N.A.).
‡Adamson, W. W.
†Allen, Ronald.
‡Allen, W. K. G.
‡Anfilogoff, N. A.
†Ayre, Sir Amos L., O.B.E. (Vice-President, I.N.A.).
Ayre, Lady.
†Baker, G. S., O.B.E., D.Sc. (Vice-President, I.N.A.).
Baker, Mrs. G. S.
†‡Balbirnie, R.
Spencer, Mrs. Norman.
†Batey, John T., D.Sc. (Vice-President, I.N.A.).

* Also attending International Engineering Congress, Glasgow.

†Beal, Ralph.
Beal, Mrs. R.
†Beckett, R. A.
†Belch, Alexander.
Belch, Mrs. Alexander.
‡Bell, Frank P.
†Bellingham, A. M., Major.
†Belsey, W. J.
Belsey, Mrs. W. J.
†Biggart, A. L.
Biggart, Mrs. A. L.
†Bolton, E. J.
†Boyd, John S., M.A., LL.B.
Boyd, Mrs. J. S.
†Boys, G. V., M.A. (Secretary, I.N.A.).
Boys, Mrs. G. V.
†‡Brand, J. C., C.B.E., Eng. Capt. R.A.N.(ret.).
‡Brigden, W. E. G.
†Bruce, A. D.
Bruce, Mrs. A. D.
†Bryant, Frederick, C.B., O.B.E. (Member of Council, I.N.A.).
‡Buchanan, John, Eng. Lt.-Comm. R.N.(ret.), D.S.M.
†‡Bull, J. W.
Bull, Mrs. J. W.
‡Burgis, F. M.
Burgis, Mrs. F. M.
‡Burn, Lewis.
†‡Calderwood, J., M.Sc. (Member of Council, I.M.E.).
Calderwood, Mrs.
†Caldwell, James, Major.
†‡Canter, G. W. G.
†Carter, G. E.
‡Christianson, W. A.
‡Clarke, R. T.
‡Cobb, W. S.
†‡Colville, F. J.
†Cooper, W. Roylands.
‡Corneille, John T.
‡Cranston, E. W.
†‡Crighton, A. E. (Vice-President, I.M.E.).
†‡Crighton, J.
‡Crompton, Thomas A.
Crompton, Mrs. T. A.
†‡Curling, B. C. (Secretary, I.M.E.).
Curling, Mrs. B. C.
†Dana, R. W., O.B.E., M.A. (Honorary Member, I.N.A.).
†Davidson, C. I.
‡Davies, F. B.
†‡Denholm, D. M.
Denholm, Mrs. D. M.
†‡Dewar, James M. (Vice-President, I.M.E.).
Dewar, Mrs. James M.
†‡Dewar, Norman M.
Dewar, Mrs. N. M.
‡Dodds, T. E.
†‡Dorey, S. F., D.Sc. (Member of Council, I.N.A., Vice-President, I.M.E.).
†Dugdale, F. W., B.Sc.
Dugdale, Mrs. F. W.
‡Edmiston, J. G.
‡Ellis, G. R., Eng.-Comm., R.N.(ret.).
‡Ellis, W. E.
†Farmer, J. D.
‡Flindt, E. Ivor.
Flindt, Mrs. E. I.
‡Flood, S. H.
‡Foley, Sir E. Julian, C.B. (President, I.M.E.).
†‡Fraser, Kenneth.
Fraser, Mrs. K.
†‡Freeman, Sterry B., C.B.E., M.Eng. (Member of Council, I.N.A., Vice-President, I.M.E.).
Freeman, Mrs. Sterry B.
†‡Garnett, H. A.
†Gibson, G. W. E.
†‡Gibson, J. Hamilton, O.B.E., M.Eng. (Vice-President, I.M.E.).
Gibson, Mrs. Hamilton.
†‡Gillies, R. M.
‡Goddard, J. Alan.
Goddard, Mrs. J. A.
†Goodall, Sir Stanley V., K.C.B., O.B.E., R.C.N.C. (Vice-President, I.N.A.).
†‡Gordon, S. G.
†‡Graham, J., O.B.E.
Graham, Mrs. J.
‡Gregg, A. E. C.
Gregson, W., M.Sc., Major.
Gregson, Mrs. W.
‡Gummer, R. H.
‡Hall, E. Richard.
‡Hampshire, Charles J.
‡Hansard, Douglas A.
†‡Hardy, A. C., B.Sc. (Associate Member of Council, I.M.E.).
Hardy, Mrs. A. C.
†Harris, J. W., Captain R.N.R.
Harris, Mrs. J. W.
‡Harvey, R.
‡Hatcher, E. C.
Heck, John S.
†‡Heck, W. Dennis, B.Sc. (Vice-President, I.M.E.).
†Helyer, A. J.
†‡Henriques, W. Q.
Henriques, Mrs. W. Q.
†‡Hill, W. Scott, Eng. Rear-Adml.
Hill, Mrs. W. Scott.
†Hillhouse, P. A., D.Sc., Professor (Vice-President, I.N.A.).
‡Hilton, G. M. B.
‡Hirschfield, S. B.
Hirschfield, Mrs. H. L.
‡Hoes, W. E.
†‡Hunter, Summers, Junr. (Member of Council, I.N.A., Vice-President, I.M.E.).
Hunter, Mrs. Summers.
†Hunter, T. S.

Hunter, Mrs. T. S.
†Hurd, Sir Archibald.
Hurd, Lady.
‡Hutchinson, G. R.
†Isherwood, Sir William, Bt.
Isherwood, Lady.
‡Jeffcoat, A. H.
†‡Jespersen, H. S.
†John, F. O. (Member of Council, I.N.A.).
‡Johnson, R. W.
‡Jolly, R.
‡Kennedy, R. S. (Vice-President, I.M.E.).
‡Kent, S. N. (Member of Council, I.M.E.).
†‡Kitching, G. W.
Kitching, Mrs. G. W.
†‡Knopp, Leslie.
†Kreitner, H., Dr. Ing.
‡Lawrie, P.
†Lillicrap, C. S., M.B.E. (Member of Council, I.N.A.).
‡London, J. T.
‡Luhrs, H. Gordon.
†Lyndsay, H. A., B.Sc.
Lyndsay, Mrs. H. A.
†‡McAlister, F.
†McGeoch, L. A.
†McGovern, John (Member of Council, I.N.A.).
McGovern, Mrs. J.
‡Macintosh, J.
‡MacKegg, H.
‡McLeod, R. J.
‡McLellan, F. M.
†McMenemey, W. H. (Member of Council, I.N.A.).
†McNeill, J. M., M.C., M.Sc. (Member of Council, I.N.A.).
McNeill, Mrs. J. M.
‡Main, James.
†Mark-Wardlaw, A. L. P., Captain (E.), R.N.
Mark-Wardlaw, Mrs.
‡Markham, Ernest, Wh.Ex.
Markham, Mrs. Ernest.
‡Marriner, G. T.
†Marriner, W. W.
‡Marshall, F. M.
Black, Miss B.
†‡Martin, W. Hamilton.
Martin, Mrs. R. Hamilton.
‡Mees, E. E.
†Meryon, E. D., R.C.N.C.
Meryon, Mrs. E. D.
‡Morton, Robert.
‡Moseley, O. H.
‡Mussett, G. A.
†Napier, H. A. M., B.Sc.
†Narbeth, J. H., C.B., C.B.E., M.V.O.
†Nicolson, D.
Nicolson, Mrs. D.
‡Ormiston, G.
‡Orren, R. N., Major, R.A.O.C.
†Page, W. P.
‡Padbury, R. B. P.
‡Palmer, J. E.
‡Parker, A. H. (Member of Council, I.M.E.).
†‡Parnall, W. R., Eng. Rear-Adml.
Parnall, Mrs. W. R.
†Parsons, Hon. Geoffrey L.
Parsons, Hon. Mrs.
‡Paxman, E. P.
†Payne, M. P., I.S.O., R.C.N.C. (Member of Council, I.N.A.).
†‡Peacock, James.
Peacock, Mrs. James.
†‡Pigott, S. J., D.Sc. (Past-President, I.M.E., Member of Council, I.N.A.).
†‡Pilmour, W. H.
‡Plows, G. B.
‡Porn, Marcel.
Porn, Miss Alice.
‡Porter, F. W.
Porter, Mrs. F. W.
†‡Potts, Robert S.
†‡Preece, Sir George, K.C.B., Eng. Vice-Adml. (Member of Council, I.N.A.).
‡Priestley, Leslie H.
‡Quarrell, A. P.
‡Rainie Robert, M.C. (Chairman of Council, I.M.E.).
‡Reid, F. H., B.Sc., Wh.Ex.
‡Rhynas, J. A.
†‡Richardson, A. W., Eng. Comm. R.N.(ret.), (Member of Council, I.M.E.).
Richardson, Mrs. A. W.
‡Richardson, C. G. G., Eng.-Lt., R.N.(ret.).
‡Roberts, E. G. Russell.
†‡Robertson, Alfred, C.C. (Hon. Treasurer, I.M.E.).
Robertson, Mrs. Alfred.
‡Robson, T. B.
†‡Roger, G. W.
Roger, Mrs. G. W.
†‡Rogers, C. H. D.
†‡Rogers, H. M.
Rogers, Miss H. L.
†Rouse, P. G., B.A.
Rouse, Mrs.
†‡Roxburgh, W. L.
†Sampson, J. H.
†Saul, G. C.
†Segrave, Sir Thomas G., C.B.E., Capt. R.I.N.
Segrave, Lady.
‡Senior, H. V.
Senior, Mrs. H. V.
†Shepherd, F. G.
‡Silley, G. F.
‡Silley, H. A. J.
†Skiffington, D. M.
†‡Sloggett, G.
Prosser, Miss M., B.A.
‡Smith, Aubrey B.
Smith, Mrs. J.
‡Soukup, Ch.
†‡Spanner, E. F. (Member of Council, I.M.E.).
†‡Speck, George.

SPECK, MRS. GEORGE.
‡SPEECHLY, C. C.
†STANSFIELD, L. D., M.B.E., R.C.N.C.
†STEELE, JAMES.
‡STEPHENS, E. R.
†STEVENS, C. H., C.B.E.
†STREVENS, L. G.
†STONEHAVEN, THE RIGHT HON. LORD, P.C., G.C.M.G., D.S.O., LL.D. (President, I.N.A.).
STONEHAVEN, LADY.
‡SYCAMORE, W. A.
†‡TANFIELD, E. W.
TANFIELD, MRS. E. W.
†TAYLOR, JOHN P.
‡TEARE, W. A.
†‡TELFER, E. V., D.Sc., Ph.D. (Member of Council, I.N.A.).
TELFER, MRS.
†‡TENNANT, W.
‡THOMAS, J.
THOMAS, MISS.
†THOMSON, WILLIAM, B.Sc.
‡THOMSON, W. G.
‡TIMPSON, A. F. C., Captain, M.B.E., (Vice-Chairman of Council, I.M.E.).
†TOBIN, T. V., M.A.
‡TOWNEND, W. T.
TOWNEND, MRS.
‡TRAILL, A. P., Wh.Sc. (Vice-President, I.M.E.).
‡TREWEEKS, H. C., Eng. Lt.-Comm. R.N.S.R.
TREWEEKS, MRS. H. C.
†‡TURNBULL, JAMES.
†TUTIN, JOHN, D.Sc.
TUTIN, MRS. A. E.
†VAUGHAN, A. R., M.B.E.
VAUGHAN, MRS. A. R.
‡WALKER, CHARLES A.
†‡WALKER, H. C. (Member of Council, I.M.E.).
†‡WALL, A. T., O.B.E. A.R.C.S. (Vice-President, I.N.A.).
WALL, MRS. A. T.
†WALLEY, THOMAS.
WALLEY, MRS. G. M.
†‡WALLIS, DR. R. PENDENNIS.
WALLIS, MRS. R. PENDENNIS.
†‡WATSON, G. RIDLEY, B.Sc.
‡WATSON, G. O.
‡WELSH, R. J.
†‡WHAYMAN, W. M., C.B., C.B.E., Eng. Rear-Adml. (Hon. Vice-President, I.N.A., Vice-President, I.M.E.).
WHAYMAN, MRS. W. M.
WHAYMAN, MISS E. E.
†‡WIGHT, H. D.
WIGHT, MRS. H. D.
†WILLIAMS, H. G., O.B.E.
WILLIAMS, MRS. H. G.
†WILLIAMS, H. W.
‡WILLIAMS, W. T., O.B.E., B.Sc., Wh.Ex. (Vice-President, I.M.E.).
†‡WILSON, H. A.
†‡WOOD, EVELYN, B.Sc.
†‡WOODESON, W. A.
WOODESON, MRS. W. A.
†‡WOODS, A. R. T. (Vice-President, I.M.E.).
†WOOLLARD, LLOYD, M.A., R.C.N.C. (Member of Council, I.N.A.).
†YARROW, SIR HAROLD, Bt., C.B.E. (Vice-President, I.N.A.).
YARROW, LADY.
‡YOULDON, F. W.
YOULDON, MRS. F. W.
†‡YOUNG, L. H. F., M.Eng.

The International Engineering Congress, Glasgow.

The International Engineering Congress was held at Glasgow from 21st to 24th June, 1938, and was attended by about a thousand members representing twenty-two different countries. The Congress was held under the joint auspices of the Institution of Civil Engineers; Institution of Electrical Engineers; Institution of Engineers and Shipbuilders in Scotland; Institution of Gas Engineers; Institute of Marine Engineers; Institution of Mechanical Engineers; Institution of Naval Architects; Institute of Welding; Iron and Steel Institute; North East Coast Institution of Engineers and Shipbuilders.

The President was the Right Hon. Viscount Weir, P.C., G.C.B., there being also fifteen Vice-Presidents, including The Rt. Hon. The Lord Provost of Glasgow, Sir John A. Stewart; E. Bruce Ball, Esq., J.P.; S. B. Donkin, Esq.; The Rt. Hon. The Earl of Dudley, M.C., D.L.; Sir E. Julian Foley, C.B. (President, I.Mar.E.); A. C. Gardner, Esq., F.R.S.E.; Sir Alexander Gibb, G.B.E., C.B., F.R.S.; Prof. C. J. Hawkes, M.Sc.; John M. Hogg, Esq., J.P.; Sir George Lee, O.B.E., M.C.; Sir James Lithgow, Bt., M.C., D.L.; David E. Roberts, Esq.; R. Robertson, Esq.; Sir Frank Smith, K.C.B., C.B.E., F.R.S.; The Rt. Hon. Lord Stonehaven, P.C., G.C.M.G., D.S.O. The Honorary Treasurer was S. J. Pigott, Esq., D.Sc. (Past-President, I.Mar.E.) and the Honorary General Secretary P. W. Thomas, Esq., B.Sc.

The organisation of the various events of the Conference was carried out by the following committees, the Glasgow Executive Committee being responsible for the local arrangements, including the social events and visits to works, while the London Executive Committee dealt with the arrangement of papers for the technical sessions.

General Committee :

Chairman: A. C. Gardner, F.R.S.E. [1,2,3]

Vice-Chairman: Prof. P. A. Hillhouse, D.Sc. [1,2]

Glasgow Executive Committee :

Chairman: G. J. Innes. [1,2]

Vice-Chairmen: A. Newlands, C.B.E. [1,2]; J. Smith, B.Sc. [1,2]

Hon. Secretary: P. W. Thomas, B.Sc.(Eng.). [1,2,3]

London Executive Committee :

Chairman: S. B. Donkin. [1,2,3]

Vice-Chairman: Sir John E. Thornycroft, K.B.E. [3]

Joint Honorary Secretaries: Brig.-Gen. M. Mowat. C.B.E., F.R.S.E. [1,2,3]; E. Graham Clark, M.C., B.Sc. [1,2,3]

Committee Members :

J. L. Adam [1,2]; J. T. Batey, D.Sc. [1]; J. R. Beard, M.Sc. [3]; Major H. Bell, O.B.E. [2]; G. V. Boys, M.A. [1,2,3]; W. T. K. Braunholtz, M.A., Ph.D. [1,2,3]; W. Cullen, D.Sc. [3]; B. C. Curling [1,2,3]; J. Harbottle [1,2]; K. Headlam-Morley [1,2,3]; A. Hutchinson, M.A. [1,3]; Sir William J. Larke, K.B.E. [1]; A. McCance, D.Sc. [1,2]; J. McLuskie [1,2]; Prof. A. L. Mellanby, LL.D., D.Sc. [2]; James Miller [1,2]; R. B. Mitchell [1,2]; J. Montgomerie, D.Sc. [3]; A. Ramsay Moon, B.A., B.C.E. [1,2,3]; R. Rainie, M.C. [3]; P. F. Rowell [3]; Sir Charles J. O. Saunders, K.B.E. [3]; H. C. Smith [1]; E. W. Fraser Smith, M.A. [1,2,3]; J. S. Wilson [3].

On the opening day, Tuesday, 21st June, the general body of visitors assembled in the Concert Hall of the Exhibition, where they were welcomed by the Earl of Elgin, President of the Exhibition, and by Mr. John Colville, Secretary of State for Scotland. Thereafter Viscount Weir delivered his presidential address.

Following these introductory proceedings the delegates separated into three groups to listen to the delivery of papers entitled "The Building of Ships—A British Survey", by Sir James Lithgow; "Some Recent Developments in the Iron and Steel Industry in Great Britain", by Dr. A. McCance and Mr. T. W. Hand; and "The Use of British Coal—A Review and a Forecast", by Sir Richard Redmayne. There was no discussion in connection with these papers or with any of the papers presented subsequently at the Congress. The remainder of the forenoon was devoted to the simultaneous presentation of three further papers entitled "Technical and Economic Developments in Electrical Engineering", by Mr. S. B. Donkin; "Progress of the Internal Combustion Engine During the Last Twenty Years", by Mr. H. R. Ricardo; and "Materials Research and Modern Machining Practice", by Professor Dr.-Ing. A. Thum, of Germany.

The afternoon of Tuesday was left free for the visitors to inspect the Exhibition, including, for the ladies, a Fashion Display in the Women's Pavilion. In the evening the visitors were received in the City Chambers by the Lord Provost and Corporation of Glasgow.

Following the reception of guests by the Lord Mayor and Magistrates in the Satinwood Salon from 8.30 to 9.0 p.m. the guests proceeded to the Banqueting Hall, where short addresses of welcome were delivered by the Right Hon. The Lord Provost, Sir John Stewart and the Right Hon. Viscount Weir, P.C., G.C.B., President of the Congress. A reply on behalf of the visitors was made by Herr Oberburgermeister J. Dillgardt of Essen. Thereafter there was a concert of vocal music in the Council Hall by the "William Morris" Choir, conducted by Mr. James B. Houston, M.A., F.E.I.S., and dancing in the Banqueting Hall to music rendered by Dave Brook's Orchestra. Refreshments were served in the Committee Rooms and Upper Corridor throughout the evening.

