INSTITUTE OF MARINE ENGINEERS,
INCORPORATED.

Patron: HIS MAJESTY THE KING.

SESSION 1930.

President: LIEUT. COM'R. SIR AUGUST B. T. CAYZER, Bart., R.N. (ret.)

VOLUME XLII.

World Power Conference, Berlin.

At the Council meeting last January, Mr. J. L. Chaloner was asked to represent the Institute at the forthcoming World Power Conference, Berlin; in due course he submitted the following extremely concise and interesting report.

July 1*st*, 1930.

To the Chairman and Members of Council,

The Institute of Marine Engineers.

In accordance with your instructions I attended the World Power Conference, Berlin, June 16th to June 25th, 1930 and now have pleasure in submitting for your perusal and guidance my report.

I. HISTORICAL.

The whole conception of international exchange of scientific knowledge and technical experience, is due to Mr. D. N. Dunlop, who, on the occasion of the British Empire Exhibition, Wembley, organised the first World Power Conference. The international Executive Council, acting under the memorandum approved July 11th, 1924, gave consideration to the advisability of constituting the World Power Conference a permanent international organisation. It was resolved that the following Objects should be adopted as the permanent Objects of the World Power Conference:—

The purpose of the World Power Conference is to consider how the sources of heat and power may be adjusted nationally and internationally—

By considering the potential resources of each country, in hydro-electric power, coal, oil and other fuels and minerals.

By comparing experiences in the development of scientific agriculture, irrigation and transportation by land, air and water.

By conferences of civil, electrical, gas, marine, mechanical and mining Engineers, Technical Experts and Fuel Experts and authorities on Scientific and Industrial Research.

By consultations of the consumers of Fuel and Power and the Manufacturers of the Instruments of Production of Power.

By conferences on Technical Education to review the educational methods in different countries, and to consider means by which the existing facilities may be improved.

By discussions on the financial and economic aspects of industry, nationally and internationally.

By conferences on the possibility of establishing a permanent World Bureau for the collection of data, the preparation of Inventories of the World's Resources, and the exchange of industrial and scientific information through appointed representatives in the various countries.

II. GENERAL ORGANISATION.

1. The World Power Conference is constituted of the existing International Committees together with any further National Committees to be formed from time to time. Where no National Committee exists the Government,or some Institution representing the interests within the scope of the Objects of the World Power Conference, appoint a representative.

2. Each National Committee is constituted in a manner desired by each country. It is recommended that as far as possible each National Committee should include representa-

tives of governments, scientific, technical, and industrial organisations, and individual interests concerned with power, its production, distribution and utilisation.

The Institute of Marine Engineers is not represented on the British National Committee, which includes representatives of:—

The Association of Consulting Engineers.
The Institution of Gas Engineers.
The Institution of Civil Engineers.
The Institution of Petroleum Technologists.
The Institution of Chemical Engineers.
The Institution of Mechanical Engineers.
The Institution of Electrical Engineers.

The total number of members on the British National Committee is 42.

3. The management of the World Power Conference affairs is vested by the National Committee and Representatives in an International Executive Council.

III. ORGANISATION OF MEETINGS.

The First World Power Conference was held at the British Empire Exhibition, Wembley, 1924, and was opened by H.R.H. The Prince of Wales, K.G., in the presence of 2,000 Delegates representing over forty countries. The International Executive Council were of the opinion that a period of six years should elapse between Plenary Conferences. In order to stimulate interest provision was made for sectional meetings to be held between Plenary Conferences in different geographical areas to discuss programmes of specific subjects coming within the scope of the World Power Conference. Up to the present the following sectional meetings have been held:—

1. September 1926.— Utilisation of Water Power and Inland Navigation, Basle.	Organised by Swiss National Committee.
2. September, 1928—Fuel Problems, London.	Organised by the British National Committee.

3. May, 1929—Utilisation of Water Power Resources, Barcelona.	Organised by the Spanish National Committee.
4. October, 1929—Development of Power Resources, Tokio.	Organised by the Japanese National Committee.

IV. SECOND PLENARY WORLD POWER CONFERENCE, BERLIN, JUNE, 1930.

(*a*) *General.*

The objects of the World Power Conference and the subjects which require ventilating are governed by the problems instigated by modern technique, industry and commerce.

I cannot do better than quote an extract from an address on this aspect of the function of the World Power Conference as prepared by the Berlin Organising Office:—

> *Engineering.* Available power is to be found stored up by nature in concentrated form in coal, in oil, and in natural gas, while continually the sun is providing new sources of water power. Mankind utilises these sources of chemical and physical energy in order to generate heat from prepared fuel, and power to drive machinery. The output from these sources of developed power is now used in one form or another in every industry, in locomotion, and in the home.
>
> Power, in fact, is now distributed in an ever-widening radius, traversing frontiers and even passing from one Continent to another. Power developed in one place is utilised in another to generate power in a new form. Power produces clothing, food, light and heat. Power transports us, our goods and our thoughts. Power lengthens and enriches our lives:
>
> > The minimum waste of power, the most reliable methods for its utilisation, and the broadest field of application; these are the aims of the power engineer.
>
> *Economics.* The more widespread the generation, distribution and utilisation of power, the greater is the demand for highly skilled workers, and the greater the

demand for and the reward gained by capital. Every year the demand for power increases. Rationalisation and mechanisation speedily promote the demand for machinery, tools and furnaces, for all of which power is a necessity. The world market for power is offering ever wider opportunities, and, in addition, is providing a fruitful field of investment for capital. Dividends and wages derived from the supply of power are dependent upon the development of the market for power. These markets produce new capital and provide fresh opportunities for the employment of labour:

> The opening of new markets for power, the improvement of such markets so as to provide a profitable field for investment; these are the aims of the power economist.

Administration. High voltage lines for electric power; high-pressure mains for gas and oil, and express railless transport by motor-cars and aeroplanes, offer limitless fields for the utilisation of power.

The industrial users of power become freer in the choice of their factory sites. The decentralisation of the population into rural areas, with all its attendant benefits for body and mind, is facilitated. Power is at the service of all. It knows no barriers. State problems and problems of power economy are linked up:

> Wise legisation, the protection of health, and the more extended use of power: these are the aims of the power administration.

Education. Power resources harnessed to human needs are used night and day by every individual. He does not always understand them. He has to learn to control them and to use them to the best advantage in every human activity. He must learn to value power economy and power engineering as the very basis of his civilisation. New aims to be achieved must not only be demonstrated, but understood. Engineering science is the science of civilisation. The pure science of to-day, is the engineering science of to-morrow:

> To make mankind of to-day the wise ruler of his soulless servant; to fuse technical and human education into one harmonious whole: these are the aims of the new education.

(*b*) *Attendance.*

The World Power Conference was attended by 3,891 members and visitors, and for reasons of general interest the membership statistics are appended:—

1. EUROPE.

	Members.	Visitors.
Belgium	27	2
Bulgaria	7	—
Denmark	20	9
Danzig	2	—
Britain	217	49
Esthonia	13	4
Finland	11	1
France	103	8
Greece	1	—
Holland	32	1
Ireland	3	1
Italy	65	17
Jugo Slavia	19	2
Latvia	11	3
Lithuania	3	—
Luxemburg	12	5
Norway	48	8
Austria	111	14
Poland	61	4
Portugal	8	1
Rumania	20	11
Russia	59	2
Sweden	66	15
Switzerland	90	16
Spain	18	3
Czecho-Slovakia	119	17
Hungary	31	9
Germany	2,258	241

2. AMERICA.

Argentina	11	1
Bolivia	1	—
Brazil	4	—
Chile	6	—
Colombia	1	—
Cuba	1	—
Gautemala	1	—

	Members.	Visitors.
Canada	19	10
Mexico	—	—
Peru	5	—
Uruguay	1	—
United States	162	42
Paraguay	1	—
Ecuador	3	1
3. ASIA.		
Ceylon	—	—
China	15	—
India	9	3
Japan	188	3
Dutch East Indies	3	—
Persia	1	—
Siam	3	—
Turkey	3	—
4. AFRICA.		
British Guiana	—	—
Gold Coast	1	—
Morocco	1	—
Southern Rhodesia	—	—
Tanganyika	—	—
Nyasaland	—	—
United States of South Africa	5	1
Egypt.	1	1
5. AUSTRALASIA.		
Australia	7	2
New Zealand	3	1

(*c*) *Organisation of Lectures.*

The development of power supply and utilisation formed the main subject around which this Conference centred. There was, therefore, a definite indication that progress may be looked for in such directions as the following:—

New Fields for the Application of Power.

Efficient utilisation of Generating Plants and Distribution Networks, improvements of Load Factor.

Storage of Power.

Advantageous interconnection of different Power Producing Plants.

Large Central Plants and Large Power Distribution Systems.

Reduction in Costs of Construction.

Effective Propaganda and Rational Tariff Systems.

Co-operation between Power Producers, Power Consumers, Public Authorities, and the Legislature.

Safety Measures.

Information and Education.

The official languages were French, German and English. Facilities were provided by means of microphones and headphones whereby any lecture delivered in another language could at the same time be heard in one's own language.