Before the civic reception a dinner was given to the official delegates by the President and Viscountess Weir at the Central Hotel, those present including Messrs. J. L. Adam, M. and Mme. A. Augustin-Normand, F. S. Badger, Mr. and Mrs. E. Bruce Ball, Mr. and Mrs. G. W. Barr, Mr. and Mrs. James Barr, Mr. and Mrs. J. R. Beard, Major and Mrs. H. Bell. Mr. and Mrs. R. L. Biggart, Sir A. Stephen and Lady Bilsland, Dr. H. H. Blache, G. V. Boys, Dr. W. T. K. Braunholtz, Mrs. E. Brown, W. J. Buchanan, Mr. and Mrs. E. V. Buchanan, Miss Buchanan, Georg Buchsbaum, Marquis G. B. Serra di Cassano, Mr. and Mrs. J. Cenek, E. Graham Clark, C. T. Cocks, Miss Cocks, Prof. and Mrs. G. Cook, Mr. John Craig, C.B.E., and Mrs. John Craig, J. Craig, Mr. and Mrs. B. C. Curling, Count A. and Countess de Curzon, Rev. A. Nevile Davidson, John Davidson, Mr. and Mrs. C. Davies, Miss Davies, Mr. and Mrs. Leslie A. Davis, Sir Maurice and Lady Denny, Mr. and Mrs. John M. Denny, J. Dillgardt, S. B. Donkin, Mr. and Mrs. J. W. W. Drysdale, The Earl and Countess of Elgin, Dr. A. P. M. Fleming, Sir E. Julian Foley, E. W. Fraser-Smith, Mr. and Mrs. A. C. Gardner, Mr. and Mrs. H. Gerrish-Smith, Sir Alexander Gibb, Miss Glen, Dr. and Signora E. Gobbi, M. and Mme. L. Graux, Dr. and Mrs. Werner Gregor, E. Grund, Baron van Haersolte, T. W. Hand, M. Harle, Mr. and Mrs. F. D. Herbert, Prof. P. A. Hillhouse, Mr. and Mrs. Norman L. Hird, Mr. and Mrs. John M. Hogg, Mr. and Mrs. W. H. Howden, Mr. and Mrs. G. J. Innes, Mr. and Mrs. Geo. Jackson, Mr. and Mrs. R. D. Keillor, Sir Alexander and Lady Kennedy, Prof. and Mrs. Wm. Kerr, Dr. H. Kölzow, Mr. and Mrs. A. Korving, M. and Mme. Maurice E. Laborde, Mr. and Mrs. W. W. Lackie, Sir W. B. and Lady Lang, Mr. and Mrs. C. R. Lang, J. E. Languepin, Sir George Lee, A. Lilienberg, Prof. A. and Mrs. Lindblad, Sir James and Lady Lithgow, Pearson Lobnitz, Miss Lobnitz, J. Louis, Dr. A. and Mrs.

[1] General Committee. [2] Glasgow Executive Committee. [3] London Executive Committee.

McCance, Major J. McGregor, A. G. Mackay, W. P. F. McLaren, Mr. and Mrs. A. S. MacLellan, Mr. and Mrs. J. W. McLuskie, Mr. and Mrs. K. H. McNeill, W. W. Marriner, Prof. C. Matchoss, Mr. and Mrs. J. B. Mavor, Sam Mavor, Miss Mavor, Dr. and Mrs. P. A. J. Mees, G. E. Meijer, Prof. and Mrs. A. L. Mellanby, Prof. and Mme. J. Meuwissen, Mr. and Mrs. James Miller, J. A. Ralston Mitchell, Miss Ralston Mitchell, R. B. Mitchell, N. V. Modak, Dr. and Mrs. J. Montgomerie, James E. Montgomrey, A. Ramsay Moon, Mr. and Mrs. R. D. Moore, Dr. and Mrs. L. F. Morehouse, Dr. and Mrs. W. J. Muller, K. Mygind, Lieut. R. Nagano, J. Obrapalski, Mr. and Mrs. G. A. Orrok, J. F. V. Ossa, E. Palmgren, E. Parry, Dr. S. J. and Miss Pigott, J. Podoski, J. W. Powell, Mr. R. Rainie, M.C., and Mrs. R. Rainie, Mr. and Mrs. R. V. Ramalho, Miss Ramalho, Sir Richard Redmayne, Miss Redmayne, Mr. and Mrs. H. R. Ricardo, J. R. Richmond, David E. Roberts, Mr. and Mrs. R. Robertson. Rear-Admiral G. H. Rock, Gen. G. Rota, Signorina E. Rota, Signorina F. Rota, Signorina V. Rota, W. Russell, Capt. and Mrs. C. A. Salvesen, Dr. R. de Santis, Prof. G. Schnadel, Y. Schoerner, The Lord Sempill, Prof. and Mrs. H. L. Seward. Mrs. Shipp, Mr. and Mrs. C. E. Silverthorne, Mr. and Mrs. J. Smith, R. Sneddon, Miss Sneddon, John G. Stephen, Mr. and Mrs. G. A. Stetson, Mr. and Mrs. Allan Stevenson, Lord Provost Sir John A. Stewart, The Viscount Stonehaven, Prof. G. Szigeth, Admiral and Mrs. J. G. Tawresey, P. W. Thomas. Mr. and Mrs. Wm. Tod, Miss Tod, Lieut. K. Toyama, Prof. S. J. Truscott, Dr. E. Véssei, Miss Walin, Wm. Wallace, Miss Wallace, Mr. and Mrs. N. Warren-Waterhouse, The Viscount and Viscountess Weir, Sir Cecil M. and Lady Weir, Mr. and Mrs. J. G. Weir, Hon. J. K. and Hon. Mrs. J. K. Weir, Hon. John W. Weir, Miss Wilcox, J. S. Wilson, Mr. and Mrs. C. W. Wright, Sir Harold and Lady Yarrow.

On Wednesday morning, 22nd June, the delegates again attended at the Exhibition to listen to further addresses. There were three sessions at each of which three papers were presented simultaneously. During the first session Lord Sempill dealt with "International Air Transport", Monsieur E. Mercier presented "Some Views on the Problem of Electricity Generation and Distribution in France", and Mr. A. Lilienberg, of Sweden, discussed "Municipal and Industrial Planning". The second session covered papers entitled "Naval and Mechanical Constructions in Italy", by General G. Rota; "The River Clyde and the Harbour of Glasgow", by Mr. A. C. Gardner; and "Recent Developments of the Gas Industry in Canada." by Mr. J. Keillor. The papers presented during the third session were "The Central Station in One Man's Lifetime", by Mr. G. A. Orrok, of America; "Town and Country Planning and its Relation to Industry", by Mr. G. L. Pepler; and "Gas—Yesterday, To-day, and To-morrow", by Sir David Milne-Watson.

Wednesday afternoon was devoted to visits to the following engineering works, shipyards, and other establishments of kindred interest in the Glasgow area: Albion Motors, Ltd., John Brown & Co., Ltd., Wm. Beardmore & Co., Ltd.. Blackie & Son, Ltd., Clyde Valley Electrical Power Co. (Clyde's Mill Station), Wm. Dixon, Ltd., Harland and Wolff, Ltd., London, Midland & Scottish Railway Co. Locomotive Works, Mavor & Coulson, Ltd., Yarrow & Co., Ltd., Clyde Navigation Trust (Glasgow Harbour). At the yard of John Brown and Co., Ltd., at Clydebank, the visitors enjoyed the privilege of inspecting the hull of the new Cunard White Star liner "Queen Elizabeth", the inspection being very thorough and including a walk along the upper deck from stern to stem.

On Wednesday evening the Chairman, G. J. Innes, Esq. and the Committee of the British Corporation Register of Shipping and Aircraft entertained privately a number of naval architects and marine engineers from among the Conference official delegates and other guests to dinner on board the Anchor Line's new twin screw motorship "Cilicia" at Yorkhill Quay, Glasgow. Speeches of welcome were delivered by the Chairman, Mr. Innes and Mr. H. Cowan-Douglas, director of the Anchor Line, and were responded to by Lord Stonehaven, Sir Julian Foley and General G. Rota (Italy). Afterwards the visitors inspected the ship, which was in readiness for departure on her maiden voyage to India.

On Thursday, 23rd June, a large number of the visitors proceeded down the Clyde in the turbine steamer "Queen Mary II". An excellent view of the shipyards, mostly well employed, was obtained as the steamer passed slowly down the river. Entering the Firth, the steamer proceeded to the east coast of Arran and later, passing through the Kyles of Bute, landed her passengers at Wemyss Bay, whence they returned to Glasgow by train. Another party proceeded on a motor coach trip to Loch Lomond, Crianlarich, and Lochearnhead, returning through the Trossachs. A third party left Glasgow by train for Dumfries, whence by motor coach the visitors proceeded on a trip which included an inspection of the works of the Galloway Water Power Company and ended at Ayr, the return to Glasgow being completed by train. A fourth party travelled by motor coach through the Carron Valley to Alloa. the return journey being made by way of the new Kincardine-on-Forth bridge.

Visits to the following works in the Glasgow, Paisley, Kilmarnock, and Edinburgh districts occupied the morning and afternoon of Friday, 24th June, the closing day of the Congress:

Glasgow and District.

Alternative Morning Visits: Babcock & Wilcox, Ltd.; Colvilles, Ltd.; Glasgow Corporation Electric Power Station, Dalmarnock; London & North Eastern Railway Locomotive Works; North British Locomotive Co.. Ltd.; G. & J. Weir, Ltd.

Alternative Afternoon Visits: Barclay, Curle & Co., Ltd.; John Brown & Co., Ltd.; Blackie & Son, Ltd.; Clyde Navigation Trust; Clyde Valley Electrical Power Co. (Yoker Station); Fairfield Shipbuilding & Engineering Co., Ltd.; Harland and Wolff, Ltd.; Singer Manufacturing Co., Ltd.; James Templeton & Co.; Thermotank, Ltd.; G. & J. Weir, Ltd.; Yarrow & Co., Ltd.

EDINBURGH AND DISTRICT.

Morning: Bruce, Peebles & Co., Ltd.

Afternoon: James Bertram & Son, Ltd.; Wm. Younger & Co., Ltd.; Bruntons (Musselburgh), Ltd.; Inveresk Paper Co., Ltd.; Morrison & Gibb, Ltd.; Sight-seeing tour of Edinburgh.

KILMARNOCK AND DISTRICT.

Morning: Glenfield & Kennedy, Ltd.; Andrew Barclay, Sons & Co., Ltd.; Saxone Shoe Co., Ltd.

Afternoon: Bairds and Dalmellington, Ltd., Auchincruive Pit; Westburn Sugar Refineries, Ltd., Greenock; John Drummond & Son, Ltd., Greenock; India Tyre & Rubber Co., Ltd., Inchinnan.

PAISLEY AND DISTRICT.

Morning: J. & P. Coats, Ltd.; Clark & Co., Ltd.; James Robertson & Sons, Ltd.; Brown & Polson, Ltd.; George Dobie & Son, Ltd.; Paisley Corporation Gas Works; Thomas White & Sons, Ltd.

On completion of the above visits the parties were entertained to lunch jointly by the Provost and Magistrates of the town and by the various firms visited, in the George A. Clark Town Hall.

Afternoon: John Lang & Sons, Ltd., Johnstone; Scottish Industrial Estates.

At the close of the Congress on Friday evening a Reception and Conversazione was held for the visitors in the Palace of Art at the Empire Exhibition, by kind invitation of the President and Council of the Institution of Engineers and Shipbuilders in Scotland.

The weather on the whole was unkind to the visitors. Scotland, under genial meteorological conditions, can be an enchanting country, but Glasgow, when the weather is bad, can be as dismal and dreary as any town in the kingdom. It was particularly unfortunate that on Thursday, the day devoted to sight-seeing excursions, the weather was at its worst. The majority of the visitors on that day elected to proceed on the steamer trip down the Clyde, but the pleasure and interest of the voyage in the Firth were largely spoiled by almost continuous rain and by the blankets of mist which lay thick upon the hills. Nevertheless, in spite of the weather, the Congress as a whole was successful in its main purpose, the uniting of engineers from many lands by the bonds of their profession. The organisation of a large international meeting of the character of the Congress is no light task, but in the capable hands of the honorary general secretary, Mr. P. W. Thomas, everything which was not at the mercy of the weather proceeded smoothly and efficiently.

LIST OF OFFICIAL DELEGATES.

Australia: Institution of Engineers (Australia), N. Warren-Waterhouse, B.E.

Belgium: Société Royal Belge des Ingénieurs et des Industriels: L. Graux (Past-President), J. Meuwissen; Federation des Associations Belges d'Ingénieurs: L. Graux (Past-President).

Canada: Engineering Institute of Canada: E. V. Buchanan (Vice-President), Maj. J. McGregor, D.S.O.

Chile: Instituto de Ingenieros de Chile: M. R. Cruz, J. F. V. Ossa.

Czechoslovakia: Czechoslovak Electrotechnical Association: J. Cenek (Secretary).

Denmark: Dansk Ingeniorforening: K. Mygind, B.Sc.(Eng.), H. H. Blache, B.Sc.(Eng.), Dr. Tech.

Finland: Tekniska Foreningen i Finland: E. Palmgren.

France: Société des Ingénieurs Civils de France: J. Louis (President, No. 5 Section), M. Harlé (President, No. 8 Section); Association Technique Maritime et Aeronautique: A. Augustin-Normand (Councillor); L'Institut de Soudure Autogène: J. E. Languepin.

Germany: Nationalsozialistischer Bund Deutscher Technik: Oberbürgermeister J. Dillgardt; Verein Deutscher Ingenieure: Dr. Ing H. Kölzow (Director), Prof. C. Matchoss (late Director); Hamburg Experimental Tank Society: Dr.-Ing. E. Foerster (Vice-President); Schiffbautechnische Gesellschaft: Prof. G. Schnadel; Verein Deutscher Eisenhüttenleute: Dr.-Ing. E. Berndt, Dr.-Ing. F. Kocks.

Holland: Technical, Nautical and Aeronautical Institute: Dr. P. A. J. Mees (Hon. Treasurer), Baron van Haersolte (Director); Koninglijk Instituut van Ingenieurs: A. Korving, Dr. W. J. Muller (Councillor).

Hungary: Budapest Székesfóváros Gázmüvei: Dr. E. Véssei (President), Prof. G. Szigeth.

India: Mining, Geological and Metallurgical Institute of India: A. G. Mackay (Vice-President), R. Sneddon (Councillor); Institution of Engineers (India): N. V. Modak, B.E.

Italy: Vasca Nazionale par le Esperienze di Architettura Navale: Dr.-Ing. Gen. G. Rota (President), Dr.-Ing. R. de Santis; Sindacato Nazionale Ingegneri: Dr.-Ing. G. Rota, Dr.-Ing. E. Gobbi.

Japan: Zosen Kiokai: K. Toyama, Lieut. R. Nagano.

New Zealand: New Zealand Institution of Engineers: E. Parry, B.Sc.

Poland: Stowarzyskenib Elektrokow Polskich: J. Obrapalski, J. Podoski (Secretary).

Portugal: Ordem dos Engenheiros: R. V. Ramalho.

South Africa: South African Institute of Electrical Engineers: C. T. Cocks (Past-President), C. Davies; Chemical, Metallurgical and Mining Society of South Africa: W. Russell, Prof. S. J. Truscott, D.Sc.; South African Institution of Engineers: C. E. Silverthorne; South African Society of Civil Engineers: W. P. F. McLaren (Vice-President).

Sweden: Svenska Teknologföreningen: A. Lilienberg, Y. Schoerner; Tekniska Samfundet: G. E. Meijer, B.Sc. (Secretary), Prof. A. Lindblad.

United States: Society of Naval Architects and Marine Engineers: J. W. Powell (President), H. Gerrish-Smith (Secretary); American Institute of Electrical Engineers: A. P. M. Fleming, C.B.E., D.Eng., L. F. Morehouse, D.Eng.; American Institute of Mining and Metallurgy: C. W. Wright, B.S., M.E.. K. H. McNeill; United States Naval Institute: Prof. H. L. Seward, Rear Admiral G. H. Rock, B.Sc.; Franklin Institute: Admiral J. G. Tawresey; Boston Society of Civil Engineers: F. S. Badger; American Society of Mechanical Engineers: G. A. Orrok, G. A. Stetson, Ph.B., M.E.; American Society of Civil Engineers: G. A. Orrok, W. J. Buchanan.

The Institute Membership in New York.

At the June meeting of the Council a letter was received from Mr. Samuel Aitken, Vice President, reporting that the Members of The Institute in New York had held a dinner-meeting in the Engineers' Club on 29th April, 1938. This meeting had proved highly successful, and a sub-committee was formed in order to arrange for a dinner-meeting once every three months. A resolution was passed by the Members deputing Mr. J. H. King, Manager of the Marine Department of Messrs. Babcock & Wilcox Ltd., and Mr. J. L. Luckenbach, President of the American Bureau of Shipping, to call at The Institute during their visit to London in connection with the coming International Conference of Naval Architects and Marine Engineers and present the good wishes and felicitations of the New York Members.

Upon the arrival of Mr. King and Mr. Luckenbach in London arrangements were made for their reception at 4.30 p.m. on Monday, 13th June, at a special assembly of the Council prior to the ordinary Council Meeting convened for that evening. There was a full attendance of Council Members to greet the visitors, who were accorded a warm welcome. The Resolution they conveyed was in the following terms:—

> "At a Meeting held on 29th April, 1938, in New York by the New York Members of The Institute of Marine Engineers, it was resolved that Mr. James H. King and Mr. John L. Luckenbach be requested, upon their coming visit to Great Britain to attend the International Meeting of Naval Architects and Marine Engineers, to call at The Institute of Marine Engineers in London and convey to The Institute the sincere good wishes and greetings from the Members of the New York district to the membership in London".

It was unanimously resolved on the proposal of the Chairman that a letter be sent to Mr. Aitken expressing the Council's appreciation of the above resolution and of the activities of the New York Members as reported in his letter and by the two visiting Members, with the Council's best wishes for their continued success.

Diesel Engine Operating Notes.

Specially contributed by John Lamb (Member).

A contingency to be reckoned with in oil engines, as in steam engines, is the possibility of laying off one unit in the event of some of the working parts being seriously damaged. This can be more easily accomplished in an oil engine, because each unit is practically independent instead of being interdependent as in the steam reciprocating engine.

Suppose, for instance, that owing to the failure of a crosshead bearing bolt the damage resulting necessitated the removal of the piston, piston rod, and connecting rod in order that the engine could be set to work on the remaining units. Beginning at the bottom of the engine it would first of all be necessary to stop the lubricating oil supply to this unit. This will be done by driving a good fitting wooden plug into the hole in the crank-pin. To make the plug more secure it should project ¼in. or so above the surface of the pin and have a vee-shaped groove cut in the end. If then a few turns of fine wire are wound around the pin and the plug secured by it, there will be no danger of the plug being forced out by the pressure of the lubricating oil and the centrifugal force. The cylinder lubricators will also require to be put out of action.

If the engine is of the two-cylinder type, the scavenging air and exhaust ports will next require attention. In the event of the piston being undamaged these will be easily dealt with, since the ports can be effectively blanked by placing the piston in such a position that all the ports are masked. If, however, the piston must be removed, it is an easy matter to blank the ports by a number of piston rings sprung into the cylinder, which when in contact with each other completely cover the ports. The gaps between the ends of the rings should, of course, be located opposite the ports. Piston rings fitted in the manner described will be sufficient to prevent escape of burnt gases and scavenging air into the engine-room, and obviate the troublesome job of fitting blank flanges at the points where air and burnt gases enter and leave the cylinder.

If the cylinder head can remain in place, the only other work necessary is to disconnect the gear operating the cylinder head valves, and stop the fuel pump from discharging. The cooling water to the cylinders and pistons offers no difficulty, since this can usually be shut off by stop valves.

When for some reason it becomes necessary to disconnect and hang up a piston in the cylinder and operate with it thus, the starting air as well as the fuel and injection air of the defective unit must be blanked off to prevent starting air entering the cylinder and blowing the piston out when the engine is set in motion. Strange as it may seem, this important matter has been overlooked on more than one occasion and very serious damage done to costly parts of the engine.

In the case of four-cycle engines the air inlet and exhaust valve rocking lever must be disconnected. Further precautions are necessary to prevent exhaust gas under pressure from the other cylinders finding its way into the cylinder in which the piston is hung up, by firmly securing the exhaust valve in the closed position. It is also advisable to secure the air inlet valve in open position, in order to allow any compressed air or gas under pressure that may mysteriously find its way into the cylinder easy access to the atmosphere, and thus prevent accumulation of pressure.

When setting an engine in motion, the first few charges of fuel injected into the cylinders are greatly in excess of the amount injected under normal working conditions. Consequently the exhaust pressures are higher than at normal full load, and the pressure may be high enough to overcome the exhaust valve spring of the defective unit, when gases under pressure would enter the cylinder and act on the piston unless the precautions recommended are taken. Moreover, it may happen that an unburnt charge of fuel is exhausted from one of the other cylinders and ignited in the exhaust manifold by the hot gases therein, thus causing an explosion and a rapid local increase of pressure which may reach the exhaust valve of the defective unit.

It is not so long ago that one piston and connecting rod of a trunk piston engine had to be hung up in its cylinder owing to a broken lubricating oil pipe causing one of the gudgeon bearings to "run out". The starting air, fuel and injection air were correctly blanked off, and the air inlet and exhaust valve rocking levers disconnected. Upon starting the engine the piston and with it the connecting rod, although well secured by wire ropes, was blown into the crankcase, doing as can doubtless be well imagined very serious damage. The blank flanges in the starting and injection air lines were found intact, so that the conclusion reached was that the exhaust gases under pressure must have overcome the exhaust valve spring, and the air inlet valve being closed, the pressure of gas in the cylinder accumulated and, acting on top of the piston, caused the wire ropes to break with the result mentioned.

When selecting a blank flange for the starting air line, remember that the pressure it must withstand is high, and that the impact with the air is sudden. Such flanges should therefore be $\frac{1}{8}$in. thick at least. On one occasion when a thin flange was fitted, repeated starting caused the centre of the flange to be blown out and the inevitable happened.

INSTITUTE NOTES.

CORRESPONDENCE.

Fuel Economy in Steam Reciprocating Engines.

To the Editor of the Transactions.

Dear Sir,

In 1936 a certain ship (quoted hereunder as "A" ship), belonging to the company with which the writer is associated, received a prize from the management for the reason that her fuel consumption showed a remarkable reduction of about 27 per cent. without any costly renovation of existing engines or the installation of any additional device.

It is true that many mechanical improvements and devices have been introduced in recent years with a view to bringing about a saving in fuel consumption of marine engines. All these devices cost a good deal, however, time is required for their installation, and it is not absolutely certain that they will bring about a saving such as will repay the money invested. It is, therefore, very remarkable that such a great saving as 27 per cent. should have been realized without any expensive mechanical devices.

The chief concern of marine engineers is how to obtain the highest efficiency with all existing machines. Of course, they can recommend to their employers any mechanical devices which in their opinion will be effective in enhancing efficiency, but their recommendations will not be accepted if reconditioning and the expenditure of an enormous amount of money are involved, or if considerable time is required for the changes recommended. Their attention must needs be directed to the attainment of maximum efficiency with the least possible expenditure either of money or of time.

To study this question of fuel economy, it may be convenient to compare the "A" ship with her sister ship (quoted hereunder as "B" ship). The "B" ship has the same type of engines and boilers as the "A" ship and is on the same run as the latter. The only marked difference is that lagging is applied to the "A" ship more extensively than to the "B" ship. Below are the places where lagging has been applied to the "A" ship and not to the "B" ship :—

(1) Both end plates of each boiler.
(2) Each boiler bottom.

(3) Cylinder bottom of main engine.
(4) Steam cylinder and slide casings of auxiliary machines (by which are meant ballast pump, sanitary pump, general service pump and so on).
(5) All valve boxes, tee pieces, cross pieces and flanges of steam and exhaust piping.
(6) Feed-water piping and feed heater.

From the foregoing it will be noted that a fairly large area of the heated part of the "A" ship was lagged. All this was done by the crew during her laid-up periods (she was laid up as an uneconomical ship). Since coming into service again her fuel consumption has been reduced by about 15 tons and by nearly 10 tons compared with the present performance of the "B" ship.

No engineers will knowingly admit a heat loss through radiation, but too frequently such things are neglected. In fact, although lagging is always applied to all large piping, small pipes are seldom lagged despite the fact that heat escapes therefrom day and night. Formerly few makers applied lagging to the bottoms of boilers. On one of the vessels belonging to the writer's company, however, satisfactory results have been obtained from such lagging fitted by her own crew. At the beginning only No. 2 boiler was covered, No. 1 boiler being left bare. Calling at various ports, the firing of her boilers was each time suspended for several hours, and it was always found that No. 2 boiler had higher steam pressure than No. 1 boiler. Hence No. 1 boiler was also lagged.

The lagging on cylinder covers will not only prevent a radiation loss of heat but will avoid a condensation loss of steam. This can be effected without much difficulty, the only need being the use of steel box covers lined with some non-conductive materials. Why do not makers apply lagging to the cylinder bottom which there is no need to remove?

It is well known that the upper part of the engine room is hot. In summer time, for instance, engineers often burn their fingers by touching hand rails there. Yet no attempt is ever made to find remedies and the greater part of the hot surfaces are left uncovered. It has been said that efficiency cannot be expected in a hot engine room. The writer considers this to be true and applicable to both the engine-room staff and the machinery. The difficulty can be surmounted to some extent by means of lagging.

Such non-conductive materials as glass-silk and magnesia-covering are obtainable, but on the writer's ship asbestos powder is usually used, containing a small quantity of cement, say five per cent., mixed if necessary with vegetable glue because this can be applied easily to cylinder bottoms or valve box bottoms. Lagging will protect the body of the boiler from cold air. Should furnace mouths or ash pits be sealed tightly while in port, the result will be much better. Another merit of lagging was experienced by its application to water gauge stand pipes of the main boilers of the "A" ship. Old defective asbestos lagging applied to the stand pipes was taken off and a new diatom earth lagging was applied. As a result, the difference of water levels before and after the draining-off of the gauge glass, which formerly showed 8 inches, has been reduced to only 4 inches. It will be noted that the evaporating area and steam space can be considerably enlarged, with a corresponding decrease in the quantity of water. In other words, easy evaporation can be realized and good quality of steam obtained by lagging.

Efficient running which is required in large machines is also vital for small ones. Particularly in the case of small cylinders, lagging is much more effective in respect of condensation than in big cylinders because of the ratio between hot surface area and cylinder volume.

Referring to the boiler room practice, in the "A" ship the cleaning of fires is carried out every 12 hours, while in the "B" ship cleaning takes place every 6 hours. It goes without saying that the longer the interval of cleaning the greater the advantage, depending of course on the actual condition of the boilers. In the present case, for instance, the "B" ship fires are cleaned twice as often as the "A" ship, notwithstanding the fact that they use the same quality of coal.

It will often be noticed that although there is a very small quantity of ash on the fire-grates due to the ship having left a port only a short time before, a stoker who is just going off duty will start cleaning fires. This is an example of waste of power.

There is plenty of heat loss in any ship. As a leakage of steam from pipe joints or spindle glands is more noticeable than the radiation loss, engineers are naturally doing their utmost to prevent such a loss. Yet one has to feed nearly five tons of boiler water per 1,000 h.p. per day. How much waste of fuel is due to such invisible losses? It would certainly make a surprising figure. Though steam reciprocating engines have been in use for years, there are a lot of improvements which should be made both in working and in maintenance.

Fuel economy is a world problem. Now that there is a shortage of liquid fuel, hydrogenation of coal is being projected in all countries. The need for economy in the consumption of coal will be felt more keenly than ever. What the writer has discussed above may be only a drop of water in the ocean, but it will be satisfactory if it serves to draw the attention of those in charge of steam reciprocators to the practicability of bringing about a substantial saving in fuel consumption by means of lagging.

Yours, etc.,

Kozo Mochizuki.

Osaka, Japan.

ADDITIONS TO THE LIBRARY.

Purchased.

The Friction of an Oscillating Bearing. By A. Fogg, M.Sc. and C. Jakeman. Lubrication Research Technical Paper No. 3 of the Department of Scientific and Industrial Research. H.M. Stationery Office, 9d. net.

Presented by the Publishers.

Transactions of The Institution of Engineers and Shipbuilders in Scotland, Vol. 81, 1937-38, containing the following papers :—

"The Strength of Ships' Plating", by Cox and Clenshaw.
"Damage to H.M.S. 'Hunter'," by Stanley.
"Vagaries of Internal Combustion", by Small.
"Accidents in Factories and Workshops", by Thomas.
"Accidents in Factories and Workshops", by Royal.
"Industrial Accidents", by Oakley.
"Effects of Viscosity on the Wave-Making of Ships", by Wigley.
"Modern Non-Ferrous Castings and their Engineering Interest", by Hudson.
"Engineering Problems in Modern Architectural Design", by James.
"Turbo-Compressors for High Pressures", by Kearton.
"Some Factors Affecting the Yield Point in Mild Steel", by Cook.
"Annual Load Line Surveys", by King.
"Medium and High Speed Diesel Engines for Marine Service", by Paxman.
"Ships' Speed Meters", by Hoppe.

Steam Generators. By D. W. Rudorff, Dipl. Ing. Charles Griffin & Co., Ltd., 182 pp., 78 illus., 10s. net.

Those interested in the new types of boiler that are rapidly going into service, both in land and marine installations, will welcome this book. Much of the information given by Mr. Rudorff may be obtained by referring to makers' catalogues or to the papers that have appeared from time to time in this journal, but the skilful manner in which the author has presented his material and the lucid descriptions he has given of underlying principles makes this treatise one that can be confidently recommended to those who wish to know the present-day position of the latest practice in steam production.

After a brief introduction in which some discussion is presented on the special features of the boilers to be considered, the author proceeds to describe in detail all the well-known types that are now being employed. These include the Benson, Sulzer, Velox, La Mont, Loeffler and Schmidt-Hartman boilers. The descriptions deal not only with the boilers themselves, but also with the apparatus necessary for feed water and fuel regulation. A final chapter is devoted to natural circulation boilers and then brief outlines are given of some recent examples of American and German practice.

Although no great amount of historical detail is given, it is surprising to find that hardly a single reference is made to the part that has been played by British engineers and investigators in boiler development, and it would appear that the author has almost exclusively confined his reading to American and Continental publications. Surely something might have been said of the early experiments on natural circulation by Gurney, the fundamental work on heat transmission by Osborne Reynolds, and the practical applications of Reynolds' theories by Nicolson.

Mechanics of Machinery. By C. W. Ham, M.E., and E. J. Crane, M.E. McGraw-Hill Publishing Co. Ltd., 2nd edn., 476 pp., 389 illus., 24s. net.

The authors are to be congratulated upon the appearance of a second edition of their book, which they offer as an improvement in content and arrangement of material upon the first. An entirely new chapter has been added on gear tooth systems and production methods, which is very comprehensive and includes excellent descriptions, well illustrated in most cases, of Stub tooth systems, American standard spur gear tooth forms, standard tooth proportions for bevel gears and worm gears, methods of producing gear teeth and finally a note on the grinding of gear teeth. The chapter also contains some useful comparative tables of the above types of gear with varying ratios. The other new feature incorporated in the second edition is the addition of an extremely useful and varied series of problems relative to each chapter grouped at the end of the book. It is to be regretted in this connection, however, that answers to problems, where possible, have been omitted.

The book makes its special appeal throughout since the authors have been at great pains to introduce many unusual examples in addition to all the standard forms, particularly in the chapters on linkwork, cams and the balancing of machinery, which includes a number of multi-cylinder automobile engines.

The work has been written in an easy style and is profusely illustrated with excellent diagrams and should present no difficulty to the average student. An appendix containing a force analysis of a standard six-cylinder engine of the automobile type with complete tables of results taken at every 15° of the crank revolution will prove of particular interest to tutors, as will also the large number of up-to-date and very varied problems for the drawing board, with dimensions, scale and location on the sheet, which have been carefully selected with a view to illustrating, as far as possible, the practical application of the fundamental theories.

Although primarily written for students of an intermediate standard, much of the work can be readily adapted to suit the requirements of the advanced student in the subject of theory of machines.

The Works' Manager's Handbook. By W. S. Hutton and E. Pull, M.I.Mech.E., M.I.Mar.E. The Technical Press, Ltd., 9th edn., 462 pp., illus., 30s. net.

For over twenty years engineers have been familiar with Hutton's "Works' Manager's Handbook for Civil and Mechanical Engineers", and it is not surprising to find this interesting book now in its ninth edition. Mr. Pull, himself a technical author of established reputation, has undertaken the work of revision and the result of his labours is offered in an attractively bound volume which contains much that will be helpful to those who aspire to executive posts in the mechanical branches of engineering.

Although the work is divided into six general sections under the headings of Steam and Gas Engines—Hydraulic Memoranda—Millwork—Steam Boilers and Chimneys—Heat, Warming and Ventilating—Working of Metals, Alloys and Casting—and Strength of Materials and Workshop Data, there is no arbitrary division of the subjects dealt with, the book being in the form of notes and memoranda collected and recorded during the author's experience.

In revising a work of this nature it must always be difficult for the reviser to bring the matter up-to-date without vitally altering the character of the book. In the present case Mr. Pull appears to have found the difficulty insuperable, for although the reader will find what may be termed the unvarying fundamentals of engineering practice perfectly reliable, he must be prepared for much that is far from representative of modern practice. For instance, in the section on cutting metals at high speed, only a high-speed steel no longer marketed is mentioned, neither stellite, tungsten carbide or other steels now in universal use being referred to. In the same section, much space is devoted to change wheel combinations for screw cutting, although practically all modern lathes are fitted with quick change gear-boxes capable of cutting any standard thread. The advance in design of lathes is also applicable to shapers, planers, milling, drilling and grinding machines, all of which are now commonly driven independently either by geared motors or short centre motorized drives and all operate at cutting speeds far in excess of any given in this book. Equally lagging behind modern practice is the data on strengths of concrete where it is stated that the approximate crushing strength of a concrete composed of 1 cement and 3 small gravel is 400lb. per sq. in. at 28 days and 700lb. per sq. in. at 90 days; actually such concrete would be regarded as quite unsuitable for constructional purposes. Modern cement, washed sand and aggregate mixtures commonly resist crushing stresses of 3,000 to 4,000lb. per sq. in. at 28 days, whilst the specification of the Joint Committee of the Royal Institute of British Architects, the War Office, Admiralty, the District Surveyors' Association and the London County Council requires that a concrete of 1 cement, 2 sand and 4 aggregate (a relatively weak mixture) shall have a minimum crushing strength of 1,800lb. per sq. in. at 28 days and 2,400lb. per sq. in. at 90 days.

This failure to reflect the advance of engineering is further apparent in the absence of any mention of such commonplace developments as ball and roller bearings, acetylene and electric welding or lifts, and in the inadequacy of information on Diesel engines, refrigeration, electricity and heating boilers. None of these subjects is given more than a page of odd notes and in the case of heating boilers, the whole subject is dealt with by the remark that "For heating purposes by hot water, the saddle boiler gives good results—one square foot of heating surface exposed to the direct action of the fire or three square feet of flue surface will heat forty feet of four inch pipe". Even when saddle boilers were popular this vague statement cannot have been very helpful, and it can mean nothing to the heating engineer who now installs a sectional boiler capable of giving 6,000 B.Th.U. per sq. foot of heating surface and who has long since discontinued the use of large diameter pipes for heating purposes.

The reviewer would emphasise his earlier remark that this is an interesting and useful book in that it contains an immense amount of useful information on a wide variety of subjects, but it should give the engineer of to-day the latest information on the subject of his enquiry if it is to serve as a thoroughly dependable book of reference.

All About Ships and Shipping. Edited by E. P. Harnack. Faber & Faber, Ltd., 7th edn., 684 pp., copiously illus., 7s. 6d. net.

This work is described as a handbook of popular nautical information, and it is very fully illustrated with numerous diagrams, plans and illustrations. Packed full of information not usually found in the more technical manuals, the contents include descriptions of the making of the ship, the sailing of the ship, course and direction, distance, time, atmosphere, tides, the Merchant Service, distinguishing emblems, signals, lights, the buoys of the United Kingdom, ship canals, docks, the high seas, yachting, Lloyd's and Lloyd's Register of Shipping, interesting events connected with shipping and commerce, etc., and a nautical vocabulary. There is also a list of ships in the Royal Navy, lists of the capital ships and cruisers of the principal foreign navies, and the fleets of the principal shipping companies. The seven coloured plates and numerous diagrams, together with the thirty pages of house flags and funnels of shipping companies, national flags and international codes all in colour, are excellently reproduced, and at its modest price of 7s. 6d. the book represents exceptional value.

The Existing Tendencies of the Techniques of Heat. By Professor M. Vernon. Dunod-Editeur, 92, Rue Bonaparte, Paris (6e), 189 pp., 48 illus., 65 francs.

The part which the author has taken in the evolution of the technique of heat for a decade is well known. The present study, which is published in French, reproduces with his agreement a conference organized by "La Technique Moderne", and juxtaposes numerous analytical indications on particularly important points, the whole forming a sort of synthesis. After having shown the importance of techniques of heating, the book sums up the essential ideas in the conception of the machinery. It then describes recent industrial applications of accelerated convection and useful information is given on the caloric radiation of gases. It specifies the laws of radiation between a flame or a gas and one or two furnaces in order to deduce from this the measures one should take in the conception of high-pressure boilers, a subject very real and much more delicate than a superficial examination could make one suppose. The author ends with a description of the actual evolution of furnaces, fireboxes and combustibles.

The work demonstrates that the techniques of heat are full of possibilities and that they actually gain a certain benefit from the physical study of the transmission of heat. This underlines the need in this matter, as in others, for the collaboration of the laboratory and the factory. In reading this work, which will be very useful to technicians, it occurs to one that the actual evolution of the techniques of heat has interest to all engineers.

Nickel Silver: A Survey of Published Information. By T. F. Pearson, M.Sc. Research Report R.R.A. 472 of the British Non-Ferrous Metals Research Association, 36 pp., 3s. net. (Obtainable from the Association at Regnart Buildings, Euston Street, London, N.W.1, or from any bookseller).

As a preliminary to certain researches which the British Non-Ferrous Metals Research Association has in hand, the author made a careful examination of available information on nickel-silver alloys. The results of his survey are set out in the present publication.

After a short introductory section, the specifications for nickel silver alloys issued in various countries are listed and discussed. Then follows a section devoted to the mechanical and physical properties of the alloys. Values for the mechanical properties in both cast and wrought forms and at various temperatures are noted, together with the endurance properties. Data on physical properties include thermal conductivity and electrical resistance, density, tarnish resistance, shrinkage and fluidity, etc. The various aspects of melting and casting are next dealt with. Some casting defects are mentioned, and there is a short account of sands and sand moulding. The effects of impurities on behaviour in casting and working and on properties then receive attention, the impurities considered including lead, tin, manganese, aluminium, iron, silicon, carbon, phosphorus, magnesium, sulphur, oxygen, antimony and arsenic. Finally there are accounts of the working of the alloys (rolling, extrusion, jointing, cleaning and finishing) and of the effect of annealing. A select bibliography of nearly 90 items is provided, reference to which is made throughout the text.

Gas Analysis. By A. McCulloch, M.Sc. H. F. & G. Witherby, Ltd., 166 pp., 38 illus., 7s. 6d. net.

Ability to carry out a gas analysis depends on a thorough understanding of a few fundamental principles together with efficient instruction and a manipulative skill which can only be acquired by practice. The fundamental principles and efficient instruction can be obtained by a close study of Mr. McCulloch's book, which provides an excellent informative and modern treatise on the subject. While the book is intended primarily for technical students, it is sufficiently advanced to be valuable as a work of reference.

The introductory chapters deal with fundamental principles and the sampling of gas, while hints are given on the care of gas analysis apparatus. This is followed by the use of various absorbents for the determination of carbon dioxide, oxygen, unsaturated hydrocarbons and carbon monoxide. In chapter 2 stress is laid on the order in which the gases are analysed and it unfortunate that the order in the chapter does not agree with that given in the practical examples, pages 69 and 81. Oxygen is usually determined before unsaturated hydrocarbons. The analysis of gases by combustion methods such as for hydrogen and saturated hydrocarbons is treated separately.

The author has wisely limited the detailed instructions to five typical types of analysis apparatus; the Bunte, the Orsat, the Buckley-Sinnatt, the Bone and Wheeler, and the Haldane. Exception may be taken to the practice of filling the Bunte burette with water before taking a gas sample (see page 55). This practice would lead to low carbon dioxide figures due to the solubility of carbon dioxide in water. The concluding section on analytical methods gives instructions for the estimation of nitrogen, hydrogen sulphide, oxides of sulphur, nitric oxide, benzole, etc.

The gas referees' method for the determination of calorific value of gas using the Boys calorimeter is given in full. As this is included, might it not be advisable to devote a section to the calculation of loss of heat in flue gases?

The publishers are to be congratulated on the production both of the letterpress and the illustrations.

Divers in Deep Seas. By David Masters. Eyre & Spottiswoode, 284 pp., illus., 8s. 6d. net.