You may be interested to have a few details of this system, introduced for the very first time. The lecturer would deliver his speech in the ordinary way, using the conventional form of microphone. This microphone was not only attached to the loud speakers and the headphones within the hall, but also to six sets of headphones used by six interpreters (two for each official language) seated immediately in front of the lecturing platform, but screened off from the public hall by suitable canvas awnings. Whilst the lecturer was speaking, say in English, one German and one French interpreter would read the translation into a muffled mouthpiece type of microphone in front of him connected with an adequate number of headphones attached in a very neat manner in front of each chair in the lecture hall (Note: in lecture hall No. 1 there were 150 headphones connected in this manner). Alongside each set of headphones there was a switch, and one merely moves a button to the language in which one desires to hear the lecture delivered.

A most elaborate system of light signals is part of the equipment. The names of the lecturers are arranged on an illuminated screen with an arrow against the one actually speaking. Replicas of this screen on a somewhat smaller scale are situated in various parts of the building so that at any time one may acquaint oneself very rapidly with the name of any speaker lecturing in any one of the three conference halls.

In front of each lecture table are lighted screens showing the languages in which the lecture may be heard through the headphones. Each speaker joining the discussion was allowed five minutes, because according to statistics the cost of the Conference whilst in session was £50 per minute. In front of the speaker's desk were a series of lights as follows:—

A flickering blue and red light indicated that the speaker was going too fast for the interpreters.

A blue light showed the lecturer as having spoken for three minutes ;

A green light showed four minutes expired: and a red light that it was time for him to shut up, unless he desired to be struck down by the mallet always ready in the hand of the chairman.

One is reluctant to criticise any minor defects for the principal reason that this is the very first experience with such a system on a large practical scale. In commenting, therefore, on certain details, it is not the intention to be destructive, but constructive, and merely record the experience for future guidance:—

1. It will be observed that each interpreter must have in front of him a translation of any speech delivered so that the translator can keep pace with the lecturer. It occurs to one that such a restriction limits the scope of the discussion very much.

2. It will further be observed that there are actually three people talking at the same time, which is confusing in principle and ineffective in delivery. The monotonous tone of a translator without soul or enthusiasm for his subject, creates an atmosphere entirely unsuitable to effect the desired interest or attention for some new theory, principle or policy a particular speaker desires to propound.

From the foregoing you may conclude that the discussion did not entirely fulfil its object, that is, the free and full exchange of views from an international point of view. The World Power Conference, as such, is attaining a size and magnitude with which its very object of free exchange of experience and views from an international point of view and the freedom of speech has to be seriously curtailed.

(*d*) *List of Technical Papers and their Discussions.*

General. The subject matter was divided into thirty-four sections; a brief reference might prove of interest:

Section 1. Electricity in the Household and in Agriculture.

Fourteen papers dealt with the domestic field of application of electric energy and also electricity as applied to agriculture. There already exist numerous types of useful appliances for mechanising household work, such as hitherto required manual labour. It must, however, not be overlooked that much still remains to be accomplished with respect to standardisation and reduced cost of existing types of appliances on the one hand, and the development of new appliances more adequately meeting actual requirements on the other. In order to further this development, tariffs are necessary that ensure the use of current being economical, and care is required in rate fixing in view of the necessary investment of fresh capital.

Electric lighting is of particular value in agriculture for poultry raising and the stimulation of plant growth. Intelligent and conscientious publicity is of paramount importance to the solution of all these problems.

The trend of development raises the question as to the possibility of the general introduction of electric heating for accelerating natural growth in agriculture.

Section 2. Electricity in Crafts and Industry.

Fifteen papers dealt with the various problems connected with electro-chemistry, electric heating, electric welding, electric lighting, electric filtration and motors in general.

Take for instance electric welding; Discussion centred around the best method of ensuring a sound weld; limiting the risk of defective welds; avoiding molecular alteration in the material immediately adjoining the welded connection; the system of current; material of electrodes; protective gas; automatic equipment and training of staff.

Another aspect dealt with related to the electric method of filtration and its economic advantages, including the greater freedom in the choice of sites for power works and industrial installations.

Section 3. Three-Dimensional Load Models and Current Tariffs.

Seven papers dealt with what was entirely a power production problem. It is well known that the load factor and form of tariffs are of primary importance to the economical operation of public electricity supply undertakings. Endeavours were made to answer such important questions as methods suitable for power factor improvements; the decomposition of the load diagram for purposes of tariff fixing. Many of the factors can be militating against the improvement of tariffs and the possibility of standardisation of tariff questions.

Section 4. *Economic Problems of High Temperature Distillation.*

Ten papers dealt with gas manufacture by high temperature distillation, one aspect being the economies of benzol extraction in the gas industry. It is hoped that this discussion will be an encouragement for desired progress in Great Britain, as increased supply of liquid fuel must be advantageous to the user.

Coal is no longer chosen haphazard, but according to definite principles, which ensure a high gas yield and a good coke. It is the duty of the careful gas expert, to ensure the highest possible homogeneity of the product used for gasification, by preparing the coal used in suitable machines (blending, grinding), because the use of a constant mixture is the most essential factor to realise a higher efficiency.

Section 5. *Gas Markets.*

Fifteen papers dealt with the use of gaseous fuels, and the present strength of this industry is very significant in view of the severe competition which has had to be met from electricity. No pessimism prevails within the gas industry, which, having lost an important portion of the lighting load, has gained much from the industrial load due to the many advantages accruing from the use of gas for industrial heating purposes.

Section 6. *Costs and Comparative Efficiency of Different Forms of Energy from the Consumer's Point of View.*

Seven papers dealt with an important aspect from the consumer's point of view. One not unnaturally might ask the question as to whether the consumer should take energy in the crude form (coal or oil) or in the prepared form (gas, electricity, steam). Again in the case of private power generating plant, the question arises as to the type of power generating plant to be adopted. It has been said, and very rightly so, that to answer the question, "What is the most economical form of energy" would occupy the entire attention of a future World Power Conference.

Section 7. *Construction and Operation of Large Power Plants.*

There were nine papers dealing with this subject. It is well known that the larger electric power plants and distribution systems can only be developed satisfactorily if laid out with a view to future requirements. American practice now recommends drawing up an exact master plan setting forth the lines of development, consideration being given to reliability, simplified operation, maximum economy, net-work stability and possibility of extension.

The problem of smoke abatement is increasingly urgent, and requires special attention both in existing and projected plants. Government regulations, which are becoming more and more rigid in this respect, will compel very careful attention being given by engineers to this matter.

From the technical and economic aspect no completely satisfactory solution has so far been found. The tests carried out at London with a view to eliminating as far as possible the sulphuric acid contained in the flue gases are of great interest. The results of the tests which were carried out with the coal washing process appear to be highly promising. These results are also confirmed by German tests, in which the flue gases were used for raising early vegetables.

It has been proposed in many quarters to extend the stipulations for industrial plants concerning the smoke nuisance to domestic ovens and boilers.

Another interesting proposal regarding smoke abatement has also been made, by which the dust content of coal is removed by preliminary treatment before it leaves the mine. Should this method be practicable we may look, in spite of the greater cost of the coal entailed by this preliminary treatment, for a considerable decrease in the nuisance caused by dust as well as a reduction in the freight of the fuel.

Interesting suggestions in connection with the difficulties experienced in extending distribution mains in large cities is a proposal for establishing an international commission to be engaged on preparing standard methods for laying mains and cables in large Cities.

Section 8. Combined Heat and Power Supply Plants.

Fifteen papers dealt with the problems connected with heat and power production in individual plants. The problem of production, the problem of the equilibrium of balancing of steam and power demand must be considered; this can take place by means of steam accumulators or by bleeding the turbines for steam; also, by Diesel engines, in the individual concern. On a broader basis generally with lower costs by connection with a public electricity supply station, and common steam production by works in close proximity. The process of extreme centralisation of power production effected by public electricity supply will be repeated in a correspondingly altered guise if every participant regards the common economic welfare. The exploitation of waste heat from industrial furnaces (especially steel works) and of the balancing of demands in co-operation with the public electricitv supply must also be carried out in a similar manner.

The problem also raises the question of exploitation of surplus energy by co-operation between electricity stations and industrial plants. Under this category fall the problems of distribution not only of electricity, but steam, hot water and all kinds of waste heat. It is recognised that there are still great prospects for exploiting waste heat sources in blast furnace plants and steel works. The discussion clearly indicated the great amount of attention that continues to be paid to this cheap source of supply of energy.

Section 9. *Fuel, Power and Heat Economics in Individual Countries.*

Eleven papers dealt with the means of increasing the consumption of power in order that the available generating plants may be employed with a reasonable load factor and operate economically. The planning of power systems implies not only the investigation and solution of technical difficulties, but also the clear line of demarcation of economic limitations which handicap technical possibilities. The outstanding question under this subject heading is the extent to which power supply can be improved by international exchange of power.

Section 10. *Steam Turbines, Gas Turbines and Reciprocating Steam Engines.*

Thirteen papers dealt with the turbine design relative to modern requirements. Electric power stations continue to require units of greater capacity, and at the same time they must be capable of withstanding heavy overloads from time to time. In such gigantic condensing turbines the blades in the last stages are difficult to deal with, especially when as a result of high initial pressures they are working with wet steam. No final conclusions have been arrived at as yet regarding the value of intermediate superheating, draining of the steam or choice of the most suitable blade material. On the other hand the lower limit for an economical size of turbine is of considerable importance especially for works power plants. In this case the high pressure section give rise to difficulties on account of the small volume of steam passing through. Opinions appear to be still divided regarding the influence of short blades on efficiency.

In this connection the question of the upper economic output limit for reciprocating engines is important for purposes of comparison. Concurrently with the efforts to apply high pressures in steam power plant, experiments are being made with a new process employing two different expanding media.

A new development deserves attention, which (starting from the gas turbine) provides for a steam generator fired under pressure from an exhaust gas turbo-compressor, the steam being applied to generate power by means of steam turbines.

The present trend of development appears to be summarised by the three following questions, which were put forward as primary facts for discussion:—

1. What arrangement (number of stages, number of cylinders, governing) should be chosen, for turbines of large output in order to secure economically a high overload capacity?

2. What is the efficiency of the turbine in the high pressure stage when the volume of steam passing is small?

3. What observations have been made from experience in working with wet steam and what success has been achieved by adopting measures to prevent injurious effects therefrom?

Section 11. *Boilers and Furnaces.*

Seventeen papers dealt with furnaces, steam boilers, automatic furnace regulators, feed water management; and the papers indicated the principal line of development, namely:—

(*a*) Greatly increased boiler outputs.

(*b*) Evolution of simpler and cheaper forms of construction.

(*c*) Extensive elimination of manual labour.

(*d*) Adaption of furnaces to fuels of the most widely different characters.

(*e*) Production of boiler construction, materials more suitable for high pressures and high temperatures.

The present reflections on the problems are clearly defined by the following very instructive questions raised by the general report:—

1. What saving in furnace, boiler and boiler-house can be effected by a change to boilers of 300 to 500 tons per hour steam generation?

(*a*) Is there a certain size of boiler, above which the costs of the boiler proper in proportion to each ton per hour maximum steam-generation, again increase?

(*b*) By what means, with small boiler installations, on which no such high demand can be put as on electricity-works, can the unfavourable effect of small output on the installation costs of the boiler and boiler-house, be at least partly compensated?

(*c*) What proportion between the output of a boiler and that of a turbine (particularly with turbines of more than 50,000 kilowatts output), must at least be allowed with regard to reserve, maintenance and life-duration of the particular boiler parts?

2. What specific loadings of grate-area, furnace-space and boiler heating-surface, with admittedly peak-load works with low load-factor or with approximately constantly loaded industrial boiler-installations with only an eight-hour working period, give the best overall economy (including capital charges and maintenance)?

(*a*) Is a certain loss of efficiency, resulting from small-dimensioned furnaces or small-dimensioned heating-surfaces, cheaper in the installation-costs, more economical and technically more advisable?

(*b*) Are certain particular constructions of boiler and furnace to be recommended for such circumstances?

(*c*) Of what influence, in this connection, are the quality and price of the coal?

3. How does extensive jacketing of the furnace-chamber with cooling-surface affect quick heating, boosting capacity, range of control and efficiency-curve?

(*a*) Is there a difference between mechanical stokers and pulverised coal furnaces?

(*b*) Does the temperature of the combustion-air, the size of the furnace-chamber and the gas-content of the coal have any influence?

Section 12. *Solid Fuels: Production, Trade and Preparation.*

Ten papers dealt with this very important subject, a particular aspect of which is the economics and commercial development of low temperature carbonisation. The published results show a liquid fuel yield varying from 16 gallons to 50 gallons of tar per ton carbonised. The best methods of treating and utilising these tars have not yet been ascertained. The tars differ in character from ordinary gas works or even coke oven tars and from natural petroleums. It appears possible that the value of the tar may be increased by some method of "cracking" or "hydrogenation" to produce motor spirit. Coke yielded by these processes is intended for domestic use. It seems, therefore,that the satisfactory development of the low temperature carbonisation process should add to our supplies of liquid fuel.

Section 13. *Rationalisation and the Technical and Economic Problems of Water Power Utilisation.*

Thirteen papers dealt with the economies of hydro power plant and the possibility of more automatic control, the reduction in Capital Costs and operating charges.

Section 14. *Dams.*

Three papers dealt with the various types of dam construction, including gravity, arch, buttressed and earth dams. One of the outstanding questions to-day is that of Government regulations for the construction and management of dams to satisfy adequate public safety without hindering progress by too much legislation.

Section 15. *Economic Problems Relative to Power Storage on a Large Scale.*

Eight papers dealt with the storage of energy for peak load purposes. In covering sudden demands with Diesel engines, oil fuel forms a very satisfactory means of stored power. The Ruths accumulator makes similar claims and during the discussion much controversy arose as to the time factor between the peak load and the available storage of energy in this form. Several arguments in favour of the Diesel engine proved the economical superiority of this system, both from the point of view of capital expenditure and general service efficiency.

Section 16. *The Water Power Industry in Individual Countries.*

Twelve papers dealt with the water resources and the means of utilising them to a still greater extent for the production of power, particularly in countries where coal is being imported. The largest possible single unit together with high pressure power transmission lines are aiding in the practical solution of this important problem. A particularly interesting instance relates to the utilisation of tidal power in the Argentine. The scheme is, however, still on paper, but the proposed experimental plant at the mouth of the Deseado, at a cost of £15,000, should provide very valuable data.

Section 17. *Co-operation of Different Power Producing Plants.*

Three papers dealt with the co-operation of different power plants and a very interesting aspect deals with the proposed co-operation between gas works and electricity power stations. The question of possible economic advantage from such an important co-operation with regard to generation, distribution and sale, is one likely to receive some reply within the near future on the basis of actual practical experience.

Section 18. *Construction of Large Generators and Transformers and Other Electrical Machines.*

Sixteen papers dealt with the generator design and many of the constructional details which at the present form the weak spots of this class of machinery.

Section 19. *Switchgear, Including Automatic Control Apparatus for Power Stations, and Remote Metering and Signalling Apparatus.*

Twelve papers dealt with the effect which design and construction of auxiliary machinery and accessories have on the economic generation and distribution of power. The question of entire automatic control is one which continues to receive the attention of manufacturers. There remains a persistent stream of improvements which it is most difficult to keep track of by means of technical publications or general deliberations.

Section 20. *The Transmission and Flow of Energy in Single and Multiple-Connected Networks.*

Twelve papers dealt with the distribution of electrical energy, important questions requiring attention being the possible limits of voltage and cable capacity. What are the precautions to be introduced to make these networks of transmissions lines immune from breakdown?

Section 21. *Individual Problems of Power Supply in Different Countries.*

Ten papers dealt with power supply problems in various countries. An important aspect which is to be kept in mind is the extent of possible international co-operation with regard to generation of power and transmission. The line of thought underlying this purpose is the possible desirability and advantage of inter-connecting the power stations of such Continents as Europe, Asia, America.

Section 23. *World Problems of Power Economics.*

Eight papers dealt with power economics and the formulation of uniform standards in order to introduce the possibility of measuring exactly the progress of the economics system by modernised energy distribution.

Section 24. *Problems Relating to Water Rights.*

Five papers dealt with the further aspect of water rights and water legislation. The question is as to whether the development of the water power is to be a matter of national policy or individual enterprise.

Section 25. *The Effect of Legislation and Control by Public Bodies on Gas and Electricity Supply.*

Six papers dealt with the question of public control versus private industry. State ownership is recommended in several papers, and it is the contention in certain quarters that legislative influence, as for instance in the case of the gas industry in Great Britain, has not been a handicap either to the consumer or to the industry.

Section 26. *Steam and Electrically-Operated Railways.*

Seventeen papers dealt with the varied problems of rail traction. The electrification of railways advances relatively slowly, although the conversion from steam to electricity not only means reduction of running expenses but also has a valuable competitive effect against road and air transport. The increased reliability of service and the elimination of the large transport of coal are also claimed as further benefits from this change to electricity. There is, however, no doubt that opinion is still very much divided on this point.

Section 27. Power Supply on Ships.

Six papers dealt with power supplies and it is rather refreshing to note the very strong representation of British interest in this section. Sir Charles Parsons' statement regarding high pressure steam practice is important: " If we consider the difference in price between oil and coal, a high pressure plant with coal-fired boilers will be found to be the cheapest form of power generator." It is satisfactory to learn that during the discussion Sir Charles did not maintain this somewhat dogmatic attitude. The controversy between steam and oil was fought out to the bitter end, but it is regrettable to find that the contributors were mainly concerned with the attitudes and policies of various manufacturers as distinct from the more useful information of the marine superintendent. The points for the discussion are embodied in the following queries, although it may be questionable whether they are representative of those aspects of marine propulsion which merit primary attention at the present time:—

1. What are the advantages and disadvantages in applying steam pressures of over 60 at.?

2. Is it more expedient in the case of the pulverised fuel furnace to pulverise the coal on board or to have it ready in bunkers?

3. When are drives with or without gearing and liquid couplings preferable with Diesel engines?

4. To what extent can waste gas and the heat of cooling water be utilised with Diesel engines?

5. To what extent is electric heating and cooking really economical on ships?

6. How can auxiliary drives be made more economical?

Section 28. Production of Natural and Synthetic Oils, their Treatment and the Properties of Motor Fuels.

Nine papers dealt with liquid fuels, an important question being the relation between laboratory analysis and utility of oil fuels for power purposes. Investigations for the conversion of residual fuels in the high grade quality liquids continue without there being available any fuels which are high in quality and low in cost at the present time. Very little progress appears to have been made with the production of commercial supplies of synthetic fuels.

Section 29. *Stationary Internal Combustion Engines and Research Work in this Connection.*

Eleven papers dealt with stationary internal combustion engines, and very little of novel experience as an addition to our present knowledge appears to have been forthcoming. A modification of the Still principle has been put forward for consideration. Nothing was said which might indicate any progress in the utilisation of solid fuels in internal combustion engines.