In this book the author has collected a large number of true stories of salvage, some of which will be recalled by many readers, others being told to the general public for the first time. One after another, the heroic deeds of seamen who have averted disaster to both ship and crew, thereby earning the high honours of the sea, are set out in a clear and graphic style which conjures up many a vivid picture of grim endeavour on board ship. The author is at his best in describing the swift and dramatic action upon such occasions as the sinking of the "Empress of Ireland", the rescue of the boys from the "Schulschiff Pommern", the heroic feat of Chief Engineer Arnold in the blazing tanker "Esturia" and of Captain T. S. Knill, who lost his ship but saved the town of Novorossisk from destruction by an explosion.

In a chapter entitled "The Mystery of the 'Maine'" the author, with the aid of a remarkable photograph, advances conclusive evidence that, although the American expert commission decided that the cause of the disaster was an exterior explosion, the explosion actually took place inside the ship.

Notable among the passages on diving are those in which the author describes the gradual extension of descents to 344ft., the British record, and the combat against caisson disease or compressed-air sickness which was eventually terminated by the invention of the decompression chamber. The lurking dangers to which divers must inevitably expose themselves and which continually threaten them with a swift and unexpected fate are illustrated by true stories of salvage work under water. Besides being of great interest to the landsman, who will welcome the breath of sea air which blows for him in these pages, this book discusses the problems of salvage vessels and equipment, which should interest those who take a more technical view of the subject. The book is excellently illustrated with 24 full page photographs.

A Text-book of Laying Off. By E. L. Attwood, O.B.E., and I. C. G. Cooper. Longmans, Green & Co., Ltd., 123 pp., 121 illus., 7s. 6d. net.

The name of Mr. E. L. Attwood, O.B.E., is so well respected amongst students of naval architecture that it is hardly necessary to offer any praise for the present volume on laying off, in the writing of which Mr. Attwood has co-operated with Mr. I. C. G. Cooper, Senior Loftsman in H.M. Dockyard, Chatham.

With a considerable increase noticeable in the use of welding for making large scale, built-up arrangements of flues and piping, marine engineers are likely to find a great deal in this text book on laying off which will be of actual practical assistance to them in their engineering work, and for this reason the book is to be strongly recommended to marine engineers who find themselves faced with the problem of cutting plates to form, for plain and conical pipe intersections, uptake plates and so on. The book is moderately priced at 7s. 6d., and offers very sound and comprehensive instruction on the geometry of shipbuilding and steel sheet work generally.

ABSTRACTS OF THE TECHNICAL PRESS.

The Motor Vessel "Patria".

The twin screw cargo and passenger motor vessel "Patria", which has been built for the Hamburg-America Line by the Deutsche Werft of Hamburg, represents the world's largest Diesel-electric vessel, the principal particulars being as follows: Length o.a. 182·15 m. (597ft. 6in.); breadth extr. 22·5 m. (73ft. 10in.); depth moulded to B deck 12·4 m. (40ft. 8in.); draught 7·75 m. (25ft. 5in.); abt. 8,500 tons deadweight; gross tonnage 15,000 g.r.t. The propelling machinery consists of six 3,000 b.h.p. single-acting two-cycle M.A.N. Diesel motors direct coupled to 3,300 volt synchronous a.c. generators which supply current to two propelling motors developing 15,000 collective s.h.p., sufficient to drive the vessel at a speed of 19 knots. For the excitation of the main generators and the propelling motors three sets of a.c./d.c. transformers are provided, one of which serves as a stand-by. Current for the low-tension system is supplied by a number of 400 kW. a.c. transformers governed automatically to provide a constant secondary voltage of 380/220 volts. The connections are so arranged that any of the main generators can feed either propelling motor. In normal service three of the generators will supply current to the starboard motor and the remaining three to the port motor; a direct electrical connection can, however, be effected on both sides. Accommodation is provided for 210 first-class passengers and 150 tourists. The first-class public rooms include a large dining room extending through two decks, a lounge and veranda cafe, restaurant, smoke room and bar. The entrance hall extends over the whole breadth of the vessel with entrance ports on both sides and is adjoined by the offices of all officials dealing with passengers such as the chief purser, the chief steward, and the baggage master, the doctor's consulting room, bookstall, hairdresser's, and other shops. The first-class promenade deck is completely enclosed, a sports deck being arranged in the after part of the vessel, together with a sun-deck suitable for games and dancing placed at the level of the navigating bridge. For the tourist class a sheltered deck promenade about 200ft. in length is arranged on each side of the vessel from which the dining room, the main lounge, the main staircase, and the games deck are directly accessible.—*"Schiffbau", Vol. 39, No. 14, p. 241-2, 15th July, 1938.*

Spray Penetration.

According to Mehlig's theory (*Zeitschrift V.D.I. 79, No. 40*) the ratio of the lengths of penetration in two given intervals of time is independent of the back pressure, *i.e.* the air pressure in the chamber. Data by Holfelder are quoted to support this. Tests by Sass are cited to show that the penetration is proportional to the root of the orifice diameter. These results are quoted by S. J. Davies (see ABSTRACTS, *May, 1938, Transactions, pp. 30-31*) in his study of "Recent Developments in High-Speed Oil Engines". The author claims that both formulæ are incorrect and by dimensional theory the following equation is obtained :—

$$\frac{l}{d}\left(1+\frac{\rho\ \text{air}}{\rho\ \text{oil}}\right) = f\left(\frac{t}{d}\cdot\frac{\rho\ \text{air}}{\rho\ \text{oil}}\cdot\sqrt{\frac{\Delta p}{\rho\ \text{oil}}}\right)$$

independently of any theory of spraying (see *Journal of Applied Physics, 8, No. 8, Aug., 1937,* and *Penn. State College, Engg. Bull., No. 46*). Both terms are dimensionless, and with back pressure as the only variable it reduces to

$$l\ (1+\rho\ \text{air}) = f\ (t\ \rho\ \text{air})$$

From this the penetration at any pressure can be calculated if it is known for any other. This has been confirmed experimentally and further it fits the data of Beardsley and of Sass, which do not support Mehlig's formula. With varying orifice diameter it reduces to

$$\frac{l}{d} = f\left(\frac{t}{d}\right)$$

i.e. the ratios of penetration and of time to orifice diameter, when plotted against one another, give a single smooth curve for different diameters. Numerical examples are given with curves for l $(1+\rho$ air) against $t.\rho$ air, and for l/d against t/d; these are approximately parabolic about a horizontal axis.—*P. H. Schweitzer, "Engineering", 17th June, 1938, p. 688.*

Standardization of Venturi Meters.

The author reviews recent research work with special regard to D I N specifications, the object being to keep down the pressure loss to a minimum. Ruppel (*Prüfen und Messen, Berlin, 1937, p. 19*) and Wentzell and Groessle (*Wasserkraft und Wasserwirtschaft, 1937, p. 133*) have investigated the problem of transfer of jet measurements to a Venturi meter. Ferroglio (*Ricerche d'Ingeniera, 1937, No. 3*) finds that the throughput is higher than that of the standard jets for all opening ratios $m=(d/D)^2$. Ruppel, however, finds that below $m=0{\cdot}3$ lower values are obtained, but Wentzell and Groessle find a uniform spread of points on either side of the jet curve. Difficulties arise in comparing the results as the dimensions of the meters are not standardized, *e.g.* the angle varies from 7° to 22°

and l/D from 0·7 to 1·5. The results of Ferroglio and of Ruppel agree in showing a diminished pressure loss with rising Reynolds' number, but differences in definition exist; the author pleads for closer co-ordination, and suggests points worth investigation. For short Venturi tubes the theoretical values are generally less than Ferroglio's experimental values; his formulæ do not permit deduction of the most favourable dimensions, but merely those which give the minimum pressure loss for a given angle and ratio.—*H. Lohmann, "V.D.I. Zeitschrift des Vereines deutscher Ingenieure", 28th May, 1938, pp. 684-685.*

Eye Protection in High Temperature Operations.

In general the eye of the welder is much closer to the white-hot metal than that of the steel melter, and the problem is that of protection from ultra-violet radiation, infra-red radiation and glare, present simultaneously. (1) Ultra-violet waves from 0·3 to $0{\cdot}4 \times 10^{-3}$ mm. are relatively harmless, even when intense. (2) Shorter waves cause "sand in the eye" but no permanent damage need occur. (3) White-hot glare from 0·4 to $0{\cdot}75 \times 10^{-3}$ mm. may cause temporary blindness due to retinal over-strain. (4) Radiation between $0{\cdot}75 \times 10^{-3}$ mm. (the extreme red limit), and $1{\cdot}3 \times 10^{-3}$, if intense, causes permanent injury to iris, lens and retina. The damage is gradual, *e.g.* welder's eye and glass-maker's cataract; most of the infra-red radiation is absorbed in the outer portions of the eye, and causes damage there. The author pleads for the B.S.I. specification, since glare-reducing dark glasses may not be protective against the other radiations, and attempts to link up this with U.S.A. specifications. A blue glass or a red glass is not effective alone, and even a combination of these two is not protective against infra-red, which in general is filtered out by ferrous iron in the glass. Such glass is greenish, but colour alone is not an infallible criterion, nor indeed of any importance. Further, the higher the temperature the denser should be the glass, but for welders' *assistants* this opacity may actually be unsuitable. Finally the author recommends that the goggles used shall be suitable for the radiation source, *e.g.* a distant arc, a nearby furnace or arc, or molten metal.—*R. R. Butler, "The Engineer", 1st July, 1938, pp. 24-25.*

Prevention of Eye Injuries in Industry.

Attention is drawn to the exhibition organised by the Royal Eye Hospital, London, to encourage the use of goggles, veils and guards; this will be maintained as a permanent museum in the casualty ward. For grinding, welding and riveting, toughened or armoured glass is used; for air pilots metal-sputtered glass which reflects harmful rays without obstructing vision. Splinter screens, oxy-acetylene welding with the aid of goggles, and chipping, are actually demonstrated in use. Gauze helmets for use in bottle filling or cleaning, asbestos screens for furnace work, and the dangers of negligence, are also illustrated. First-aid and magnetic removal of splinters are shown in films. It is estimated that 250,000 industrial eye injuries occur annually, about 80 per cent. in the engineering and metal trades, in which grinding, welding, chipping, milling and boring are chiefly responsible.—*"Engineering", 1st July, 1938, p. 20.*

Heat Transfer in the Condensation of Steam.

Wide discrepancies in condensation data have been cleared up by direct observation, the disturbing factor being the exact mechanism of condensation. When droplets are formed the rate of transfer is up to 20 times that through a liquid film which wets the surface; further, the rate of heat transfer increases with decreasing droplet radius and coalescence aids rapid draining. In general rough and clean surfaces encourage film formation while smooth and greasy surfaces promote droplet formation. Nusselt's average heat transfer coefficients are a multiple of the term

$$\left(\frac{Q\,\rho^2\,\kappa^3\,g}{4\,\eta\,h\,\theta}\right)^{\frac{1}{4}}$$

where Q is the latent heat of the steam at saturation, ρ the density, κ the conductivity, η the viscosity of the condensate and θ the difference between steam saturation and the tube wall temperatures. For long vertical tubes at high rates of transfer the condensate in the lower portions should be turbulent, *i.e.* $4t\rho V/\eta = 4C/\eta = 1600$, where C is the rate of condensation per unit perimeter in lb. per ft. per hr., but the transition may occur at Reynolds' numbers even lower, owing to agitation of the film by live steam. A further development of the theory gives for steam flowing through a pipe

$$\Delta P = (\text{dimensionless constant}) \times (v^2 \rho_s / 2d)$$

where ΔP is the pressure drop, v the linear velocity, ρ_s the density of the steam and d the pipe diameter. Further corrections may be applied. The author concludes that the simple expression is probably fairly correct for slowly moving air-free steam, and the extended theory for higher steam velocities, but with drop condensation both break down. She discusses the enormous discrepancies which exist in experimental results in different countries over the period 1897-1936, and the departures from the idealised formulæ. 0·5 per cent. of air impurity has been found to halve the rate of heat transfer. For steam condensing *outside* horizontal tubes, where the critical velocity is not usually reached by the condensate, the results are roughly in agreement with an appropriate Nusselt formula. In general, in evaporators an increase in the steam-side coefficient would increase the overall coefficient by approximately the same amount as a similar increase in the water-side coefficient brought about by increasing the water velocities. The possibility of droplet condensation is therefore very attractive, especially in the forced circulation type where liquid velocities are already very high.—*Margaret Fishenden, "Engineering", 10th June, 1938, pp. 643-645.*

Time Tests on Welded Steels Containing Molybdenum.

Gas and electric welds in plates, 16-50 mm. (0·6—2in.) thick, of five low alloy steels used in boiler construction were investigated. The percentage compositions lay within the following limits—C 0·11-0·16, Si 0·16-0·36, Mn 0·31-0·77, Cu 0·17-0·33, Cr 0·04-0·88, Ni 0·02-0·31, Mo 0·32-0·48. For welding rods the following were used:—Austenitic steels of high alloy content and alloy steels with low percentages of Mn, Mn-Mo, Mo, or Cr-Mo; in the electric welding only bare rods were used. In general the experiments were carried out at 500° C. The time limit of the unwelded steels was 13-17 kg./mm.^{2} (8·25-10·80 tons/in^2); with good welding it lay about 14-21 kg./mm.^{2}, and consistently reached 90 per cent. of that of the original material; in most cases the values were 5-10 per cent. and in some cases as much as 20 per cent. *above* the time limits of the unwelded steel. Subsequent thermal treatment had little effect, even an annealing for over 500 hr. carried out at 500° C in two cases.—*H. Schottky and W. Ruttmann, Wärme, 61, 1938 No. 8, p. 144, and "V.D.I. Zeitschrift des vereines deutscher Ingenieure", 28th May, 1938, pp. 686-687.*

Water-Hammer Time Tests on Pure Iron.

A water jet 8 mm. in diameter (0·32in.) under a head of 3 m. (10ft.) was interrupted at 39 m/sec. (130 ft./sec.) by a recrystallised iron specimen polished until single crystals in the surface ceased to be visible; under the microscope a few defects and non-metallic inclusions were seen. After $1{\cdot}26 \times 10^6$ interruptions, twinning and some crystal boundaries could be seen, the former being evidence that the deformation was dynamic and not static. After $5{\cdot}6 \times 10^6$ the twinning was accentuated, as well as the Neumann lamellæ visible in the first stage, but the latter had not increased in number. Grain boundaries were also more pronounced and corrosion had begun, especially along the Neumann lines which were more seriously attacked than the former. The unevenness in the various crystals of the surface actually resembled etching pits rather than local deformation. After $7{\cdot}7 \times 10^6$ interruptions the corrosion which was visible at isolated spots in the previous stage became more general and the patches joined together. After $15{\cdot}4 \times 10^6$ there was widespread slip and separation of the grains, corrosion and loss of weight were marked. These results agree with those of Gough and Sopwith (*Aero. Research Comm. Report No. 1433, 1930*) for aluminium in tap water, while Thum and Ochs (*Korrosion und Dauerfestigkeit, Berlin, 1937*) show that in a mild steel, surface attack starts from precipitated carbide at the grain boundaries. It seems well established that under water-hammer conditions corrosion starts from twin boundaries or Neumann lines. Ulrich (*Zeitschrift V.D.I., 78, 1934, p. 53*) has reached similar conclusions. The author discusses the possibility of internal crumbling (where the surface is resistant) and the part which frictional oxidation may play in the case of surfaces in relative motion.—*M. Vater, "V.D.I. Zeitschrift des Vereines deutscher Ingenieure", 28th May, 1938", pp. 672-674.*

The Internal Combustion Engine.

At the International Engineering Conference at Glasgow the author treated progress in the last 20 years in non technical terms. The old conception of combustion in the petrol cylinder is no longer valid and nitrogen is not completely inert. Intermediate combustion products are believed to be the cause not only of detonation but also of cylinder wear; they are less easily formed from compounds containing oxygen (*e.g.* acetone, alcohol) or from ring molecules (benzene, etc.) than from chain molecules (petrol, etc.). In the heavy-oil cylinder detonation is absent and the main problem is good mixing. In general a single jet plus air swirl design is best for quick running, thermal efficiency being rather lower and output per unit volume higher. A multiple jet plus moderate swirl is more suitable for larger, slower running engines. In road haulage the supremacy of the four-cycle motor does not appear justified, having regard to two-cycle performance. The author regards the aero engine as a peak of mechanical achievement, brilliant in design, with a power/weight ratio of about 1 h.p. per lb., highest thermal efficiency, mechanical reliability and great durability, normally covering 100,000 miles without overhaul. By increasing octane number from 80 (a good roadside fuel) to 87 (aviation petrol), power output can be increased by 15 per cent., a further increase to 100 would give a further increase of 30 per cent.; these improvements are due to the greater compression that is possible. Sleeve-valve aero-engines, now at the threshold of usefulness, have important theoretical advantages. The author foresees no great future for the oil engine in aircraft (anti-knock fuels to-day show an efficiency approaching that of heavy oil); the design is necessarily heavier, and freedom from fire risk has no *military* value. Possible future designs include high-compression four-cycle, low-compression highly-supercharged, single-piston two-cycle, double-piston two-cycle (German) units. Finally he contrasts the small, cheap, light, quick-running oil engine with the massive, durable, slow, rhythmic and expensive steam engines of our forefathers.—*H. R. Ricardo, "The Engineer", 24th June, 1938, pp. 702-703.*

A New Material for Pipes.

At a meeting of the American Chemical Society a process for making pipe lines of sulphur instead of steel was described. To make a pipe sulphur is mixed with coarse sand or coke, in addition to shredded asbestos. Such pipes were said to be able to stand pressures up to 75lb. per square inch.—*"The Engineer, 27th May, 1938, p. 593.*

Cast Iron Straight-edges.

Following its recent issue of a draft specification for standard surface plates and marking-off tables, the B.S.I. has now published a draft specification for cast iron straight-edges. Both these publications form items of a general series of specifications for engineers' precision tools. They have been prepared by a committee in the usual manner, but are being widely circulated in draft form, so that they may be subjected to the examination of engineers who have not so far been approached on the subject. A copy will be sent to any *bona fide* inquirer by the British Standards Institution, 28, Victoria Street, S.W.1, and comments on the contents should be addressed direct to the Institution. Whilst it does not seem probable that much objection can be taken to the specification as drafted, it is to be hoped that all who are interested in the matter as precision tool makers or users will study it. We would particularly call attention to Appendix B, which deals with the Testing of Straight-edges, and stresses the value of the sensitive spirit level for that purpose and to the vague paragraph on Ageing in the body of the specification. In view of the great importance of ageing, it would seem desirable to make definite rules for natural ageing. A method of heat treatment for artificial ageing is given in an appendix. No reference is made in either place to the removal of the skin, before or during ageing. That practice was deemed necessary at one time, and probably some makers still regard it as desirable. We mention these points only to indicate that the draft specification is one that merits consideration.—*"The Engineer", 8th July, 1938, p. 47.*

A Fast Ferry Ship.

A new ferry ship, the "South Steyne", built by Henry Robb, Ltd., for service in Australia between Sydney and Manly Beach, will be the fastest vessel of its kind in the British Empire. The vessel, which is double-ended and has two bows, two rudders, and two propellers, has been designed for a speed of 17 knots, and will accommodate 2,000 passengers. The principal dimensions of the ship are: Length, 220ft.; breadth moulded, 38ft., and depth moulded to main deck 15ft. 9in. The engines consist of one four-crank, triple-expansion engine, the steam being supplied by four single-ended, return-tube, oil-fired boilers.—*"The Engineer", 8th July, 1938, p. 41.*

The Merchant Navy Defence Course.

The Admiralty has decided to institute further training in gunnery for certain merchant navy officers, to supplement that already given in the merchant navy defence course. This training will be known as the merchant navy defence course, Part 2, and will commence on Monday, 18th July, 1938. It will be open to all navigating officers who have completed sessions "A", "D", "E", "F", and "G" of the merchant navy defence course, except masters in command and officers who have not been employed in the merchant navy for twelve months. The new course will take five days from Monday to Friday each week and, it is stated, since the instruction is progressive, it is most desirable that it should be completed without a break in instruction. As, however, this will not always be possible for officers whose periods in harbour are short, the course has been divided into two independent sections, which can be taken separately, either being taken first. Section I will occupy two days and Section II three days. Each section, once commenced, must be completed without a break in instruction. The merchant navy defence course, Part 2, will be held at London, Liverpool, Glasgow, South Shields, Cardiff, and Hull in the same establishments as the merchant navy defence course.—*"The Engineer", 8th July, 1938, p. 41.*

A New Adhesive for Plywood.