Section 30. *Air-Craft and Automobile Engines.*

Nine papers dealt with the important aspect of high-speed internal combustion engines including the Diesel type. Some interesting working results are published and there are many indications of the rapid progress the high-speed light-weight type Diesel engine is making. It is becoming more and more evident that with the perfection of the Diesel type one may expect a corresponding increase in the price of the heavier fuels. It must not, therefore, be expected that great savings in fuel costs will be introduced with the commercial introduction of the Diesel type. There are, however, so many other technical advantages that the future of the Diesel engine for application as a high-speed light-weight type of machinery is ensured.

Section 31. *Mechanical Transmission of Power on Vehicles and in Workshops.*

Eight papers dealt with the important subject of power transmission systems of various forms. The trend of development appears to indicate that for powers up to 100 h.p. gearing and friction clutch will be retained. For powers up to 200 h.p. speed gears continuously engaged but friction clutches for each speed appear to be proving a most practical solution. For powers up to 300 h.p. hydraulic transmission is popular from the point of view of reliability and economy. For powers up to 1,200 h.p. electric and compressed air transmission have been developed side by side, the latter system holding out good prospects based on actual practical experience. It will thus be seen that the type of toothed gear, the form of friction clutch construction, the best system of electric transmission and the ideal type of hydraulic gear are all technical problems requiring further investigation.

Section 32. *Research Work.*

Twelve papers dealt with the very wide field of research. Transfer of heat through radiation, the process of combustion, economic problem of large wind power plant, the utilisation of remaining contents of oil-bearing sands, are only a few of the subjects which it is suggested merit further investigation with a view to conservation of our natural supplies of energy.

Section 33. *Standardisation Problems and the Rationalisation of Statistics.*

Eleven papers dealt with the very important subject of standardisation for which the British Engineering Standards Association has done such a large amount of very useful work. The outstanding question, of course, still is as to the best methods to be employed for adequate standards to be prepared on an international basis. It is, admittedly, a huge problem which requires the co-operation of every important country in order to reach the very best solution. Benefits will be increased because, on principle, it will be essential that in connection with any organised international standardisation, the producer and the consumer must collaborate, both technically and financially.

Section 34. *Education.*

Seven papers dealt with education, with specific reference to the training of Engineers. There are many differences of opinion, dividing themselves into two schools, one of which recommends that the Engineering Colleges confine themselves to the teaching of fundamental principles. The other school prefers to concentrate on specialisation of subjects from the very beginning of an engineering student's training. It must be admitted that both schools have their merits and as a result there are many advocates of the "sandwich" system, with which in many instances excellent results have been obtained. That sound technical training may be obtained in various ways is admitted, the only question being which is the quickest and best. This can only satisfactorily be answered by an international exchange of experiences and international collaboration. With the increasing ramifications of power economics in the different countries the establishment of fundamental rules for the training of young engineers and technicians would appear to be an urgent necessity. It not only affects the development and improvement of power production but also the community at large, which is economically interested in such development either as a producer or a consumer of energy.

V. CONCLUSION.

In addition to the main sessions, there were a number of informal meetings and separate addresses including:—

"Place of Minerals in a Power Controlled World, by H. F. Bain. ("American Hour.")

"Electricity and Energy," by Professor G. Vallauri. ("Italian Hour.")

"Mechanical Power as a Factor in Culture," by Dr. Enstrom. ("Swedish Hour.")

"New Forms of Rationalisation," by Professor Dr. Serruys. ("French Hour.")

"Sub-Atomic Energy," by Professor Sir A. W. Eddington. ("British Hour.")

There is no need to report on the social arrangements made by the German Committee, which, as might have been anticipated, were excellent.

As a result of the deliberations of the International Executive Council, it is possible to announce the following arrangement:—

The International Executive Council has set up on the basis of some definite proposals put before it, a Sub-Committee which is to submit to its next meeting in 1931, after consultation with the National Committees certain proposals promoting the rational development and increasing the usefulness of the World Power Conference. Among the principal matters regarding which recommendations are expected, are proposals for avoiding in future too voluminous Transactions and for facilitating a continual exchange of power statistics and information regarding important publications between the National Committees. It has approved of the decisions of the German Preparatory Committees for the Second World Power Conference to publish the Conference Papers this time in 21 separate volumes divided up amongst the various fields concerned and of selling these separately. Volume 21, which contains the seven General Addresses in their original languages, is already complete.

Very satisfactory progress has been made with regard to consolidating the friendly relations with other international organisations. An understanding has been come to with the International Commission on Large Dams and the International High Tension Conference with regard to the mutual demarcation of the fields of interest. The World Power Conference can in its future meetings count on receiving special reports of these organisations as has already been the case on this occasion in the shape of the special report contributed by the International Commission on Large Dams. Similarly, at the proposal of the " Commission Mixte Internationale pour les ligne téléphoniques et les canalisations souterraines," the International Executive Council has agreed to an informal exchange of current information with them. The International Executive Council has resolved as the result of three reports kindly furnished by the International Standards Commission, the Electrotechnical Commission and the new International Association for Testing Materials to continue to hand over to these organisations all standardisation problems falling within their scope and to suggest that these organisations decide among themselves upon the division of the work amongst one another.

The International Executive Council of the World Power Conference having had called to its attention certain proposals for the creation of a World Engineering Federation and also of a permanent World Engineering Congress, decided that such new organisation would result in overlapping with existing bodies, and so would lead to duplication of activities and over-organisation of international work.

Of the four Resolutions of the Fuel Conference in London, 1928, three are in the course of being carried out. The fourth, regarding international regulation of the calorific value problem, was brought to a final solution at a special meeting on the 20th of June, during the Second World Power Conference. It was unanimously agreed that the World Power Conference should utilise all the resources at its disposal to induce everybody when giving data based on calorific value always to make it perfectly clear, whether the upper or the lower (gross or net) calorific value forms the basis of such data. For this purpose (1) an official list of the terms used for the two values is being drawn up in all principal languages, as well as (2) international indices for both. These definitions and indices are to be published during the current year. The international standardisation organisations mentioned above are to be requested to create an international standard definition for the upper and the lower calorific value.

The International Executive Council has decided to accept the tentative invitation of Sweden and of the Scandinavian

Countries and to suggest 1933 as the date of the next Sectional Meeting of the World Power Conference, to be held in Scandinavia on the question of Power Supply of big industrial undertakings.

The third Plenary Meeting of the World Power Conference will take place in America in 1936.

The International Executive Council has on record that it would welcome a discussion on the advantages and the disadvantages of charging for electricity on the basis of either the KW-hour or the KW-year or a combination of the two. It understands that the Union Internationale des Producteurs et Distributeurs d'Energie Electrique will give consideration to including this question in the Agenda of one of its next meetings.

Finally, the International Executive Council wishes to express sincere thanks towards several authors and organisations who were good enough to place at the disposal of its members and the National Committees a number of publications of the highest technical value.

(Signed) J. L. CHALONER.

CORRESPONDENCE.

SAFETY VALVE BLOW-OFF PRESSURE (p. 487).

An Addition and a Correction.

CARDONALD, GLASGOW.

3rd Sept., 1930.

I observe the footnote on page 489 of the Transactions of the Institute of Marine Engineers for August.

It might be of interest to note that in the case of the *Duchess* boats for the C.P.R. Co. it was only necessary to increase the drum ends by 1/32nd inch to make the boilers, which had been designed for 350 lbs. W.P., suitable for 370 lbs. W.P. or approximately 5% higher. The increase in weight is infinitesimal. I think all builders should design water-tube boilers for a W.P. of 5% more than the pressure at which the boilers are to work.

On page 488 (second paragraph—end of sixth line), the date of the old trials is given as 1915. This should have been 1875.

DONALD MACNICOLL.

LONDON, W.C.2.
29th August, 1930.

The Secretary,
Institute of Marine Engineers.

Dear Sir,

The communication from Mr. Donald MacNicoll (Cockburns Ltd.) published in the August issue of the Transactions has no doubt already proved of interest to large numbers of our members, including those who, like myself, are following the progress of the steam engine and at the same time noting the increasing adoption of internal combustion machinery in the mercantile marine.

It is not Mr. MacNicoll's valuable remarks on the margin allowable for safety valve lifts at different pressures that call for criticism. What I would be glad to know is the identity of the " internal combustion advocates, who state that within a few years not a steam vessel will be plying the seas." Mr. MacNicoll, with commendable restraint, calls these prophets " pure faddists." Far stronger terms could be used to meet the case, but in any event I trust Mr. MacNicoll is not allowing them to make his flesh creep. They should be publicly named and exposed.

Any level-headed engineer knows that there are cases in which the shipowner (the man who matters, since he foots the bills for construction and upkeep) cannot decide on any other form of machinery than internal-combustion engines for his particular services. Other instances arise where steam engines are clearly suitable.

There are no questions of ethics, patriotism or faddism about the matter, either on one side or the other. It is solely a hard problem of pounds, shillings and pence.

Yours faithfully,

EDMUND G. WARNE (Member).

STUDENT-GRADUATE EXAMINATION PAPERS.

The following are the papers set for the examination which was held on April 7th—10th, 1930:—

Mechanics.

Monday, April 7th, 1930. 10 a.m. to 1 p.m.

Answer *six* questions only.

1. State the parallelogram of forces. Three forces, 30, 48 and 60 lbs. respectively, are acting along the sides of an equilateral triangle (clockwise). Find the direction and magnitude of the resultant.