A new type of adhesive for the glueing of plywood has been developed by Bakelite, Ltd. Known as "Plybond", the new material is in the form of a thin sheet of paper which has been impregnated with Bakelite resinoid. This latter possesses the property of first becoming fluid under the influence of heat and then rehardening to an infusible and insoluble state when heating is continued. In the manufacture of plywood, the procedure adopted is to interleave the various plies with "Plybond", the whole then being formed into a homogeneous board in a heated press. The resultant sheet is claimed to be water and steam resistant, while it offers considerable resistance to insects and fungus. Immersion in water of a plywood board bonded with "Plybond" is said to result in an increase in strength, while only a very slight weakening of the bond is apparent after prolonged boiling in water.—*"The Engineer", 8th July, 1938, p. 41.*

Successor to the "Leviathan".

Although the keel of the new United States liner, to replace the "Leviathan", has not yet been laid, the preparatory work is progressing according to schedule in the yard of the Newport News Shipbuilding and Dry Dock Company. The keel will be laid in late August or early September, and the launch is expected to take place on 15th July, 1939. The vessel, it is hoped, will be handed over for service with the United States Lines in February, 1940. —*"The Engineer", 22nd July, 1938, p. 93.*

Dutch Motor Liner.

Work on the Java-China-Japan Line's motorship "Tjikalengka" is being speeded up at the yard of the Nederland Shipbuilding Company, as it is intended to launch the ship a month earlier than had been planned. On the vacant berth a stand will be prepared for the launch of the liner "Oranje", which will be ready for service next year. She will be the largest Dutch motor liner and the largest Dutch ship in the service to the Netherlands East Indies. She will be of about 20,000 gross tons.—*"The Engineer", 22nd July, 1938, p. 93.*

Shipping at Liverpool Docks.

The total tonnage of vessels using the Mersey Docks and Harbour Board's dock during the year ended 1st July, 1938, amounted to 16,530,693 tons. This figure constitutes a record, being greater than the figure for the preceding year by 407,000 tons and 350,000 tons more than the previous record year of 1930.—*"The Engineer", 22nd July, 1938, p. 93.*

Energy Sources of the World.

Figures comparing the energy sources of the world, which have been compiled by the International Labour Office, show that in 1935 coal and lignite represented 60·3 per cent., oil 16·5 per cent., water power 6·6 per cent., natural gas 3·8 per cent., and wood 12·8 per cent. Comparative figures in 1913 were: Coal and lignite 74·1 per cent., oil 4·5 per cent., water power 2·4 per cent., natural gas 1·4 per cent., and wood 17·6 per cent.—*"The Engineer", 22nd July, 1938, p. 93.*

British Shipping in the Pacific.

A joint statement in the following terms was issued on Friday, July 22nd, by Sir Edward Beatty and Lord Craigmyle, relating to the proposed construction of two liners for Pacific service:—A draft agreement has for some time been under discussion by the Canadian Australasian Line and the Governments of the United Kingdom, Canada, Australia, New Zealand and Fiji for the maintenance and improvement of the passenger and cargo service between Vancouver, Suva, Auckland, Sydney, and Melbourne, which provides for financial assistance from the interested Governments to the shipping company for the construction in Great Britain of two new ships for Pacific service, designed to maintain the prestige of Empire shipping on the Pacific Ocean. Plans and specifications for two new ships have been submitted by the company to selected shipbuilders, and quotations for construction have been received by the company. Unfortunately shipbuilding prices have reached an uneconomical peak, and therefore the company has decided that construction is impracticable for the present. The discussions leading to the draft agreement have been undertaken with the greatest friendliness and good will, and leave no room for doubt as to the essential character of the service in the interests of Empire trade. While the temporary postponement is to be regretted, the company anticipates the resumption of discussions looking to the construction of the new ships as soon as economical shipbuilding prices prevail. It is desired to pay tribute to the keen, practical interest displayed in the project by the Ministers of the interested Governments, and by their officials, through whose efforts the preparation of the draft agreement has been possible.—*"The Engineer", 29th July, 1938, p. 109.*

The Use of Coal in Mercantile Ships.

In introducing a Supplementary Estimate of £143,804 for the Ministry of Mines, in the House of Commons on Monday, July 25th, Captain Crookshank, the Minister of Mines, spoke of a possibility of a return from oil to coal in certain classes of ships in the mercantile marine. He said that during the first six months of this year, as compared with last year, the output of coal had only increased in two districts, and that to a very small extent, namely, in Durham and South Wales. Over the whole coalfield there had been a decrease in output of nearly 3,500,000 tons. The biggest export drop had been to France, namely, about 1,000,000 tons. On the other hand, there had been an increase in the case of Italy, Germany, and Spain. In February, 1937, he had convened a conference of all the technical interests and people directly concerned to see whether something could be done to encourage the use of coal in the mercantile marine and thereby check the onslaught of oil. As a result of that conference a committee was formed to make investigations. That committee had arrived at a careful and unanimous report, which would be available very shortly. It was interesting to know that the committee had found that there was some possibility of a return from oil to coal in certain classes of ships, more particularly large tramps, cargo liners, and intermediate passenger liners of horsepowers ranging from 1,500 to 8,000. The committee recommended that further steps should be taken to pursue experiments in that direction.—*"The Engineer", 29th July, 1938, p. 109.*

Economy of Steam Propulsion.

Though the savings that may be effected by new equipment are of prime importance to the owner of obsolescent plant, it is certainly unfair and it may be very expensive to base a change in practice on comparisons between the existing obsolete equipment and new plant of a different type. As a case in point, *Hansa* draws attention to the misleading effect of publicity given to the operating costs of producer gas tugs "compared with consumption data from coal-burning vessels which are only fit for breaking-up". The developments of recent years have brought about substantial improvements in the economy of steam propulsion for small craft, and there is every prospect of further improvements being effected by a more general utilisation of advances in design and construction already well tried in individual applications. In new vessels requiring from 150 to 350 h.p. it has been possible for years past to guarantee a coal consumption between 1 and 1¼lb. per i.h.p.-hour, without exceeding steam pressures about 170lb., and temperatures about 550° F. Compared with this, high-pressure superheated steam equipment, for 300 h.p. tugs now under construction, will consume about 0·95lb. of coal (13,000 B.Th.U. per lb.) per b.h.p.-hour, the live steam conditions being 400-lb. pressure, 660° F. Yet higher pressures and temperatures introduce no difficulties beyond the scope of modern marine engineering practice, and exhaust turbines have added substantially to the overall economy of steam propulsion. Coal consumptions down to about 0·8lb. per i.h.p.-hour are guaranteed and attained in so many cases that a figure of this order, and not the extravagant figures of old vessels, should be taken when considering the merits of rival systems.—*"Shipbuilding and Shipping Record", 16th June, 1938, p. 771.*

The "Aquitania".

The "Aquitania" was not built to be a record breaker, but to carry a large number of passengers at 23 knots speed. Like the "Mauretania", her performances are becoming better with increasing age. Built in 1913, she is now reaching the age when her service should be over, but instead of showing signs of weariness, she has been engaged, with the "Queen Mary", in a weekly trip across the Atlantic. On Saturday, June 4, on her homeward voyage, she steamed 590 miles in 23 hours. On her outward voyage she completed the crossing at an average speed of 24·41 knots, thus eclipsing her previous best west-bound average speed of 24·27 knots. This speed is sufficient to enable her to cross the Atlantic in a little over five days, the actual time in a recent crossing being 5 days, 7 hours and 19 minutes between Cherbourg breakwater and the Ambrose Channel light vessel. This leaves very little time for refuelling and replenishing her stores when engaged in the weekly run; accordingly, on occasional voyages a longer stay in port is allowed. From the sailing lists she is billed to leave Southampton on 25th May, 8th June, 22nd June, 6th July and 27th July, thus showing a fortnightly sailing save for the last date, when a three weeks' interval elapses. The ability of this vessel to give such performances after 25 years' service says much for the soundness of her hull and machinery. Undoubtedly new propellers have improved her performances, and owners have every confidence that she will continue to maintain her present efficiency until the "Queen Elizabeth" comes into service in the spring of 1940.—*"Shipbuilding and Shipping Record", 16th June, 1938, p. 771.*

Veteran Allan Liner.

Metal is of more use than storage facilities in Spain at the present time, and the former Allan liner "Sardinian", which has been a hulk at Vigo since the end of 1920, is now to be broken up. She was built by Steele & Co., of Greenock, for the Allan Line in 1874, an iron screw barque of individual design, with a gross tonnage of 4,376 and compound engines. To begin with, the vessel was a passenger carrier highly regarded in the St. Lawrence trade. At the beginning of 1882 she lost her rudder and rudder post in bad weather in the North Atlantic and drifted for three days before being picked up by the Dominion liner "Texas". Passengers were transferred with great difficulty, and the vessel was towed the 800 miles to Liverpool, taking three weeks. The "Texas" was awarded £6,000 salvage. In the following year she was chartered to the Inman Line for the Liverpool-New York service and again in 1886. In 1897 Denny of Dumbarton took her in hand and fitted her with new triple-expansion engines, instead of having compound engines tripled as was usually done. Two new boilers of 170 lb. pressure were also installed. In 1899, the "Sardinian" was employed carrying the first Canadian contingent to the Transvaal War and for several years before the Great War was generally employed on the Liverpool and Clyde services. The vessel was taken up under the Liner Requisition scheme in April, 1917, shortly before the Canadian Pacific acquired the Allan Line, and escaped all enemy attention, being put on to the London-Canadian cargo service until shortly after the armistice, when she was carrying Belgian refugees home to Antwerp for two months and bringing back British troops.—*"Shipbuilding and Shipping Record", 16th June, 1938, p. 771.*

Change-Over Engines.

Of less technical interest and novelty, but no less significant of German thoroughness in their four-year plan, is the attention now being given to the design and use of internal combustion engines which can be readily switched over from oil to gas fuel, or vice versa. When there is an occasional or seasonal supply of some waste or cheap material capable of being burnt in a gas-producer, it is very often a paying proposition to make somewhat greater capital expenditure on a larger oil engine than is actually required and add a gas-producer of suction or other type. The main change required to run the engine on gas may be the substitution of a different cylinder head. The extra size of the engine compensates for the lower calorific value of gas compared with oil. In *Die Warme* (Berlin), Herr R. Lessnig considers some of the factors which require attention from the potential purchasers of change-over engines. He gives some practicable measures for minimising the power loss, which he puts at 20 per cent. for a 50-h.p. oil engine running at 500 r.p.m. The time taken to change over a 300-h.p. 6-cylinder unit he finds to be from 4 to 6 hours; but this must depend on the number of men on the work, and some of our own technical school students have been known to make the change considerably faster under expert supervision.

The change of compression ratio may be made by providing specially long big-end bolts and inserting distance pieces under the foot of the rod. The most interesting German development in this connection is an engine constructed by the Daimler-Benz Company, which is said to run reliably on almost any known fuel, liquid or gaseous, but this extreme versatility requires not two, but three, sets of changeable parts. For oil fuels a compression ratio of 18 to 1 is used in this engine, for gas and petrol a ratio of 8 to 1; and secondary changes are necessary for adaption to suction gas or pressure gas.—*"The Syren and Shipping", 15th June, 1938, p. 448.*

Machinery for New American Cargo Vessels.

The notes which have already appeared here on the American Maritime Commission's new vessels, both with geared Diesel and geared turbine machinery, have indicated that considerable thought and designing skill have gone into the preparation of the specifications and designs. Orders for both motorships and steamships of this type have already been placed and there is little doubt that when these comparatively fast ships are completed they will appear as formidable competitors on the trade routes. Recently it has been announced that the machinery for the motorships of this type (four of these C2 pattern single-screw ships are building at the Tampa yard, in Florida) have been ordered from the Nordberg Manufacturing Co., of Milwaukee. These ships are to be propelled by two-stroke, single-acting Diesels using what is familiarly known in this country as Vulcan gearing; thus each ship has two engines driving a single-screw through hydraulic couplings and single-reduction gearing.

Diesel Standardisation.

The general design of the engines is interesting to the student of marine Diesel design, for it shows a tendency which has already been revealed in European factories for marine oil engine design to settle down into fairly standardised channels which experience has shown to be sound. Thus, the general layout of the cylinder cover is reminiscent of Sulzer practice and the scavenging arrangements are not unlike those employed in the Fiat engine and in certain Sulzer units. The interesting cross-head construction which Nordberg have previously found satisfactory is not unlike arrangements which have been evolved by European builders in recent years and the same can be said of the main framing. Scavenging is by means of a positive type blower, which is neatly mounted at the after end of each engine and driven from the crankshaft. Here again this is an arrangement which several makers have found desirable and now standardise, although a few years ago engine-driven scavening blowers were rare. It is not suggested that the Nordberg designers are adopting the best features which other constructors have found sound, but rather, as already emphasised, that marine oil engine design is, as it were, settling down and the experience of various makers in different parts of the world is showing that the solution of certain problems is reached in a logical manner which inevitably brings with it a certain measure of mechanical standardisation. After all, marine steam engine development followed a similar course.

A Specification of the Machinery.

The Nordberg machinery for these C2 motorships is of attractive and clean appearance, judged from the wash drawings; none of the machinery is, of course, completed. Each engine has nine cylinders mounted on a stiff monobloc main frame and a wide tank-top type bedplate; tension through-bolt construction is employed with special means for ensuring that all of these long bolts are stressed equally. Each engine has the single-face crosshead shoes and guides on the inboard side with the exhaust manifolds outboard. The cylinder diameter is 21in. and the stroke 29in. The normal output of each engine is 3,000 b.h.p. at 225 r.p.m., and a 10 per cent. overload with an engine speed of 232·5 r.p.m. can readily be carried; the specification calls for a 25 per cent. overload for two hours, the equivalent engine speed being 242·5 r.p.m. The ratio of reduction provided by the single-reduction gearing is approximately 2·45 to 1, for the normal propeller speed is 92 r.p.m. Each cylinder has its own injection pump and there is a single, automatic-type valve injection in the centre of cylinder cover; each of these valves has its own metal edge-wise type fuel oil filter and the nozzle tip is water-cooled. The injection pumps are directly operated off the gear-driven camshaft and direct reversing of the engine is effected on the Burmeister & Wain system, whereby the camshaft is virtually given an angular displacement of about 120 degrees so as to bring the fuel pump cams into the correct position for running astern. At the same time the reversing gear operates a reversing valve in the scavenging air blower and brings the astern starting air distribution valves into operation. There is a very complete forced lubrication system for the various bearings and lubricating oil is also used for cooling the pistons.—*"The Shipping World", 27th July, 1938, p. 97.*

Standardisation in Shipbuilding.

A number of British builders—notably the Burntisland yard and Messrs. Wm. Doxford & Sons, Ltd.—have produced attractive and efficient designs of standard ships which can be turned out at reasonable prices and which, generally speaking, can meet the requirements of many shipowners. It has been suggested that this policy could be developed more widely with benefit alike to British shipbuilding and shipowning. It is stated, further, that a great deal of money could be saved in the building stages, and maintenance costs and difficulties minimised later, if a greater measure of standardisation in details of equipment were effected in different departments. On the Continent, particularly in Germany, this point has received a great deal of attention. It seems absurd, for instance, that two supposedly similar ships should have different piston rings for, say, auxiliary engines of the same power and service; or should employ brushes of different construction for, say, cargo winch motors for the same duty. The instances of this lack of standardisation and manufacturing co-ordination could be extended almost indefinitely and the problem is one which deserves careful attention. If the matter were tackled by a committee composed of representatives of shipowning, shipbuilding, marine engineering, and classification interests some concrete recommendations would surely be evolved to the benefit of the industries concerned.—*"The Shipping World", 20th July, 1938, p. 69.*

A New Steam Power Unit.

The following notes, describing a French design of combined steam generator and turbo-motor, are reproduced from our contemporary, *Motor Transport,* and describe a motor lorry unit.

"A motor lorry fitted with a power unit of revolutionary design is being built for testing bv the French Army. It will operate either on producer gas or heavy-oil fuel and the motor is in the form of a steam turbine which generates its own steam. It is known as the Béchard steam-generating turbo-motor.

"It comprises a series of six hollow discs shrunk on a shaft and constituting the boiler elements. Each element consists of two discs of boiler plate 0·19in. thick and about 12in. in diameter, spaced apart by peripheral rings welded to their outer edges, while the hollow interior is divided into two parts by a baffle, also of boiler plate. The discs are spaced on the shaft by pieces of steel tube 3in. long and of larger diameter than the shaft, so that they form annular spaces around it. The discs are drilled so that water or steam can pass from one boiler disc to the next through the annular spaces. At one end of the shaft a number of small tubes connect the first disc to an axial hole drilled in the shaft and forming the water inlet. Thus, when water is admitted into the inlet, it will flow through each of the discs in succession, passing over the edges of the baffle plates.

"At the other end of the shaft is a special outlet disc made up of three sheets of boiler plate, two outer ones 0·19in. thick and an inner one about ½in. thick. The three plates are riveted together, and on the face of the inner plate are machined a series of channels communicating with nozzles formed around the periphery of the disc. These channels form outlet tubes communicating with the outlet of the last boiler disc, in the same manner as the boiler discs are connected with one another.

"Around the periphery of the outlet disc, but not fixed to it, is a series of turbine blades riveted between two rings of boiler plate and attached to the frame in which the motor turns so that they remain stationary. The frame also supports the shaft on which the boiler discs and outlet disc are mounted by a bearing at each end.

"The whole motor is enclosed in a heat-insulated housing inside which are two burners, one connected to a gas producer carried on the vehicle, and the other to a tank for fuel oil, so that either fuel can be used by lighting the corresponding burner. The burners are placed at such an angle that the flames first strike the boiler disc nearest to the outlet disc and then swirl spirally inside the housing and around the other boiler discs, escaping by a flue at the water inlet end.

"Water for the motor is carried in a tank placed to one side and connected to the water inlet by a tube. When the motor is filled, the water can rise in the boiler discs only to the level of the connection to the lowest tube in the outlet disc. Any additional water will merely flow out of this tube, so that the boiler can never be filled more than about half-full of water. In a 50-b.h.p. motor the boiler holds about 10½ pints of water.

"When the burners are lighted, the steam produced tends to escape through the nozzles of the outlet disc, and, striking the fixed turbine blades, sets the whole assembly of discs and shaft in motion. Centrifugal force acting on the water in the boiler throws it outwards within the boiler discs, and as the motor gains speed and steam is produced in larger quantity, that near the outlet disc drives the water in the boiler discs back until, when the motor is running at full speed, the discs nearest the outlet end will be filled entirely with steam and those nearest the inlet end entirely with water. The boiler discs are then divided into three zones, the first forming the water-heating zone, the second the evaporation zone and the third the superheater zone".—*"The Steam Engineer", August, 1938, pp. 445-6.*

Lubrication Research.

The Department of Scientific and Industrial Research has issued the third of a series of publications dealing with research into the problems of lubrication. The present report* records the results of experiments made at the National Physical Laboratory on behalf of the Lubrication Research Committee in an endeavour to elucidate the effect of the various factors that determine the friction of an oscillating bearing. The most suitable lubricants for efficient lubrication of bearings of this type are given.

It is pointed out that before deciding which lubricants will give the most efficient results in any particular mechanism it is essential, in the first

**The Friction of an Oscillating Bearing,* Lubrication Research Technical Paper No. 3, published by H.M. Stationery Office, price 9d. net.

place, to know which of the two types of lubricating conditions, fluid film or boundary, predominates in that particular mechanism.