2. In a wheel and axle the ratio of the wheel to the axle is 8 to one and the ratio of the weight to the effort is 4 to 1. Find the diameter of the rope.

3. What do you mean by relative velocity? Two trains of equal length are observed to pass each other when going in the same direction in 15 seconds, and when going in opposite directions in 3 seconds. If the length of each train is 180 ft., find their speeds.

4. If it takes a force of 1 ton to pull a weight of 8 tons up an incline, and $\frac{1}{2}$ ton to pull it down, find inclination of the plane—the resistance due to friction remaining constant.

5. Define Power, Work and Energy. If it takes 12 horse-power to pump 4,000 gallons of fresh water into a boiler in 1 hour against a pressure of 220 lbs. sq. in., find the efficiency of the pump.

6. A train starting from rest acquires a speed of 30 m.p.h. in $1\frac{1}{2}$ minutes; if the acceleration is constant, find the acceleration and the distance travelled in that time.

7. A body is projected upwards with a velocity of 250 f./s. and at the same instant one is dropped from a height of 2,000 ft. After what time, and at what distance from the ground will they meet?

8. A jib crane, length of jib 20 ft., has a weight of 2 tons hanging from the top. If the tie rod is at right angles with

the wall, and is 8 ft. long, find the tension in the tie rod and the compression in jib.

9. Two weights 7 and 9 lbs. are hanging over a frictionless pulley. Find what velocity is attained in four seconds. Find also the tension in the cord, and the distance fallen through in four seconds.

10. A tunnel shaft is subjected to a twisting moment of 60ft./tons; if there are eight coupling bolts pitched at 9in. radius, find the stress in the bolts if they are 3in. diameter.

Heat and Heat Engines.

Monday, April 7th, 1930. 2 to 5 p.m.

Answer not more than *three* questions from each section.

Candidates are allowed to use Steam Tables, which are supplied herewith.

Heat.

1. Equal volumes of turpentine at 70° C. and of alcohol at 10° C. are mixed together. Find the temperature of the mixture, given that the specific gravities of turpentine and alcohol are 0·87 and 0·80 respectively, and their specific heats are 0·47 and 0·62 respectively.

2. Show that the coefficient of cubical expansion of a substance is approximately three times its coefficient of linear expansion.

If the volume of a leaden sphere at 0° C. is 2·5 c.c. and its volume at 98° C. is found to be 2·521 c.c., determine the coefficient of linear expansion.

3. The following data were obtained from an experiment to determine the latent heat of steam:—

Weight of brass calorimeter: 326·3 gm.

Weight of brass calorimeter plus water: 757·7 gm.

Weight of brass calorimeter plus water plus steam condensed: 804·1 gm.

Temperature of steam: 100° C.

Temperature of water before experiment: 7·5° C.

Temperature of water after experiment: 65·2° C.

Taking the specific heat of brass as 0·09, determine the value of the latent heat.

4. Distinguish between conduction and convection of heat and give illustrations of both processes. The thermal conductivity of rubber is 0·0041 C.G.S. units. How much heat would be conducted per hour across a square metre of rubber 3 cms. thick if the difference of temperature of the faces were 12° C.?

5. Describe an experiment by which the dewpoint of the atmosphere may be determined.

Heat Engines.

6. Describe with neatly drawn sketches either

(*a*) a Stephenson link motion for reversing and altering the cut-off of a steam engine, or

(*b*) an indicator for recording the changes of pressure in a cylinder, or

(*c*) a double-beat valve operated by a governor.

7. The pressures at one-eighth stroke and seven-eighths stroke measured from the compression line of a gas engine indicator diagram, were found to be 14 and 68 lb. per sq. in. absolute respectively. Assuming the compression is according to the law, $PV^{1\cdot35}$ = a constant, find the ratio of compression of the engine.

8. Describe as fully as possible a test on any type of heat engine at which you have acted as an observer. State the object of the trial, the various readings taken, and the method of working out the results.

9. A rope brake on the flywheel of an engine carried a load of 250 lb. and the spring balance reading was 10 lb. The effective diameter of the flywheel was 5ft. and the engine ran at 200 r.p.m. Determine the B.H.P. developed.

Assuming that 85% of the heat generated by friction between the rope and the wheel was absorbed by a stream of cooling water, the rise of temperature for which was 10° C., calculate the amount of water required per min.

10. Describe how you would determine the calorific value of a fuel.

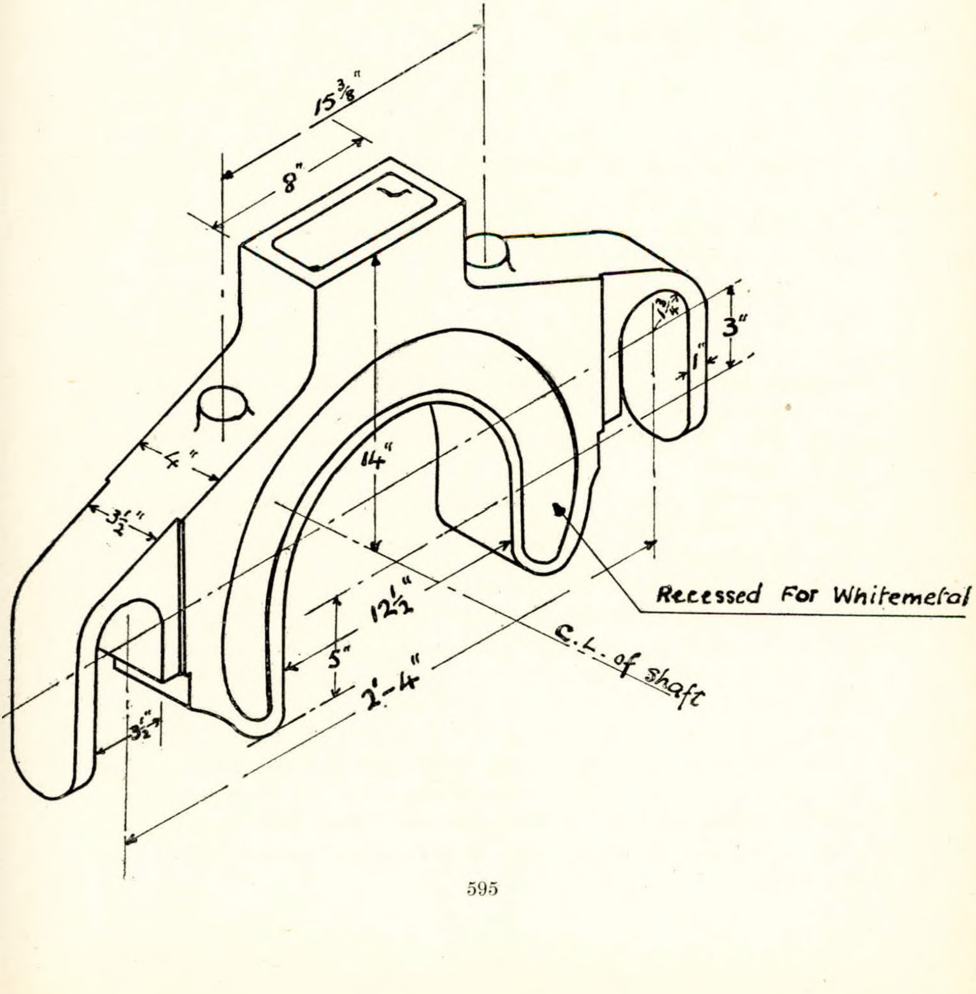
Machine Construction and Drawing.

Tuesday, April 8th, 1930. 10 a.m. to 1 p.m.

You are required to make a working drawing from the sketch below, giving sufficient information for the completion of the work in the shops.

Show the whitemetal facings and how same are secured, oilways, provision for water-cooling and any other necessary details.

Do not ink-in your drawing.



Practical Engineering.

Tuesday, April 8th, 1930. 2 to 5 p.m.

Answer not more than *six* questions.

1. What is friction? Define "coefficient of friction." Describe an experiment for measuring the coefficient.

2. Show by sketches how each of the following defects affects the indicator cards:—

(*a*) Leaky piston.
(*b*) Leaky valve.
(*c*) Omission of liner from foot of eccentric rod.
(*d*) Wiredrawing.

3. Describe in detail with sketches any work of special interest or any repairs or overhaul in which you have taken part.

4. Describe how you would secure two cylindrical marine boilers in a ship. Illustrate your answer by sketches.

5. State the properties of the materials required for (1) a steam engine cylinder, (2) a piston rod, (3) a ship's propeller. Name suitable materials.

6. Show with the aid of sketches how a backward and forward movement of the table of a planing machine is obtained.

7. What is meant by "modulus of elasticity"? A wrought iron tie rod is subjected to a stress of 16,000 lbs. per sq. in. of section—the strain is ·000552. Find the modulus of elasticity.

8. State the expression for converting temperature degrees Fahrenheit to Centigrade, also Centigrade to Reaumur. What mark on Centigrade will agree with 90° on Fahrenheit?

9. Describe how a leaky tube in a cylindrical marine boiler is made tight; also in a water-tube boiler.

10. A tunnel shaft is 12 inches in diameter, the flanges are 18 inches in diameter, and 4 inches thick. There are five bolts in each flange, $2\frac{1}{2}$ inches diameter. The length of the shaft is 22 feet overall. What is the weight, assuming the steel weighs ·28 lb. per cubic inch?

Mathematics.

Wednesday, April 9th, 1930. 10 a.m. to 1 p.m.

Eight questions only to be attempted. Not more than *three* questions may be selected from any one section: candidates cannot pass unless marks are obtained in *each* section.

ARITHMETIC.

Note.—These are arithmetical questions, and must be answered by *strictly arithmetical methods*, or no credit will be gained.

1. Find a series of numbers expressing the relative magnitudes of the following quantities:

$$21, \tfrac{27}{16}, \tfrac{5}{8}, \text{ and } 1\cdot5.$$

2. Find the cube roots of 13,824 and $41,063\frac{5}{8}$.

3. Find the values of

$$\frac{1}{\sqrt{7}}; \text{ and } \sqrt{\frac{12\cdot8}{0\cdot016}}$$

each to be correct to three places of decimals.

4. Brown has 36 coins in his pocket, their total value amounting to 7/2. Some are pennies, and the rest sixpences. Find the number of sixpences and pennies.

5. A car on the track ran 2 miles in one-twelfth the time that it took to cover 22 miles. If the speed over the 22 miles had been the same as it was when running the two miles, the time would have been 2 minutes less. Find the speeds on each run.

6. Three people have to divide £285/4/0 between them. The share of the first to the second is to be in the ratio of 4 to 5, and the share of the second to that of the third in the ratio of 11 to 17. How much does each get?

ALGEBRA.

7. Find the product of

(*a*) $(x-3), (x-1), (x+1)$ and $(x+3)$
(*b*) $(x-a), (x-b), (x-c)$ and $(x-d)$

8. Divide $(x^6 - 6x^4 + 9x^2 - 4)$ by $(x^2 - 1)$,
and $(a^2b - bx^2 + a^2x + x^3)$ by $(x + b)(a - x)$

9. Find the G.C.M. of

$$(6x^4 + x^3 - x) \text{ and } (4x^3 - 6x^2 - 4x + 3)$$

and the L.C.M. of

$$(x + 1)(x^2 - 1) \text{ and } (x^3 - 1)$$

10. Solve

$$\left.\begin{aligned} \frac{1}{x} + \frac{3}{y} - \frac{2}{z} &= 1 \\ \frac{2}{x} - \frac{1}{y} + \frac{3}{z} &= \tfrac{17}{12} \\ \frac{3}{x} - \frac{2}{y} - \frac{1}{z} &= \tfrac{7}{12} \end{aligned}\right\}$$

11. Solve

$$\left.\begin{aligned} \frac{1}{x} + \frac{1}{y} &= \frac{5}{6} \\ \frac{1}{x^2} + \frac{1}{y^2} &= \frac{13}{36} \end{aligned}\right\}$$

12. A journey of 90 miles would have been completed in three hours less time if the speed had been 5 miles per hour greater; what was the actual rate of travel?

GEOMETRY.

13. Given a straight line AB and two points C and D without the line, draw a circle passing through C and D, having its centre on the line AB. Prove the truth of your construction.

14. Draw a line AB, and take a point C distant 3 cms. from the line AB. Draw a circle of radius 4 cms to pass through C and touch AB. Show that your construction is correct.

15. In the triangle ABC, AB = 8 inches, BC = 6 inches, and CA = 5 inches. Draw a line XY parallel to BC, cutting AB at X and AC at Y, making AX 2 inches long. Find the lengths XY and CY by geometry, not by scaling the figure.

16. In geometry the terms "axiom" and "postulate" are used. Explain what is meant by these terms, and state why postulates are necessary.

17. H and K are the mid-points of the sides AB and AC of the triangle ABC. H and K are joined and produced to X so that HK equals KX. Prove (1) that CX is equal and parallel to BH, and (2) that HK equals half BC, also that HK is parallel to BC.

18. Two circles, with centres at A and B respectively, cut at P; AQ and BR are radii parallel to and in the same sense as BP and AP respectively. Show that QPR is a straight line.

English Language and Composition.

Wednesday, April 9th, 1930. 2 to 5 p.m.

1. Passage to be read for Dictation: 15 minutes are allowed. This must be taken by all candidates.

2. Write an essay on one of the following six themes:—

(*a*) Comparison of different types of engines.
(*b*) Summary and criticism of a book lately read.
(*c*) Life of a notable engineer.
(*d*) Ethics of the workshop.
(*e*) Studies in preparation for life and work.
(*f*) Playtime: its use and abuse.

Grammar, Derivation, Literature.

Candidates may attempt three of the following:—

3. Explain how the following words came to be used in English: mob, sham, veldt, bus, fusilier, gondolier, and belle.

4. Analyse grammatically, showing the clauses, the kind of clause and subject, predicate, etc.:—

"Come and trip it as you go
On the light fantastic toe."

5. Parse "come," "trip," "go"; giving conjugation, kind, voice, mood, tense, person, number, subject.

6. Quote 12 lines from a poem by Milton, Scott, Moore, Byron or Longfellow.

7. Enumerate the various ways of forming the plural of nouns from the singular. Give examples. What is peculiar about the plural of child, index, and genius?

8. Give the various meanings of: sound, bound, lay, found, die and brand. Illustrate with sentences.

Dictation.

Wednesday, April 9th, 1930. 2 to 2.15 p.m.

Dictation must be taken by all candidates. 15 minutes are allowed.

"The discovery of the scientific method, except in pure mathematics, is a thing of yesterday; speaking broadly we may say that it dates from Galileo. Yet already it has transformed the world, and its success proceeds with ever-accelerating velocity. In science men have discovered an activity of the very highest value in which they are no longer, as in art, dependent for progress upon the appearance of continually greater genius, for in science the successors stand upon the shoulders of their predecessors—where one man of supreme genius has invented a method, a thousand men of less calibre can apply it. No transcendent ability is required in order to make useful discoveries in science; the edifice of science needs its masons, bricklayers and common labourers, as well as its foremen, master builders and architects. In art nothing worth doing can be done without genius; in science even a very moderate capacity can contribute to a supreme achievement.

In science the man of real genius is the man who invents a new method. The notable discoveries are often made by his successors, who can apply the method with fresh vigour, unimpaired by the previous labour of perfecting it; but the mental calibre of the thought required for their work, however brilliant, is not so great as that required by the first inventor of the method. There are in science immense numbers of different methods appropriate to different classes of problems; but over and above them all, there is something not easily definable which may be called the method of science."

Bertrand Russell, M.A., F.R.S., Essays.

Electrical Engineering.

Thursday, April 10th, 1930. 10 a.m. to 1 p.m.

Seven questions only to be attempted.

1. A workshop is open 50 weeks in a year and uses motors totalling 60 B.H.P. The average efficiency of these is 90% and the average load 50%. Assuming the motors are working

47 hours per week, what is the yearly bill for energy at 1d. per unit.

2. A centrifugal pump is to lift 372 cu. ft. of water per minute through 7 ft.; what h.p. must be supplied to it if its efficiency is 45%? If it is driven by a motor at 240 volts, how many ampères must be supplied? (Take efficiency of motor as 85%). (N.B.—A cubic foot of water weighs 62·4 lbs.)

3. The field coil of a dynamo has a resistance of 850 ohms at 20° C. After running for six hours the resistance increases to 908 ohms. What is the approximate final temperature of the coil? The temperature coefficient of copper is approximately ·004 per degree Centigrade.

4. What do you understand by the the term "multiplying power of a shunt"? Find the resistance of a shunt which, when connected across the terminals of a galvanometer of 3,663 ohms will allow only one hundreth of the total current to pass through the galvanometer.

5. Describe, with sketches, any experiment you have performed in the laboratory.

6. Make a neat longitudinal section through the commutator of a D.C. machine, noting the materials of which each part is made.

7. Describe the Leclanché cell. What are the advantages and disadvantages of this cell?

8. Sketch, in fair proportion, the magnetisation curves of wrought iron and cast iron. Write short notes on the two curves.

9. Sketch and describe some good form of ammeter,

or

Why does a series motor need a starting resistance in the circuit? Give a diagrammatic sketch of a small starter for such a motor.

10. Describe, with a sketch an A.C. transformer. A transformer gives out 60 amps. at 60 volts from its secondary terminals. There are 450 primary and 15 secondary turns. Assuming no loss, what is the primary applied pressure and the transformation ratio?

or

An A.C. circuit containing a resistance of 10·5 ohms and an inductance of 0·05 henry is supplied with 200 volts at a frequency of 50. What is the current?

LLOYD'S REGISTER SCHOLARSHIP EXAMINATION PAPERS.

The following are the papers set for the examination which was held on May 12th and 13th, 1930:—

Arithmetic and Algebra.

Monday, May 12th, 1930. 10 to 11.30 a.m.

Only three questions to be attempted in each section:

six questions in all.

ARITHMETIC.

Note.—These questions must be answered by *arithmetical* methods, otherwise *no credit* will be given for the answers.

1. Divide $\frac{3}{5}$ into two parts, so that one part is greater than the other by $\frac{4}{13}$.

2. Reduce to their simplest forms the following:

(*a*) $$\cfrac{1}{2 + \cfrac{1}{3 + \frac{1}{4}}}$$

(*b*) $\frac{1}{2}\left\{\frac{3}{10} + \frac{1}{5} \text{ of } \left(\frac{5}{16} + 3 \times \frac{1}{8} - \frac{1}{16} \text{ of } \frac{1}{8}\right)\right\}$

(*c*) $\left(1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5}\right)^2$

3. Find the cube root of 592704 and of 1157625.

4. A company of 266 persons, consists of men, women and children; there are four times as many men as children, and twice as many women as children. How many of each are there?