The report describes the results of variations in the three main factors influencing friction, namely, speed, load and temperature. These were varied over fairly considerable ranges, and, in addition, a number of lubricants, including mineral, fatty and compounded oils, were used. The bearing surfaces were of highly polished hardened steel, and were completely submerged in oil contained in a bath which was electrically heated. The bush was stationary, and the journal was oscillated through a total angle of 30°. Incorporated in the drive was an optically recording torque-meter, photographic records of the friction force being obtained.

It was evident from the results that over the whole range of conditions investigated the friction was dependent on certain characteristics of the lubricant other than its viscosity. At the lowest frequency of oscillation the friction was independent of viscosity, and although there was a considerable reduction in the friction as the frequency was increased, suggesting the formation of a thicker lubricating film and a tendency towards fluid film conditions, the chemical composition of the lubricant played an important part in the lubrication of the bearing at all frequencies.

The investigation indicates that mineral oils are inferior to vegetable oils for lubrication of an oscillating bearing at all frequencies, but that an improvement can be obtained in the lubricating quality of mineral oils by the addition of small amounts of fatty acid or vegetable oil.—*"The Steam Engineer", August, 1938, p. 447.*

Research on Cast Iron.

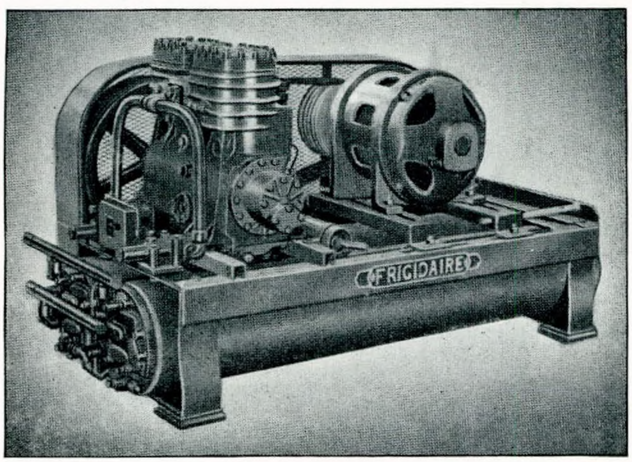
The progress of metallurgical science is continually yielding new materials as well as improving the properties of existing ones, so that while to-day far greater demands are made upon the metals used in nearly all types of machinery than was the case even a few years ago, these demands can, generally speaking, be satisfactorily met. Indeed, in many cases the designer is faced with an embarrassing choice as, for example, when he has put before him the claims of certain non-ferrous alloys which have properties equal to, if not superior to, those of the iron or steel hitherto employed for that particular job. But in spite of all this, cast-iron still remains the most important metal which is used in the construction of engines and the machines they drive, although it is universally recognised that cast iron suffers from many serious shortcomings. Happily, metallurgical research is also being directed towards the investigation of these shortcomings and, in particular, the British Cast Iron Research Association has ever since its inception—as our columns have from time to time borne witness—been responsible for a number of successful investigations which have increased very considerably our knowledge of the peculiarities of this metal, as well as enabling great improvements to be made in the quality of the castings now made for various specific purposes.

There is still, however, very much that is obscure in the behaviour of the various elements which are usually to be found in cast iron, while the demands which are being made for improvement in the quality and economy in the production of the metal still leave plenty of scope for investigation and research. Thus, while the effect of carbon in cast iron is generally understood, investigations are still being actively pursued in the laboratories of the British Cast Iron Research Association into the problems of graphite refinement. The progress made in this work was, it may be recalled, referred to in the recent annual report of the Association, the principle being based upon the fact that by dissolving a small quantity of titanium—from 0·1 to 0·2 per cent.—in cast iron and bubbling carbon dioxide gas through the melt, the graphite structure is completely refined. But when attempts are made to apply this process to a cupola furnace considerable difficulties are experienced, and while definite progress has been made, further research is necessary. Meanwhile, it is of interest to note that the application of the graphite refinement process to the production of moulds for steel ingots has been made on a commercial scale, and the results are now under examination. Another investigation which is of considerable importance is the effect of aluminium on cast iron. It is generally recognised that what are termed aluminium cast irons possess high mechanical strength at elevated temperatures, but what is perhaps of even greater importance, they possess considerable resistance to the effects of exposure to heat. Investigations are being undertaken in a series of these cast irons containing up to 7 per cent. of aluminium, and provided sound castings can be produced it is apparent that these alloys may prove of considerable value to the marine engineer. Mention may also be made of the work on high-duty cast irons containing 1·5 per cent. and upwards of carbon which are capable of being heat treated.

In the field of production, research has resulted in the development of the balanced-blast cupola the use of which yields, among other advantages, a considerable economy in fuel costs. Indeed, the report referred to above states that 175 of these cupolas having an aggregate capacity of over 1,200 tons per hour have been installed or are under construction, and it is conservatively estimated that the value of the fuel saved by these units reaches £25,000 per annum. They range from furnaces of 21in. diameter yielding 1·8 tons per hour to units of 66in. diameter having a capacity of 17·8 tons per hour, and they are used in the production of all kinds of cast iron for both light and heavy castings, malleable cast iron, refined pig iron as well as for the melting of metal for steel castings in converters. But while it is thus apparent that considerable advances are being made in our knowledge both of the metallurgy of cast iron and of the most economical ways in which it may be produced, the fact still remains that in many foundries the results of these researches are unknown and, as a consequence, inferior castings are still being turned out. It is nearly always the case when information on cast metals is given in a paper before any of our technical institutions, that in the subsequent discussion attention is drawn to the lack of co-ordination between those responsible for the various stages between the designer and the user of the completed machine. It is therefore to be hoped that the information gained as a result of these investigations will be widely disseminated and applied as much as possible in the future production and use of iron castings.—*"Shipbuilding and Shipping Record", 17th March, 1938, p. 325.*

Refrigeration by "Freon".

The use of refrigeration on board ship and of air conditioning in modern passenger liners is steadily increasing, and the design of refrigerating plant of various types has shown corresponding progress. Among recent developments has been the successful introduction of a refrigerant called "Freon" (F-12), which can claim a number of advantages. Briefly, the gas is odourless, non toxic and has an affinity with oil, an essential feature of the modern automatic refrigerator. It is a halogen derivation of methane and is a colourless gas 4·81 times as dense as air, and the vapours in all proportions are non-irritant to the skin, eyes, nose, throat and lungs. The boiling point at atmospheric pressure is —22 degrees Fahr. and at ordinary temperatures it is a liquid when under a pressure of about 75lb. per sq. in. Freon is non-combustible and non-inflammable, and, being heavier than air, will blanket and extinguish a fire in the same manner as the chemical fire extinguishers. In fact, it has been stated that its fire extinguishing properties are more than twice as good as carbon dioxide and more than four times that of nitrogen. It is said to be the safest known refrigerant. It is interesting to note that Messrs. Frigidaire, Ltd., now exclusively use this gas throughout the whole of their range of compressors from 1/5 h.p. to 20 h.p. The illustration shows the standard type Frigidaire 10 h.p. 4-cylinder reciprocating type Freon compressor, which for marine use is, of course, equipped with a vertical type water-cooled condenser.—*"The Shipping World", 13th July, 1938, p. 41.*



A 10 h.p. "Freon" Compressor.

Propulsion of the Cross Channel Ship.

Progress of the Diesel Engine to Date.

Apart from the appropriateness of the little study indicated by the title in a supplement of this kind, there are several contemporary events which conspire to make the following remarks of more than usual interest. Summer traffic on the Ostend-Dover route of the Belgian State Railways will include in continuous operation two of the fastest motor vessels in the world, both of which are cross-channel ships. During May construction was commenced on two fast day-service cross-channel ships of unusual type characteristics for the Flushing-Parkeston Quay service maintained by the Zeeland Steamship Company. The 24-hour type "Vega", sister ship to the "Venus", entered the Bergen-Newcastle fast mail service at the end of last month. She is one of the fastest motor vessels in the world, with a service speed of about 19½ knots.

The first of two similarly important ships, the "Black Prince", has just been placed by Messrs. Fred Olsen on the Newcastle to Oslo direct service. Messrs. Wm. Denny & Bros., on the Clyde, are building a Diesel-propelled ship for the Larne-Stranraer motor car traffic, which is, in dimensions and characteristics, to all intents and purposes, a cross-channel ship, and the General Steam Navigation Company is to take delivery, for next summer season, of an improved "Royal Sovereign", while two of the finest night service cross-channel ships, both motor vessels, have been placed on the Liverpool-Dublin trade by the Coast Lines group, as is related elsewhere in this supplement.

The Upper Limit.

These ships are all the result of progressive development on the part of those who have had confidence in the internal combustion engine. Will 17,000 h.p. in under 400ft. actually represent the upper limit? Perhaps it may on twin screws unless a higher power output per cylinder is possible, say, with double-acting engines. Gearing would seem to be one solution, electric propulsion another. It is not easy, in this class of tonnage, to borrow practice from other spheres. Nor can the speed of fast cross-channel motor ships be contrasted with the prevalent fashion for increase in other ship types.

The speed of the former has on its respective routes altered but little in the last 25 years, mainly because of the control on size exercised by packet ports at each end of the run. On the other hand, as far as cargo liners and tankers are concerned, about three or four knots has been added to mean voyage speed. There is little restriction on engine room space in the cargo class of tonnage, and double-acting engines have made it possible to spread the power upwards, a privilege denied to the cross-channel motorship.

It is interesting to trace some of the earlier developments which have made possible the placing of contracts for two new motorships for the Zeeland Steamship Company, and it is instructive, first, to see why the fast ship of cross-channel and similar types should in the past have been considered as an impossibility from the point of view of the internal combustion engine.

Early Developments.

Possibly prejudice had a good deal to do with it. Then, too, about ten years ago, the oil engine was only available in high powers on a fairly large number of cylinders, usually in the four-cycle type. Continuous supercharge was not in the advanced state that it is to-day, and weight was high and engines were not as compact as now.

Two equally strong reasons were the uncertainty of reliability, but, above all, doubts as to the vibration which would be caused by explosion type machinery in a light shallow draft hull. Ten years ago knowledge of engine seatings was on a par with the developments at that time of the internal combustion engine, and, furthermore, the question of weight was something to be taken into consideration. Personnel had also to be considered.

It will be recalled that when the "Prince Baudouin" was first considered, many motorships with large installations could only carry about 1½ h.p. per ton, whereas for a ship of cross-channel type to be propelled by oil engines it was necessary to carry 6 h.p. per ton, or, in other words, to quadruple the output requirements. Yet it was obvious that if a satisfactory power plant could be evolved for cross-channel ships, considerable advantages would accrue.

Such considerations are paramount in ships which have to run at the most for five hours at speeds of over 20 knots, and then tie up for varying periods. As far as the shorter periods are concerned, there is no particular advantage over steam installations, because the fuel burned in keeping the boilers ready is comparatively negligible, but for longer periods, not only is there a saving in fuel but also in staff, for the whole of the power plant can be shut down and only a small generator compressor set kept running to supply any light or power needed in the ship.

Irish Channel Ships.

In the development of the technique which has culminated in the ships mentioned above, we must go back to April, 1929, February and March, 1930, respectively, when Messrs. Harland & Wolff delivered the "Ulster Monarch", "Ulster Queen" and "Ulster Prince" to the Belfast Steamship Company, branch of Coast Lines, Ltd. These ships are 346ft. by 46·2ft. by 15·2ft., and maintain the fast overnight service between Liverpool and Belfast and vice versa.

They have a maximum speed of about 17 knots and are powered by two Harland B. & W. four-cycle, single-acting trunk piston supercharged engines, each having 10 cylinders 24·81in. diameter and 38·56in stroke, the total power output being about 7,500 b.h.p.—i.e., half of that of the "Prince Baudouin"—at 160 revolutions. They were the first of a group of ships, to which must now be added the "Innisfallen", of the City of Cork Steam Packet Company, the "Royal Ulsterman" and the "Royal Scotsman", of the Burns and Laird Line branch of Coast Lines, Ltd.; and two new ships for the Liverpool-Dublin service recently completed.

The latter, with the exception of the "Innisfallen", are fitted with two cycle trunk piston engines, and all are motor cross-channel vessels engaged in regular nightly services, spending the day in port, and returning again the next evening. Their speeds are not of the highest in this class of ship, nor so great as those of the steamers on the Parkeston/Hook of Holland and Parkeston/Antwerp service, but the fitting of oil engines in them some eight years ago was a step which has given great encouragement for other vessels to be so equipped.

High Speed Diesel-Engined Ships.

It was not until the advent of the "Prince Baudouin" in August, 1934, that really high speeds were obtained on oil-engined ships, and the motor packet vessel carrying only passengers, mail and occasionally motor cars, came into being. Before that date, however, Italy had produced a ship which was originally intended for a fast service between Trieste, Venice, Brindisi and Alexandria.

It may be that the experience gained by the United Adriatic shipyard in building this ship may have had an influence on the placing of the contract

THE PRINCIPAL MOTOR CROSS-CHANNEL SHIPS.

Ship.	Length, b.p.	Total Power*.	Screws.	Cyls./ Engine.	Bore×Stroke.	R.p.m.	Engine Type.	Speed†
"Prince Baudouin"	356·1ft.	15,000	2	12	22·83×33·07	258	Sulzer S.A. 2-cyc.	22½
"Koningen Emma"	350·2ft.	13,000	2	10	22·83×33·07	—	Sulzer S.A. 2-cyc.	22½
"Royal Sovereign"	273·0ft.	4,500	2	12	14·17×23·62	320	Sulzer S.A. 2-cyc.	19½
"Munster"	345·0ft.	6,800	2	10	19·69×35·43	160	Harland S.A. 2-cyc.	19
"Royal Ulsterman"	327·9ft.	5,500	2	8	19·69×35·43	160	Harland B. & W. 2-cyc.	19

* Normal rating. † Service.

with them for the "Vega", the new sister ship to the "Venus". The "Victoria", however, is notable from another point of view, because her total power output is much the same as that of the "Prince Baudouin" at maximum output, although the latter's normal rating is some 2,000 b.h.p. less.

There the matter rests as far as high-speed motor vessels are concerned; it remains to be seen what the new Zeeland ships will be capable of doing when they are completed. Protagonists of steam may argue with the above facts on two counts. In the first place, they may say that steam plants in cross-channel ships are capable of giving a speed of up to 25 knots in service if necessary. A partial answer to this would be that the speed figures mentioned for the motorship have all been quoted on the conservative side, and that to-day if a 25-knot ship were ordered, it would be possible to fit internal combustion engines into her. Secondly, it may be said that the ships mentioned have been compared with older steamers, and that really modern steam plant would be capable of operating on just as economical a basis.

This, of course, is to a great extent true, and the greater the flexibility of the boiler plant, the more nearly its competitiveness approaches the oil engine.

A modern steam plant to-day with advanced water-tube boilers, special feed systems and the most up-to-date auxiliaries, would require a staff of skilled, if not more skilled workers than those capable of operating present-day oil engines. It would certainly cost as much, if not more. Also as regards reliability, the oil engine could to-day claim immunity from all but the most unforeseen accidents, always provided, of course, that a good well-recognised design is chosen and that the arrangement of that design in the hull be a rational one.—*A. C. Hardy, B.Sc., "The Shipping World", 13th July, 1938, pp. 39-40.*

The Machinery of Tramp Ships.

In the last eight years, 1930-37, which include the whole period of the greatest depression the shipping industry has known, the search for efficiency and economy in the design of all types of ships and their machinery has been intensified to a degree never previously recorded, with remarkable results, especially in the case of tramps. British shipbuilders and marine engineers have vied with one another to produce tramp ships which are the last word as efficient and economical instruments of transport, and in so doing, have tried practically every form of propelling machinery.

Most owners have remained faithful to coal rather than oil, though the Diesel engine has been adopted in a good many ships. The main influence of the internal combustion engine in the tramp ship has been in intensifying efforts to improve the efficiency of the steam engine.

An analysis of the ships built during the years 1930-37 indicates the influence of the Diesel engine in a period of intense investigation of the merits of various forms of machinery. The following table shows the number of steam and motor tramps built by this country and the ten principal foreign countries during this period excluding 27 ships (108,066 tons) built by Japan for her coastal and inter-coastal trades, of which four (16,204 tons) were Diesel engined.

TABLE I.—STEAM AND MOTOR TRAMPS BUILT BETWEEN 1930 AND 1937.

	Steam.		Motor.		Total.	
Country.	No.	Tons gross.	No.	Tons gross.	No.	Tons gross
Denmark ...	—	—	8	32,779	8	32,779
France ...	13	51,973	7	34,119	20	86,092
Germany ...	9	42,564	6	30,568	15	73,132
Greece ...	10	46,456	—	—	10	46,456
Holland ...	6	30,734	1	4,652	7	35,386
Italy ...	1	7,933	—	—	1	7,933
Japan ...	20	98,569	19	102,619	39	201,188
Norway ...	3	15,671	44	210,677	47	226,348
Sweden ...	—	—	1	5,001	1	5,001
U.S.A. ...	—	—	—	—	—	—
Foreign ...	62	293,900	86	420,415	148	714,315
U.K. ...	166	788,971	36	178,418	202	967,389
Totals ...	228	1,082,871	122	598,833	350	1,681,704

It will be observed that of the total tonnage built in the eight years, 57·5 per cent. is owned by British tramp owners, including 72·8 per cent. of the steam tonnage and 29·7 per cent. of the motor tonnage.

Types of Machinery Adopted.

While in the later British ships the triple expansion engine has generally been adopted, in the case of the latest foreign tonnage, the Diesel engine obtained precedence, as the following table analysing the machinery of the ships of 1930-37, both British and foreign, shows:—

TABLE II.—MACHINERY OF THE LATEST TRAMPS.

Type of	United Kingdom			Foreign		
Machinery	No.	Tons gross	%	No.	Tons gross	%
Triple-expansion ...	120	564,350	58·5	33	150,628	21·1
Quadruple-expansion	17	82,814		3	15,651	
Triple and turbine ...	12	61,324		7	29,755	
Compound ...	3	12,828	23·0	2	11,026	20·0
Compound and turbine	11	51,580		4	21,435	
Turbine ...	3	16,075		13	65,405	
Steam ...	166	788,971	81·5	62	293,900	41·1
Diesel ...	36	178,418	18·5	86	420,415	58·9
Totals ...	202	967,389	100·0	148	714,315	100·0

It is curious to note that foreign owners have adopted turbine machinery in four times as many tramp ships as have British owners. In the last year or two, the Japanese have largely fitted turbines to their new tramps when they have not fitted Diesels.

It may, finally, be of interest to analyse the tramps of 1930-37 in certain size categories to ascertain whether steam or Diesel machinery predominates in any particular size. Table III shows that in British ships of 5,000 tons gross and over, steam machinery does do so to a noticeable extent, while in foreign ships of the same size, the reverse holds good. Five-sixths of the British motor tramp tonnage consists of ships of over 4,000 and under 5,000 tons gross, and these are mostly ships of the Doxford economy type. On the other hand, half the foreign steam tonnage consists of ships of this size. As regards tramps of over 3,000 and under 4,000 tons gross, it will be noticed that only 49 have been built by all the countries mentioned in the last eight years. They are a type which seems to be disappearing from the world's open freight markets.

TABLE III.—AN ANALYSIS IN SIZE CATEGORIES.

	5,000 tons and over.		4,000 to 5,000 tons.		3,000 to 4,000 tons.	
Country.	No.	Tons gross.	No.	Tons gross.	No.	Tons gross
U.K.						
Steam ...	60	323,507	84	382,975	22	82,489
Motor ...	6	31,252	29	143,952	1	3,214
Totals ...	66	354,759	113	526,927	23	85,703
FOREIGN.						
Steam ...	17	101,379	31	141,971	14	50,550
Motor ...	37	212,093	37	168,454	12	39,868
Totals ...	54	313,472	68	310,425	26	90,418

The average size of the British steam tramps is 4,752 tons gross and of the foreign 4,740 tons, while that of the British motor tramp is 4,956 tons and of the foreign 4,888 tons. Details and descriptions of British steam and motor tramps closely approximating to these average sizes have appeared in recent issues of *The Shipping World,* especially in the series "Notable Ships of the Year". Judging from the tramps built in the last eight years, the typical tramp ship of to-day is of 9,200 tons deadweight and 11 knots service speed, while in pre-War days she was of 7,500 tons deadweight and nine knots speed.—*"The Shipping World", 8th June, 1938, p. 746.*

Hundredth Crossing of the "Normandie".