5. A bankrupt owes Brown twice as much as he owes Andrews, and his indebtedness to Crane is equal to the sum he owes to Andrews and Brown together; what should each receive out of £300 which is available for distribution?

6. A workman was engaged for 60 days on the condition that he should receive 15/- for each day's work, but for each day that

he was absent he forfeited 5/- At the end of the period he received £12. How many days was he absent?

ALGEBRA.

7. If $a = 1$, $b = 9$, and $c = 8$, find the value of each of the following quantities :—

(*a*) $\sqrt[3]{ac} + \sqrt{4b} - 2\sqrt[3]{8}$

(*b*) $\sqrt{ab} + \sqrt{a^2b}$

(*c*) $\sqrt[3]{a} + \sqrt{2c^3}\sqrt[3]{\frac{bc}{9}} - 4\sqrt[3]{b-a}$

8. Find the G.C.M. of —

(*a*) $2x^3 - 3x^2 - 9x + 5$, and $2x^2 - 7x + 3$

(*b*) $2x^3 + x^2 - x + 3$, and $2x^3 + 5x^2 + x - 3$

9. Resolve into factors :—

(*a*) $2x^2 + 17x + 21$

(*b*) $77x^2 - 5x - 12$

(*c*) $x^2 - 6bx - 4a^2 + 9b^2$

(*d*) $4b^2c^2 - (b^2 + c^2 - a^2)^2$

10. Solve the following equations :—

(*a*) $x(m + nx)(p - qx) = 0$

(*b*) $\frac{x}{x+1} + \frac{x+1}{x} = 2\frac{1}{6}$

(*c*) $\frac{x}{x+60} = \frac{7}{3x-5}$

11. If x is real, prove that $x^2 - 8x + 22$ can never be less than 6.

12. The volumes of spheres vary as the cubes of their radii. Show that the sum of the volumes of three spheres whose radii are 3, 4 and 5 inches is equal to the volume of a sphere of 6 inches radius.

Hydrostatics and Thermodynamics.

Monday, May 12th, 1930. 11.30 a.m. to 1 p.m.

Answer not more than *three* questions from each section of the paper.

Candidates are allowed to use Steam Tables, which are supplied herewith.

Hydrostatics.

1. Distinguish between pressure and intensity of pressure; find the dimension of each of these quantities in terms of the fundamental units of length, time and mass.

A mercurial vacuum gauge reads 27·2 ins. when the barometer is at 29·4 ins. What is the absolute pressure in lb. per sq. inch?

2. A Nicholson's hydrometer, when floating in water, required a weight of 0·15 gm. to be placed upon the upper platform in order to make it sink to a fixed mark on the stem; and 5·72 gms. had to be placed upon the platform in order to make it sink to the same mark in a solution of salt. If the hydrometer weighed 94·47 gms., what was the specific gravity of the salt solution?

3. A lock gate is 35ft. wide, and the heights of the water above the bottom of the gate are 30 and 15ft. respectively. Find the resultant pressure and the height, measured from the bottom of the gate, at which it acts. (Weight of 1 cu. ft. of water is 62·4 lb.).

4. Explain how the column of mercury in a barometer is supported. Why is mercury the liquid generally employed? How is the height of the mercurial column affected (*a*) by changes of temperature; (*b*) by the narrowness of the tubes; (*c*) by differences in the value of g?

5. Explain how Archimedes' principle enables us to compare the densities of solids and liquids. A piece of lead weighs 7·88 gms. in air, 7·19 gms. in water and 7·33 gms. in alcohol; a piece of oak weighs 13·21 gms. in air, and the oak and lead together weigh 4·87 gms. in water. Find the specific gravities of lead, oak and alcohol.

Thermodynamics.

6. Twelve cubic ft. of air at 14 lb. per sq. in. absolute and at 27° C. are compressed to one cubic ft. according to the law, $PV^{1 3} =$ a constant. Determine the pressure and temperature at the end of compression and also the work spent in compression. Take R (the gas constant for air) as 96 ft. lb. per lb. per deg. Centigrade.

7. A torpedo air reservoir of 15 cu. ft. capacity is charged to a pressure of 2,500 lb. per sq. in. absolute, and the air is throttled to a pressure of 250 lb. per sq. in. absolute before passing to the engine. Assuming the temperature of the air in the reservoir remains at 10° C. during discharge, determine the weight of air available for use in the engine. R as in previous question.

8. On a boiler test a throttling calorimeter was used to determine the dryness fraction of the steam, and the following readings were obtained:—Temperature of steam before throttling, 205·1° C.; temperature after throttling, 107° C. Taking the specific heat of superheated steam at atmospheric pressure as 0·5, determine the dryness fraction of the steam.

9. Sketch a simple slide valve placed symmetrically over the cylinder ports, and in dotted lines show it at the beginning of the stroke. The maximum opening to steam of a valve is $1\frac{1}{4}$ in., the outside lap is 9/16in., and the lead is $\frac{1}{8}$in. Draw a diagram (twice size) and from it determine the travel of the valve and the angle of advance.

10. Describe, with suitable sketches, the cycle of operations of a Diesel oil engine. Briefly explain the fundamental differences between the Diesel cycle and that of an engine using petrol as fuel.

Geometry.

Monday, May 12th, 1930. 2 p.m. to 3.30 p.m.

Six questions only to be attempted.

1. H and K are the midpoints of the sides AB and AC respectively of the triangle ABC. BK and CH are produced to X

and Y, so that BK is equal to KX and CH is equal to HY; show that XY is equal to twice BC.

2. In a triangle ABC, BE is perpendicular to AC and AD is perpendicular to BC; H is the point where AD and BE intersect. P, Q and R are the midpoints of HA, AB and BC respectively. Join P, Q and R and show that the angle PQR is a right angle.

3. XY is any line drawn outside the parallelogram ABCD: AP, BQ, CR and DS are perpendiculars from A, B, C and D to XY. Show that the sum of AP and CR is equal to the sum of BQ and CS.

4. A line cuts the circumferences of two concentric circles whose radii are 3 and 5 inches respectively at P, Q, R and S, the outer circle at P and S, and the inner circle at Q and R. If QR is equal to 2 inches, find the length of PQ. Show the truth of the method you use.

5. The centres, A, B and C, of three unequal circles lie on the straight line AB, C being the midpoint of A and B. The circle whose centre is at C intersects the other two circles at Q and R; join QR and produce it to cut the circle whose centre is at A at the point P, and the circle whose centre is at B, at the point S. Show that PQ is equal to RS.

6. AB and CD are two perpendicular chords of a circle, whose centre is at O. Show that the sum of the squares on AC and BD equals four times the square on OA.

7. ABCD is a square, and APQ is an equilateral triangle inscribed in the same circle, P being between B and C. Show that BP is equal to twice the arc PC.

8. ABC is a triangle inscribed in a circle; any circle through BC cuts AB and AC at P and Q. BQ and CP are produced to meet the circle ABC at R and S: show that AR and AS are equal.

9. Prove that the common tangents of two non-intersecting circles divide (internally and externally) the line joining the centres in the ratio of the radii.

10. ABCD is a parallelogram: P is any point in AB, DP cuts AC at Q. Show that the rectangle APDQ is equal to the rectangle ABPQ.

English Language and Composition; General Knowledge.

Monday, May 12th, 1930. 3.30 p.m. to 5 p.m.

1. Passage to be read for Dictation: 15 minutes are allowed. This must be taken by all candidates.

2. Write an essay on one of the following themes:—

(*a*) "If friends thou hast and their adoption tried,
Grapple them to thy soul with hooks of steel."

(*b*) The work done by rivers.

(*c*) The beauty of Nature.

(*d*) Description of a voyage.

(*e*) Good work well done, and its opposite.

(*f*) Tools.

General Knowledge.

Candidates may attempt three of the following:—

3. Give a short quotation from each of the following authors: Wordsworth, Goldsmith, Mrs. Hemans, Mary Howitt, Browning, and Tennyson.

4. Describe the various thermometers in present use.

5. What famous men are connected with Arctic and Antarctic exploration?

6. What wild animals were found in Britain in ancient times?

7. Give a short description of the solar system.

8. Give the derivation of the following words:—refer, confer, differ, infer, suffer, proffer, contradict, predict, and sincere.

9. Where are the principal oil-fields of the world?

10. Where is water power most successfully applied to industry?

Dictation.

Monday, May 12th, 1930. 3.30 to 3.45 p.m.

Dictation must be taken by all candidates. 15 minutes are allowed.

"The very nomenclature of Biology embodies the conception that life, in whatever form it may occur, occurs as a specific whole, in which the parts and actions are essentially related to one another, and cannot be isolated without destroying their nature. The working hypothesis of Biology is that this wholeness exists, and this working hypothesis has carried Biology forward just as successfully as the Newtonian conception has carried the physical sciences forward. Biologists are, and always have been, progressively tracing the specific co-ordination which shows itself in the structure, activities and environment of living organisms. This co-ordination cannot be expressed in terms of ordinary physical and chemical conception. For this reason Biology must be regarded as a distinct science or group of sciences. A biologist interprets his observations in a different manner from that of a physicist. This, of course, raises a philosophical question, which, however must be postponed until the second course of lectures is reached."

Prof. J. S. Haldane, Gifford Lectures.

Applied Mechanics.