On July 13th, 1938, the "Normandie" left New York on her hundredth trans-Atlantic crossing, anchoring at Cowes Roads at 8.15 a.m. and reaching Le Havre in the early afternoon. A small party of guests representing the technical press was invited for the channel crossing, many having also travelled in the reverse direction on 29th May, 1935. Commodore Thoreux expressed deep satisfaction as regards her seaworthiness, ease of navigation and the excellence of her turbo-electric propulsion. During 544 days at sea the ship had travelled 330,000 sea miles and only once was it necessary to reduce speed below the 28-knot schedule. The vessel was designed for 28·5 knots and had maintained 28·58 over a hundred voyages, confirming their faith in the large ship. Apart from turbine blade modification during the first few voyages, no alterations or repairs to the machinery had been necessary; this the party inspected under the guidance of the second-in-command and the chief engineer.—*"The Engineer", 22nd July, 1938, p. 83.*

Boiler Explosion through Failure of a Blank Flange.

On Dec. 14th, 1937, a new boiler and turbo-generator was being added to Cardiff paper mill plant including two 250lb. steam engines. To reduce leakage through the turbine stop valve a brass flange only ¼in. thick was inserted in the 10in. steam pipe. Failure would have had no serious results had not the steam pipe next to the stop valve been removed, and the blank end left open to the atmosphere. In these circumstances it bulged, and steam from the full 10in. diameter escaped into the engine room; as a result a fitter and two labourers lost their lives. Obviously the thin brass plate was quite unsuitable for a flange, it was less than one-quarter as thick as the steel flanges on the pipes, and the extraordinary thing is that it should have remained effective for as long as 10 hours.—*"Engineering", 29th July, 1938, p. 147.*

1,000 B.H.P. Test-Bed Drive for Air Compressors.

On account of the variety in power and size of air and gas compressors, testing is usually complex. In a new double-bed design, one machine is erected while the other is under test, with the added advantage of compactness. A 1,000 b.h.p. auto-synchronous motor is directly coupled to a 6in. shaft mounted at the motor end in a self-aligning double-row roller bearing and carrying a Vee-rope pulley with 22 groves; with special rubber-fabric belts no control of tension is required. Speed variation of the driving shaft is obtained by changing the large plain pulley, and the number of ropes used is also varied according to the power required for testing the particular compressor. In an 8-hr. run, inlet, outlet and interstage temperatures and pressures are taken at half-hour intervals; input is taken from mean ammeter and voltmeter readings, unity power factor being maintained, and checked by a maximum demand meter. An inlet governor test, and examination of the bearings after the run are also made. The motor input reading is taken at no-load at full speed, with compressor on and off; finally belts are removed and the no-load power input of the motor is obtained. From this the actual power consumed at full load can be calculated if the transmission efficiency is known. An overspeed test of 5 per cent. for half an hour, followed by careful examination of all moving parts, may also be applied.—*"Engineering", 29th July, 1938, p. 140.*

Two-Stage Two-Crank Compressor.

Apart from the air filter and cylinder lubricator, all parts are totally enclosed, and for applications like paint spraying, food manufacture, enamelling, substantially uncontaminated air is delivered at 60-150lb./in.^{2}. Automatic plate valves as well as the cylinders are water cooled; mild steel pistons are used and each crosshead takes a floating case-hardened steel pin, held in position by end plates and retaining bolt. The spherical top of the connecting rod contains a phosphor-bronze bush, and the tapered roller bearings for the crankshaft are exceptionally large. Special attention is paid to accessibility; valves, pistons and rods, and governor are available from the top by removal of the covers, and the movement through large doors at front and rear. In a 72-hr. test with B.S.I. measurement at a 1½in. diameter nozzle, the following figures were obtained:—

Air temperature at inlet	79° F.
„ „ „ outlet	189° F.
Water temperature at inlet	55° F.
„ „ at intercooler outlet	82° F.
Barometer	30·1 in.
Speed	750 r.p.m.
Air pressure, 1st and 2nd stages—	26 and 100lb./in.^{2}
Manometer reading pressure	29·2ins. water
„ „ vacuum	2·9 „ „
Efficiency of motor and belt drive	87·5%
B.h.p.	54·0

—*"The Engineer", 8th July, 1938, pp. 46-47.*

Investigations to Determine the Heat Characteristics of a Marine Water-tube Boiler Installed in a Tug.

Up to the time of carrying out these investigations the heat calculations of marine water-tube boilers built at a Leningrad boiler shop were made by theoretical formulæ. In the cases of two tugs fitted with water-tube boilers the actual consumption of fuel per i.h.p. greatly exceeded the calculated and guaranteed consumption. As it was not possible to explain the reason for the great differences, investigations were carried out on a similar boiler installed on a sister ship. The tests were conducted with the object of determining the maximum specific output of steam obtainable from such boilers when fired with anthracite coal, also of obtaining complete characteristics under different working conditions. In order to obtain the maximum reliable data it was decided to carry out the trials when the main engines were working; for this purpose the tug was moored stem on to the quay wall. As the main engines were the basic consumer of the steam, in order to obtain the maximum output of the boiler, the normal propeller was replaced by a smaller one which made it possible to increase the number of revolutions. Before carrying out the tests the coal was screened, leaving not more than 10 to 15 per cent small. For the purpose of preventing the fuel being carried into the funnel, baffle plates were fitted within the nest of tubes* (Fig. 1). The first full power test was carried out with the baffle plates in position; the flow of the gases is represented in Fig. 1 by thick dotted lines. After drawing the fires and weighing the remaining clinkers, cinders and ashes, another full power test was then conducted without the baffle plates, the approximate flow of the gases being shown in Fig. 2. A further full power trial was carried out without the baffle plates with a two-sides flow of the gases and with the gases flowing in one direction past the superheater. The switching-over of the gases to one side only was for the purpose of ascertaining the maximum possible steam production with the superheater cut out and to determine the velocity of the gases in the nest of tubes; this is essential for obtaining the actual formula of heat transmission, since the distribution of the gas flow by a two-sides flow may only be determined by calculation. The boiler was also tested on two separate occasions with 50 per cent. and 25 per cent. of the output, with a two-sided passage of the gases and by the gases flowing past the superheater. After each test samples were taken of the coal, clinkers, cinders and ashes which accumulated within the limits of the boiler; samples were also taken of the condensed steam from the main and auxiliary engines in order to ascertain the oil content. A sketch showing the scheme of the arrangement of the installation for testing the boiler is shown in Fig. 3. Readings were taken only after a prearranged condition of the boiler under a definite load was attained; this was regulated by the revolutions of the main engines. As it was found necessary to carry out the cleaning of the fires every three hours, the particulars of the steam output and consumption of fuel were taken every hour; the other observations were made every 15 minutes, with the exception of the steam pressure and the temperature of the flue gases, of which readings were taken every 5 minutes. The boiler pressure was kept as steady as possible during the course of the first three hours up to the cleaning of the fires, and during the second three hours after the cleaning. The time spent in cleaning the fires was deducted and not included in the calculations of the mean values. In the course of the first three hours the direction of the gases was usually on one side, during the following three hours two-sided; in the subsequent three hours after cleaning, and with the same pressure, all gases were directed to one side past the superheater. The following values were determined during each stage of the investigations: consumption of fuel; weight of clinkers, cinders and ashes; consumption of superheated and saturated steam; steam pressure; temperature of the superheated steam, feed water, furnaces, gases in front of the superheater, flue gases, air before entering

* This and the other illustrations referred to not reproduced.

the fan, air in the stokehold and of the external air; analysis of the flue gases from the right and left sides; and pressure of air under the firebars. Analysis and diagrams are given of the values derived from the results of the investigations made in the course of the following stages:—when boiler was working (1) with longitudinal flow of the gases (test with baffle plates in position), (2) with transverse two-sided flow of gases, and (3) with a one-sided flow of the gases past the superheater. On the basis of the figures obtained during the tests deductions were arrived at on the following items:—(1) steam output, (2) superheated steam, (3) steam pressure, (4) draught, and (5) economy. A table is also provided giving the particulars of the machinery and mean values of the tests, and comparing those of a tug fitted with two marine boilers of the Scotch type.

Conclusions.

At the present time it may be stated with a certain amount of conclusiveness that water-tube boilers of the triangular type burning coal with a two-sided passage of the gases are not economical for river vessels, as the specific heat load on the grate and the volume of the furnace assumed when designing the boiler is too great. Water-tube boilers should therefore have a sufficiently high coefficient of efficiency as to keep the specific consumption of fuel equal to that of marine boilers of the Scotch type. Water-tube boilers installed in river steamers must answer high demands in respect of economy. In their endeavour to limit the draught of the vessel, designers often neglect economy. It is therefore no surprise that three vessels of 300 i.h.p. fitted with a water-tube boiler have a heating surface of 130 m.^{2} and a grate area 3·7 m.^{2}, while similar vessels in service fitted with two Scotch boilers with the same heating surface have only a total grate area of 4·5 m.^{2}. In like manner several tugs of 400 i.h.p. are to be fitted with a single water-tube boiler with a heating surface of 160 m.^{2} and a grate area of 4·7 m.^{2} in place of two Scotch boilers with a total heating surface of 170 m.^{2} and a grate area of 7·2 m.^{2}. Works at Leningrad have gone still further by installing on similar 400 i.h.p. vessels one water-tube boiler of 130 m.^{2} heating surface and a grate area of 3·7 m.^{2}, *i.e.* decreased the grate area by half as compared with the existing vessels fitted with Scotch boilers. Naturally the specific fuel consumption on all vessels equipped with such water-tube boilers shows a considerable increase as compared with similar vessels fitted with return-tube boilers. One cannot underestimate the bad economy of water-tube boilers, since the increase in the consumption of fuel involves also a certain loss in the weight ratio of the installation. Taking all the above into consideration one must come to the conclusion that it is not only necessary to examine the construction of water-tube boilers of the triangular type with a two-sided passage of the gases but also the whole of the heating power of the installation, with a view to reducing the consumption of steam. The modernizing of water-tube boilers of the aforementioned type burning coal must progress in the direction of increasing the grate area and the useful volume of the furnace. A satisfactory solution of this question would be to liquidate the only defect in water-tube boilers of the triangular type installed on river vessels, viz. their non-economical work when coal fired. The following observations on the foregoing tests are made by the editor of "Soudostroienie":—"The tests of coal-fired water-tube boilers as installed on a previous tug gave unsatisfactory results due to the small relative value of the volume of the furnace and grate area. Evidently this did not induce the works to give more attention to the boilers manufactured by them, and similar negative results have been witnessed in the tests carried out on the boiler of a new tug. Such action might reflect on the adoption of water-tube boilers in general, but the adoption of such boilers without doubt appears to be the present trend in marine boiler construction. The large amount of loss in the furnace leads us to assume that this was due to mistakes in the construction of the grate and the method of carrying out the firing; unfortunately these points have not been mentioned". The editor also points out that water-tube boilers are more sensitive than Scotch boilers during the cleaning of the fires, especially when one water-tube boiler as fitted in the new tug is compared with the two Scotch boilers fitted in a sister ship; he also does not agree with the method of presenting the various characteristics of the boiler under test.—*"Soudostroienie", No. 12, 1937.*

***Measures for Increasing the Coefficient of Efficiency when Designing Marine Water-tube Boilers of the Triangular Type for Coal Firing.**

The tests previously carried out on water-tube boilers of three river tugs have definitely shown that water-tube boilers of the triangular type when burning anthracite, notwithstanding that considerable forcing was attained during the tests, were found to be very uneconomical even with normal loads on the heating surface. Naturally when designing new boilers one must keep this in view and endeavour to construct a boiler which would be free from this important defect. At the present time it may be definitely stated that the defect of a normally-designed boiler of the triangular type with a two-sided flow of the gases is insufficient volume of furnace and grate area. The above refers only to boilers which are designed for coal firing. The fundamental losses which considerably reduce the

* This article is related and refers to the article "Investigations to Determine the Heat Characteristics of a Marine Water-tube Boiler Installed in a Tug", an abstract of which immediately precedes this abstract.

coefficient of efficiency, are the loss of heat due to clinkers and the loss on account of bad combustion. The poor utilization of the heating surface due to extensive inactive zones and the low velocity of the gases in the tube nests, also are unfavourable to this construction of boiler.

If one refers to †Fig. 1 and compares curve 1 with curve 2, it will be noted that the coefficient of efficiency of the boiler proper (without superheater) with a single-sided flow of gases (past the superheater), is slightly lower when compared with the coefficient with a two-sided passage, notwithstanding the fact that the heating surface of the boiler, when the whole of the gases is directed to one side, will be reduced from 65 to 44 square metres; in this case the volume of the steam also slightly falls. This fact is not accidental and may be explained as follows :—(1) The heating surface of the fire rows independent of the distribution of the gas flow, remains constant, and (2) the velocity of the gases in the nest of tubes increases twofold and therefore increases the coefficient of heat distribution. Practically the whole of the heat load of the left nest of tubes, after changing over the gas flow, is taken by the nest of tubes on the right side. In water-tube boilers of the triangular type with a two-sided flow of the gases, the velocity of the gases usually ranges within the limits of 1 to 2 metres per second. Naturally with this velocity the thermal output of the heating surface is very low, and therefore the utilization of the metal (in the form of heating surface) is imperfect. When designing water-tube boilers for river steamers it is necessary to achieve a better utilization of the heating surface. This is easily accomplished by increasing the velocity of the gases within the region of the tube nests. This solution of the problem always results in a gain, either of the heating surface of the boiler or its coefficient of efficiency. Therefore no matter whether the designer is aiming at decreasing the size of the boiler or increasing its economy, a one-sided passage of the gases should always be considered as more advantageous. Fitting the superheater beyond the tube nests, even in boilers with comparatively small superheating of the steam, is not satisfactory because of the fact that with small boilers the coefficient of utilization of heating surface drops to quite a prohibitive value, in the region of 0·65, due to large inactive zones. As an example of what could be obtained when designing a boiler with a heating surface of 65m.², an outline sketch of such a boiler with a single-sided passage for the gases is shown in Fig. 2. In the design of this boiler all measures have been taken to achieve an increase in the coefficient of efficiency; for instance, by increasing the grate area, the volume of the furnace, the heating surface of the fire rows while the flow of the gases is directed to one side. Fitting the superheater within the nest of tubes permits the dimensions of the space occupied by the old boiler to be adhered to, notwithstanding the increase of the grate area. For the purpose of establishing the economical advantages of this design as compared with the boilers fitted on the tugs previously tested, a heat calculation has been made using the same coefficients for excess of air and other values which were obtained in the course of the tests of the aforementioned boilers. The coefficient of the boiler has appreciably increased. The curve of this coefficient for the designed boiler is shown on Fig. 3 designated by curve 3. It will be observed that the coefficient of efficiency of this boiler under normal output, i.e. 22 to 24 kg. of steam for 1m.² hour, reached 70 per cent., whereas at the tests of the existing boiler only 52 per cent. was obtained. With an increase of forcing, the coefficient of efficiency gradually decreases but does not drop below 52 per cent. at the maximum output. At these stages the boiler works with the same efficiency as the one tested with a longitudinal flow of the gases. The heat balance of this latter boiler depending on the forcing is shown on Fig. 4, from which it may be seen that the coefficient of efficiency of the boiler is influenced not so much by the loss of heat due to bad combustion and the clinkers, but by the loss of heat in the escaped gases. A further increase in the coefficient of efficiency of this boiler is only possible at the expense of utilizing the heat of the exhaust gases by means of an installation for preheating the air. Such a decided increase in the efficiency of the boiler in comparison with that obtained during the tests carried out on the boilers as installed is obtained at the expense of :—

(1) Increasing the grate area from 2·1 to 2·6 m.² by 24 per cent.
(2) Increasing the volume of furnace from 1·85 to 3·1 m.³ by 68 per cent.
(3) Increasing the surface of the fire rows from 6 per cent. to 7 per cent.
(4) Increasing the velocity of the gases by 40 per cent.

The proposed design of boiler with a single-sided flow of gases and occupying the same space as the existing boiler is not only more economical but has the following advantages :—

(1) A reduction in the amount of the material in the region of 0·5 ton is obtained;

(2) A reduction in the number of drums from four to three is permissible;

(3) The number of tubes may be reduced from 508 to 329.

As is evident, the boiler is much simpler in design and is more convenient in service since the time necessary for cleaning the tubes is nearly halved. In addition to an outline sketch of the proposed boiler, two graphs are furnished showing curves of the coefficient of efficiency under different conditions and one giving curves of heat balance with a single-side flow of gases; a table is provided indicating the fundamental characteristics of the pro-

† This and the other illustrations referred to are not reproduced.

posed boiler with a single-side and a double-side passage of the gases.—*"Soudostroienie", No. 1, 1938.*

The Problem of Motion on the Surface of Water by Means of Submerged Wings.

Water transport, one of the oldest mechanical means of transport, has now become one of the slowest methods as compared with other existing means of transportation. The fundamental advantage of water transport is its comparatively low cost, but this is only the case at relatively low speeds; with speeds which could be compared with those of other methods, water transport becomes hopeless. An instance is given of a motor boat of the glider type of 1,570 kgs. displacement and 1,375 h.p. attaining a speed of 80 knots per hour; practically its whole weight consisted of the engines; such a vessel can have no commercial value. Some authorities are of the opinion that the maximum speed for exploitation of small craft with existing methods of locomotion on water, does not exceed 50 to 55 knots. A *diagram is given illustrating this opinion, and indicating the ratio of the weight of the vessel to its resistance when in motion, and the relative speed measured by Froude's numeral :—

$$F = \frac{v}{\sqrt{g^3 \quad \sqrt{D}}}$$

where v=speed in metre/second, g=acceleration due to gravity and D=displacement in tons.

A curve of resistance is shown in the diagram of a 15 m. motor boat of 12·5 tons displacement; also of a motor car. As seen from the diagram, the characteristic of displacement, and glider boats at relative speeds exceeding $F<2$ is less than 10 and with $F=4$ the value reaches 6, whereas motor cars by $F=6{\cdot}5$ have a value of 19, and an aeroplane wing may have a value up to 20 or 22 at any speed (up to a point where cavitation sets in). In view of the above, designers besides searching for the most suitable form for vessels (from the resistance point of view) for the existing methods of motion on the surface of the water, are also endeavouring to establish a more economic system of locomotion. A solution of the problem of attaining high speeds with a small expenditure of power is the system of gliding over the surface of the water by means of submerged wings. With this system the hull should be fully or partially above the surface of the water, and the supporting force (acting in the case of displacement boats in accordance with the Archimedian law, and in the case of gliders by hydrodynamical pressures set up by motion) derived from the lifting force of the wings fitted under the hull and submerged in the water. The principle of utilizing the lifting power of wings is very attractive, as theoretically the resistance of a submerged wing, generating a definite lifting force, may be several times less than a plane (which gives the same power of support) gliding over the surface of the water (within definite limits of speed). The conception of using submarine wings on high-speed motor boats and hydroplanes originated some time ago. In Italy from 1905 to 1918 a number of experimental hydroplanes were fitted with submerged wings and were reported to have given satisfactory results. In America several motor boats have been built and tested and reported to have attained very high speeds. Particulars are given of trials of a number of high-speed motor boats fitted with submerged wings; also outline sectional sketches are shown in Figs. 2 to 6 of a number of systems for placing the wings with a short description of each patent. In the case of a glider in motion, use is made of the pressure arising from the outside of the bottom; in the case of a fully submerged wing use is made of the rarefaction created on the upper surface of the wing which usually gives a greater lifting force as is shown in Fig. 7. The fundamental deficiency of the designs produced up to the present is the difficulty of obtaining stability and balance of the forces when in motion, *i.e.*, longitudinal as well as transverse stability.

Description of proposed design.

It may be stated that up to the present this problem has not been satisfactorily solved. The principal difficulty is that of obtaining stability in a longitudinal direction which impedes the introducton of a new method of gliding on the surface of the water. The author of the present article in conjunction with a colleague commenced three years ago to study the problem of movement on submerged wings and to design a stable scheme of locomotion on canals and deep rivers, which would possess the maximum simplicity and reliability. After examining a number of types they worked out the system mentioned below, as presenting a possible solution to the problem. One of the difficulties in the development of fast communication in narrow canals and rivers especially in the vicinity of towns, is the large wave formation which develops when the vessel is in motion and which may damage the banks. This is the case of both gliders and displacement boats. Another very important factor is the resistance in shallow waters for displacement craft, which necessitates a compulsory reduction in the speed, which necessarily decreases the average speed. The proposed system does not have this objection and can be effectively utilized as a means of transportation on canals. The system lies somewhat between a glider and a displacement boat. Underneath the hull at a certain distance, which depends on the waterway on which the boat will run, one or two horizontal wings of the aeroplane type are fitted on special brackets. The angle of inclination of the wings is changed by giving the vessel the desired trim (the angle of inclination in relation to the vessel's hull is constant); this forms the fundamental difference of this system from any

* None of the illustrations or tables referred to, with the exception of Fig 9, is reproduced.

previous one. Altering the trim of the boat is automatically accomplished in the following manner:— At the fore part of the boat two floats are built into the hull and protrude below the bottom of the main hull; the distance they project may be regulated by screws and the floats are connected in the hull by means of buffer springs. When the boat commences to move the projecting floats create a moment which causes the boat to change trim; this is necessary for the wing to develop a lifting force sufficiently powerful to raise the hull out of the water. In certain cases auxiliary supporting surfaces could be fitted below the floats which would partly relieve the pressure on the floats. The position of the wing is such that the longitudinal position of the centre of gravity of the boat is in front of the wing; this causes the floats when in motion to be on the surface of the water without parting from it. At an increase of speed when the lifting force of the wing becomes greater than the weight falling on it, the supporting surface will commence to rise out of the water, but since the floats cannot separate from the water, the boat will rotate round the point of contact of the floats with the water, and the angle of inclination of the supporting surface will diminish and the lifting force will drop. At a reduction of the speed the supporting surface will submerge, a reverse process takes place and the angle of inclination increases. In this manner the boat automatically adjusts itself to an angle of inclination which maintains a balance of the forces. M. Gruenberg when carrying out experiments on a model hydroplane investigated two problems:—(1) The stability of the system in motion on a disturbed surface. The experiments showed that the system was quite stable and seaworthy. The model withstood the tests in a satisfactory manner. (2) The resistance to motion. The model was tested with three loads, *i.e.*, 9 kgs., 6 kgs. and 3 kgs. The resistance data is embodied in Table 1. As seen from the given figures, the resistance increases up to the time the model is lifted by the wing, then, when the lifting force of the wing raises the hull out of the water the resistance decreases and remains constant at a definite range of speed. A graph is shown in Fig. 8 comparing the characteristics of the model with that of three other gliders.

In order to demonstrate the possibility and usefulness of the proposed system a water-taxi has been designed for service on the Moscow-Volga Canal (see sketch, Fig. 9). The particulars of this boat are as follows:—Weight with 4 passengers = 0·66 ton, weight on the initial carrying surface = 0·6 ton, weight on floats = 0·06 ton, area of wing = 0·312 sq. metre, area of wing brackets = 0·75 sq. metre, working area of floats when gliding = 0·8 sq. metre, horse power of motor = 17. The speed of this water-taxi is estimated at 40 km.p.h.; the boat would commence to rise out of the water at about 22 km.p.h. The fundamental advantages of this system are:—(1) Less resistance with smaller boats at a high speed and consequently a greater speed obtainable with the same power; (2) an absence of wave formation and therefore no risk of damaging the canal or river banks; (3) no variation in the resistance in shallow water. The disadvantages of this system may be stated to be:—(1) The necessity of having to utilize floats for additional stability; (2) a large initial draft (before the boat has commenced to rise out of the water, 2·0 to 2·5 m. for boats of medium dimensions); (3) a large draft when under way (the depth required for submerging the wings for waveless motion is about 1 to 2 m). The last two disadvantages are not very important when navigating canals and deep rivers. The author expresses

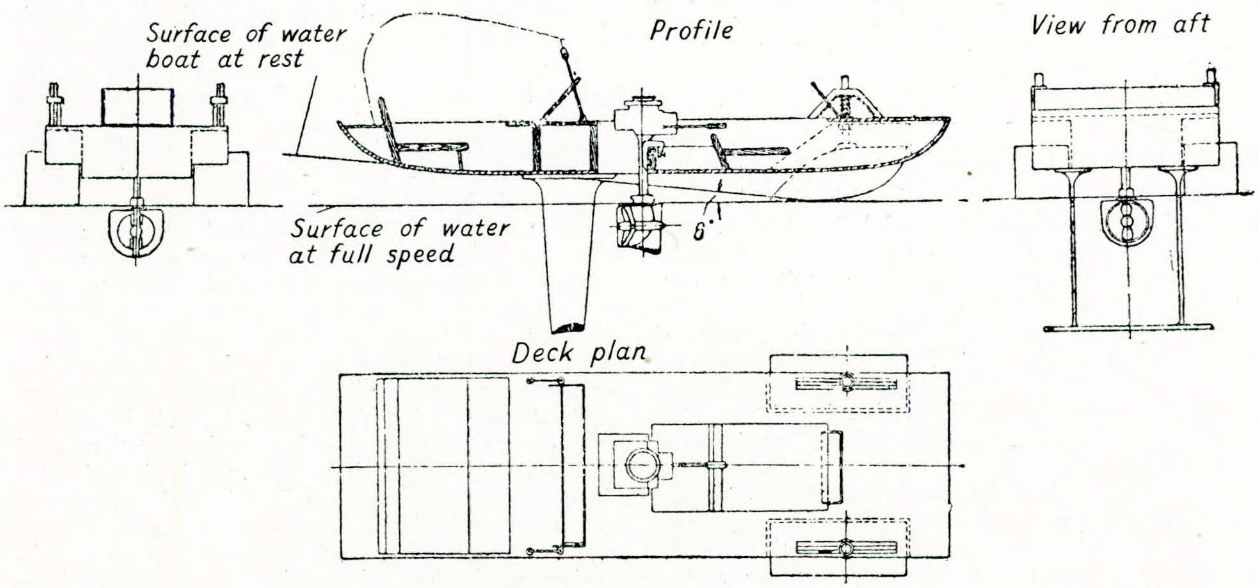


Fig. 9.

the opinion that the system under survey should receive proper consideration, since it opens up great possibilities in the development of high speed water transport.—*"Soudostroienie", No. 2, 1938.*

The Reconditioned "Carnarvon Castle".

To meet the new 13½ days Southampton-Capetown schedule, three new motor liners have been put into service, while the turbine-driven "Windsor Castle" and "Southampton Castle" have been radically reconditioned. The return to service of the "Carnarvon Castle" on July 28th represents a further step in standardization. Her particulars are :—

Length overall	686ft. 3in.
Length between perpendiculars,	645ft. 6in.
Breadth moulded	73ft.
Depth moulded	45ft. 6in.
Insulated cargo space	207,000 cu. ft.
Gross tonnage	20,122

By lengthening the ship 15ft., replacing the straight cutwater by a curved stem and fitting one large streamline-section funnel with normal top instead of the former two elliptical funnels, great improvement in the lines has been effected. New two-stroke airless-injection B. & W. engines replace the original twin sets of double-acting four-stroke engines with incorporated compressors, developing twice as much power (about 40,000 h.p.) in the same engine-room space. Shafting and tunnel accessories, together with most of the auxiliary equipment (pumps for oil, brine, water and fuel) have been renewed, while improved amenities and a new semi-balanced rudder involve a heavier electrical load. Passenger accommodation is 226 first and 245 second (48 interchangeable), 188 tourist; every cabin has running hot and cold water. Waste heat boilers supply hotel steam; oil firing is used for port steam and for cooking.—*"Engineering", 15th July, 1938, pp. 88-89.*

The Yield Point in Tensile Testing.

The author is concerned with the claim of Welter [see *Metallwirtschaft, Vol. 16, 1937, p. 345*] that in mild steel the yield point is a purely artificial phenomenon, essentially dependent on the construction of the testing machine, and especially on the measuring apparatus. He reviews the work of Siebel and Schwaigerer [*Arch. Eisenhüttenwesen, Vol. II, 1937/38, p. 319*] and of Pomp and Krisch [*Mitt. Kaiser Wilhelm Inst. Eisenforschung, Vol. 19, 1937, p. 187*] and the explanations put forward by Esser and Uebel to explain Welter's anomalous results. He reaches the conclusion that soft steel can tolerate stresses far above its yield point, provided these are uniformly applied, without noteworthy deformation. It shows an upper and a lower yield point but these can be observed only if the machine is rigid enough. Soft-sprung and dead-load machines suppress the lower point and give an erroneous impression of the plastic deformation occurring; they are thus unsuitable for stress determinations near the yield point. Ordinary tensile machines are sufficiently rigid and there is not the slightest excuse for fundamental alterations in their springing. Unvitiated measurements of yield phenomena can be made only with an equalised load gently applied and the existence of incidental forces may mask entirely the upper yield point on the force/dilatation curve.—*A. Krisch, "V.D.I. Zeitschrift des Vereines deutscher Ingenieure", Vol. 82, 11th July, 1938, pp. 728-730.*

Measurement of Mechanical Power.

Electrical energy can normally be indicated and integrated to a small fraction of 1 per cent. without disturbance, by connecting up a Wattmeter, energy meter and oscillograph. In contrast, tuning up of a prime mover depends on the almost unaided judgment of a single mechanic, but the importance of accurate power measurement during operation is now realized, especially for high-altitude flights and marine work. The author records the gradual overcoming of mechanical difficulties, and describes a semi-electrical method devised about 1910 for motors or generators up to 12 h.p. torque being measured by weights and speed by a variable stroboscope. Mechanical measurement involves driving force (or torque) and linear (or angular) velocity, and their product; of these torque is very difficult to measure. The transmission dynamometers hitherto used are either torque meters or integrating energy meters and the great need is a mechanical Wattmeter. This is difficult mechanically but easy electrically—the e.m.f. of a permanent magnet generator is directly proportional to speed, and by feeding this into an electrical torsionmeter an e.m.f. proportional to torque and speed at any instant is obtained, a damped Wattmeter indicating the mean power. Such an apparatus has been constructed by the Air Ministry [see *D. P. Alexander E. & I. 996, Sept., 1936*]. A cruciform shaft with two 20-pole inductors designed to give sine curves is used; the alternators are excited by magnetising coils. A micrometer screw rotates a stator until balance on the indicator is obtained, and the angle of torsion read off; in 4° an accuracy of 1/200° is obtained. By using one inductor on a long sleeve over the propeller shaft as in the Hopkinson-Thring torsionmeter, the device is applicable to marine work; torsion of a fully loaded shaft is said to produce 0·003in. per foot length independently of diameter. No slip rings are required and with powerful cast Al-steel or Co-Al steel magnets, a compact form for motor vehicles or small machines might be produced.—*C. V. Drysdale, Lecture to the Junior Institution of Engineers; reproduced in "Engineering", 15th July, 1938, pp. 69-71.*

Lubrication.

The effect of speed, load and lubricant on performance is investigated in a series of 2in. bore bronze bushes, 3·5in. long, having diametral clearances of 0·001in. to 0·016in., run with slack belt to avoid damage when seizing takes place. Frictional torque can be observed continuously at speeds of 10-1,300 r.p.m. and loads of 180-2,500lb/in.^{2} of projected area. External coal gas heating of the bearing is used with special means for close temperature control. At all clearances, seizing temperature is found to rise with increasing speed or decreasing load, and is usually higher for lubricants of higher viscosity. In some cases the seizing temperature rose after successive seizures, this being attributed to "running-in". Seizing temperature depends on "oiliness" and not entirely on viscosity; with perfectly finished and run-in bearings, the minimum coefficient of friction (between complete fluid film lubrication and seizure) would probably be independent of oil, clearance and load. Actually for small clearances, friction is a linear function of $\eta n/p$, but for a clearance exceeding 0·004in. for the 2in. journal, varies with a power of $(\eta n/p)$ between 0·65 and 0·85. Further, the improvement in performance that occurs on prolonged running of a lubricated bearing under oxidising conditions is investigated. At 1,300 r.p.m. with 0·008in. diametral clearance and load of 1,000lb. in a 30-hr. test on a new bush, with oil oxidised by bubbling air at 160° C. through it, successive seizing temperatures rose from 200° to 300° C., with decrease in minimum coefficient of friction from 0·0008 to 0·0005. For a variety of commercial oils it was concluded that the *improvement was due to running-in and not to oxidation.—Report on N.P.L. Research, "Engineering", 15th July, 1938, pp. 64-65.*

National Council of Engineers.

Civilisation, the author maintains, does not imply any increase in the average, as distinct from the total volume of intelligence. It is essentially material, consisting of inventions and scientific discoveries and their numerous applications, and in all these the engineer plays a large part. His influence in the management of the world is, however, not commensurate with his importance to civilisation, due to the absence of any corporate body which can speak for engineers as a whole. In America there is the Engineering Council; France and Germany also have organisations of a similar character, and even in this country other professions are better organised than engineers. Those engineering bodies which do exist here are either exclusively commercial or exclusively technical and scientific, and the latter are usually highly sectional and specialised in character. The author concludes that the formation of a representative council to carry on propaganda and advise the Government, not merely in the interests of the engineers themselves, but for the general good, is long overdue.—*"The Engineer", 22nd July, 1938, p. 95.*

Seaplanes and the Atlantic Crossing.

It is pointed out that the prevailing wind makes the westward crossing much more difficult than the eastward, and that with the 40 m.p.h. head wind which must be reckoned with, the westward passage is only just possible with present-day machines, the crucial problem being that of take-off with the large amount of fuel necessary. The successful flight of the "Mercury" indicates a possible solution of the question of assisting the take-off. In favour of this solution are the points of mobility and that the assistance does not cease until a safe height has been reached. The method is, however, complex and costly. A catapult would be less mobile, but still fairly expensive. Take-off under self-propelled conditions from a carriage on a fixed rail track reduces the mobility to zero, but this may not be important. The proposal appears to merit consideration on the grounds of cheapness, provided a sufficient reduction in resistance during the take-off is attainable.—*"The Engineer", 29th July, 1938, p. 123.*

Generating Set with Stand-by Engine.

The equipment is designed to couple up a duplicate engine to a generator, ensuring that in the event of failure of the first engine, the supply shall be resumed at the earliest possible moment. The alternator is mounted on a turntable pivoted exactly at the intersection of the middle lines of an L-shaped bedplate, on each of the limbs of which an engine is mounted. It can be swung round through an exact right angle and at once locked. The engine couplings are of quick-release design giving the advantage of dog drive without backlash. The 4-cylinder 10-20 h.p. petrol motors have both magneto and coil ignition and electric starting and are also provided with a centrifugal water pump. Special attention is given to ease of dismantling and compactness since the unit has been designed for continuous service in the tropics.—*"Engineering", 29th July, 1938, p. 129.*

Non-Metallic Bearings.

Water-lubricated rubber bearings are well established in cases where grease is undesirable, *e.g.*, water pumps and propeller shafts, and give good service and low frictional loss. Rubber bearings 0·25in. thick, backed by steel shells, were compared with a bronze bush, all being 2·25in. long with a 2in. bore. In all cases a plain rubber bearing gave a smaller frictional loss than the more usual fluted bearing, but both were satisfactory up to 200lb./in.^{2} and gave optimum performance above 500 r.p.m. Above this, up to 1,800 r.p.m. the friction in the fluted bearing was almost independent of speed and load; that of the plain cylinder increased slightly with speed. The water-lubricated bronze bush showed friction about equal to that of the plain rubber bearing, but below 500 r.p.m. seized at loads above 50lb./in.^{2}; even at lower loads rapid wear accompanied by excessive friction occurred. Under these conditions the rubber bearings showed decided superiority.—*Report on N.P.L. Research, "Engineering", 22nd July, 1938.*

The World's Shipbuilding and Marine Engineering.

Lloyd's Register statistics for ships under construction on June 30th, 1938, are reviewed. The 1,037,073 tons was 162,900 less than a year ago but considerably in excess of the aggregate construction in the three leading overseas competitors. It is made up of 107 steamships—481,420 tons, 99 motorships—551,983 tons, 16 sailing ships and barges—3,670 tons. At 156,970, new construction shows a decline of about 10 per cent. on the previous quarter but there was an increase of 106,741 tons in launchings. Excluding Russia and Spain, construction overseas was 1,789,829 tons on June 30th, a drop of about 9 per cent. on the quarter, while 558,570 tons were commenced and 561,447 launched, both showing increases of about 120,000 tons. Of foreign countries, Germany has first place with 396,953 tons, Japan second with 290,332, Holland third with 280,816, and U.S.A. fourth with 166,870. Vessels under construction included 4 steamers and 48 motorships between 10,000 and 20,000 tons, 2 steamers and 3 motorships between 20,000 and 30,000 tons, and 3 steamers exceeding 30,000. Of the 2,981,526 total h.p., 372,855 i.h.p. represents reciprocating steam engines, 667,280 s.h.p. steam turbines and 1,914,361 i.h.p. oil engines. The order of importance was U.K. 901,700, Germany 466,277, Japan 327,405, Denmark 234,930, Netherlands 219,309; all others below 200,000 h.p. —*"Engineering", 15th July, 1938, p. 77.*

Larger Battleships.

The writer is inclined to doubt the report that Japan was exceeding the 35,000-ton limit of the 1936 London Naval Treaty, to which she was not a party, having regard to her financial situation even before the China campaign, but considers that the U.S.A. and British staffs were wise to take no chances. The new 45,000 maximum is above that desired by Britain and the two new British 40,000-ton vessels authorized represent a compromise. Despite the extra weight of 16in. armament against the 14in. of the "King George V" class (5 ships) the extra 5,000 tons displacement should provide adequate armour and engine power. This country had consistently advised smaller capital ships—22,000 tons with 12in. guns, later 25,000 tons with 13·5in. guns; other European powers were agreeable, and had America accepted them, battleship tonnages might have been standardized at half the present maximum. U.S.A. tacticians, however, have always demanded liberal armament and protection, combined with a wide radius of action on account of the scarcity of oversea bases, and similar 45,000-ton ships were under construction in 1921. Apparently four of the six American vessels now projected are to be of 35,000, so that Japan's larger ships are apparently still regarded as not altogether certain. Above all, the writer deprecates the re-introduction of secrecy, which has done so much harm in the past. He points out that Germany has methodically approached the 35:100 ratio of the 1935 treaty, but with great care to avoid any semblance of competitive building, and that it is improbable that the British decision will affect two 35,000-ton ships building and one projected. Two Italian ships of the same size, "Littorio" and "Vittoria Veneto", are too near completion to be radically altered, but two others to be started this year might be. No information has been received from the Russian Government, but mastadon building is *not* anticipated. *In fine,* he concludes that in Europe warship inflation is likely to be moderate, even though U.S.A. should take up Japan's challenge by building 45,000-ton warships. — *"The Engineer", 8th July, 1938, p. 43.*

Damping of Torsional Vibrations by Liquid Couplings.

With the object of reducing vibrations resulting from impacts and sudden large variations in power, frictional or liquid or elastic couplings are sometimes introduced between prime movers and driven machines, *e.g.,* rolling mills. In this way variations in speed are minimized. The paper discusses from a mathematical standpoint, the effect of the liquid couplings frequently introduced between load and motors, or in association with gearing. A suitable damper can be designed for every condition of coupling and speed; only when the excited frequency in the coupling is equal to that introduced by the impact, can the coupling act as though solid. In such a case vibration will continue; otherwise and in general, it fades out. Even a small difference between the introduced and the natural frequency is sufficient, and care must be taken in designing the shaft, that the size is suitable. In practical applications the results are much more favourable than might be expected theoretically, on account of the many other damping influences present in the machine, such as bearing friction, which cannot be taken into account. An important conclusion is that liquid couplings cannot themselves excite vibrations.—*F. Söchting, "V.D.I. Zeitschrift des Vereines deutscher Ingenieure", Vol. 82, 4th June, 1938, pp. 701-703.*