Tuesday, May 13th, 1930. 10 to 11.30 a.m.

Answer *six* questions only.

1. State the parallelogram of forces.

The distance between two bulkheads is 24 ft.; a sling whose length is 32 ft. is fastened to each bulkhead, the difference in heights of the fastenings being 4 ft. If a cylinder cover, weighing 15 cwt. is hanging from the centre, find the tension in each side of the sling.

2. The connecting rod of a marine engine is 9ft. 6in. long, and the stroke of the engine is 4ft. If the thrust in the con-

necting rod is 60,000 lbs. when the crank makes a right angle with the centre line of motion, find load on the piston, also pressure on the guide.

3. A gun whose weight is 80 tons fires a projectile weighing 1,600 lbs. with a muzzle velocity of 2,100ft./sec. Find the velocity of recoil, also the distance it will recoil against a steady resistance of 44 tons.

4. A rectangular barge, whose length is 120ft. and beam 42ft. floating in sea water draws 2ft. more forward than aft. If the distance in a fore and aft line between the fore hold and the after hold is 80ft., find what weight must be shifted from the fore hold to the after hold to bring the barge on even keel.

5. A piece of sheet iron in the form of an equilateral triangle, whose side is 8ft., has a hole 2ft. in diameter cut out, whose centre is 3ft. from base. How far is the centre of gravity shifted up?

6. A screw jack is employed to lift a weight of 3 tons; the pitch of the screw is $\frac{3}{8}$in. and the toggle bar 2ft. long. Find the force at the end of the toggle if the mechanical efficiency is 40%.

7. A vessel approaching a port five miles distant slows down and just reaches the port in 15 minutes. What has been the retardation (assumed uniform)? Prove any formula you employ.

8. A seaman swings the lead, which is 7 lbs. weight. If the length of lead line is 16 ft. and he makes 16 complete circles in 1 minute, what is the tension in the line at the top and bottom of the circle?

9. A pulley with three sheaves at top and two at bottom is employed to lift 15 cwt. Find pull on the free end if 5% is lost at each sheave.

10. In a differential pulley block there are 20 teeth in the large wheel and 18 in the small wheel. What pull on the endless chain would be required to lift one ton assuming mechanical efficiency is 40%? What prevents the weight from running back?

French.

Tuesday, May 13th, 1930. 11.30 a.m. to 1 p.m.

Candidates *must* attempt Question 1 (translation of English into French). They may choose five of the other translations and questions set. They must only attempt *six* questions altogether.

1. Translate the following into French:—

A Shipwreck.

Three years ago, when Flambard was at the seaside, and when it rained, he used often to pass an hour in the company of an old sailor with a wooden leg, who told him of his voyages and his wonderful adventures. Flambard made him repeat his most incredible tales, above all, that of the famous shipwreck of the *Sarcelle* in the Pacific Ocean, to which he listened with gaping mouth. The *Sarcelle* was a brigantine of 1,500 tons. She came from San Francisco and was bound for Sydney with a cargo of rails for making railways. Everything had gone well as far as the Polynesian Islands. The heat was torrid and the ship, taken in a calm, swung gently on the swell and awaited the breeze.

2. Translate into English:—

"Les marins, couchés à moitié nus sur le pont brûlant, dormaient accablés par la chaleur intense, mais le capitaine se promenait fièvreusement sur la passerelle. De temps en temps, il allait donner un coup d'œil au baromètre dont le mercure paraissait s'agiter d'une façon étrange. Il savait à quoi s'en tenir; le typhon approchait. Il éveille ses hommes et leur ordonne de carguer la plupart des voiles. Il n'était que temps. L'ouragan, tel un monstre déchainé, se précipite sur la Sarcelle et l'emporte comme une plume. Les vagues énormes la submergent presque, et, pour comble de malheur, un poussée formidable de vent emporte les mâts d'un coup. La Sarcelle était à la merci des éléments. Une heure après sa coque se broyait sur les recifs de corail d'une île déserte. Tout l'équipage s'était noyé sauf notre vieux marin qui avait vécu pendant trois mois de noix de coco et du produit de sa pêche. Il avait été sauvé par un navire anglais qui faisait une croisée dans ces parages."

3. Make sentences to show how the following words may be used as adjectives and also as adverbs: vite, soudain, net, juste, haut, fort, faux, cher.

4. Give the feminine of the following nouns: Le cheval, un oncle, le paysan, le sanglier, le taureau, le fils, le roi, le singe, le loup, le sot, un hôte, le Grec, le Turc, le neveu, le duc, le coq.

5. The four verbs—monter, descendre, entrer and sortir—are used transitively and intransitively. Make sentences containing each verb in the Perfect Tense, Indicative Mood, Active Voice, showing both ways. Give translation in English.

6. Write out fully all the moods and tenses of "Avoir."

7. Write out the simple tenses of the Indicative Mood of "Ne pas se lever."

8. Write out the verb "Vivre" fully, giving Participles, Indicative, Subjunctive and Imperative Moods.

9. Give the French equivalent for: "to give credit," "to do a favour," "to bring good luck," "to be thirsty," "to pay a visit," "to attend" (or "to mind"), "to want," "to take care."

10. Give the French for the following:—

"Are you the governess of this child?" "Yes, I am."
"Are you a governess?" "Yes, I am."
"Are they (Fem.) sick?" "Yes, they are."

11. Give the principal parts of "craindre" and "croire." (Inf. Parts.; 1st person Present Indicative; Past, Historic, Future and Present Subjunctive).

12. Complete the sentences below:—

(*a*) Il faut que . . . . . .

(*b*) Il est temps que . . . . . .

(*c*) Il est certain que . . . . . .

(*d*) Il est probable que . . . . .

13. Express in French directly and indirectly the following:—

He says to his mother that he is sick.

The master asks the pupil if he has done his exercise.

Spanish.

Tuesday, May 13th, 1930. 11.30 a.m. to 1 p.m.

Candidates *must* attempt Question 1, translation of English into Spanish. They may also attempt *five* of the remaining questions and translations. They must not attempt more than *six* altogether.

1. Translate into Spanish:

"The Observance of the Secret."

"A certain minister of a foreign court was so convinced of the importance that pertained to the maintenance of secrecy in his responsible position, that he made a mystery of even the most insignificant affairs. Becoming ill with an ulcer on one of his legs, he sent for a physician in order to be cured of it, insisting that the secret should be guarded most absolutely. Soon after, another ulcer was formed on the other leg; then he called in another physician and entrusted him to cure it without telling him either of the other ulcer or the other doctor who was attending to it, and on this one also he imposed the most rigorous silence. The result was as might be expected, for the two doctors adopted totally opposite treatment, and brought about a rapid and fatal result, the death of the invalid. On the following day, when the minister's lips had been closed for ever, a friend of the deceased, ignorant that he had died, asked his secretary about the invalid's condition; he answered that His Excellency was dead but that his last order had been that no one should know it."

2. Translate into English:

"En el jardin de la Capella Expiatoria."

Debian encontrarse á las cinco de la tarde en el pequeño jardín de la Capella Expiatoria, Julio Desnoyers llegó media hora antes, con la impaciencia del enamorado, que cree adelantar el momento de la cita presentándose con anticipación. Al pasar la verja por el bulevar Haussmann, se dió cuenta repentinamente de que en Paris el mes de Julio pertenece al verano. El curso de las estaciones era para él en aquellos momentos algo embrollado que exigia cálculos. Habían transcurrido cinco meses des de las últimas entrevistas en este 'square' que ofrece a las parejas errantes el refugio de una calma húmeda y fúnebra junto á un bulevar de continuo movimiento y en las inmediaciones de una gran estacíon de ferrocarril."

Les Cuatro jinetes del Apocalipsis.
Vicente Blasco Ibanez.

3. Write out fully the Indicative Present and Imperfect of Haber, Tener, Ser and Estar, with personal pronouns.

4. Name the six grammatical genders of nouns in Spanish: give specimens of each with article agreeing thereto if possible.

5. How are the affixes " on, azo, acho, ote, ona, aza, acha and ota " used? Give instances illustrating their use and the change of meaning in each case.

6. Put the following into Spanish:—

" Have you seen the Spanish painter?"
" Yes, I saw him yesterday."
" How many pencils have you in your hand?"
" I have four blue pencils."
" Is the banker in his office."
" No, he is not in his office but his partner is."
" How is the weather to-day?"
" The weather is very bad; there is a great storm."

7. Give the meanings of the following words:—

abanico, Navidad, avaro, encima, marido, tambor, polvo, estrella, preguntar, buque, águila, silla, bastante, sol, algunos, ventana.

8. Show how to place personal pronouns in the following sentences:—

" The man said to me."
" The dogs followed them."
" The woman saw him."
" Heaven denied them that pleasure."
" Mary gave it to me."
" John came with me."
" Give us money."
" Peter brought her to them."

9. Show how to use relative pronouns in the following sentences: —

"The painters whom you saw and of whom John spoke are very rich."

"She knows what is good."

"She, who has money, has care."

"The man, whose brother is general of the army, found a treasure in the city."

10. Give, in words, the cardinal and ordinal numbers up to twenty.

11. Write out fully the indicative, present, imperfect and perfect definite (historic past) tenses of "amar," "comer" and "vivir."

12. Write out the proper names of the days, months and seasons; also Spanish words for: second, minute, hour, day, week, month, year, and century—giving singular and plural.

13. Translate the following verse: —

"Á medida que decrece
la luz misteriosa y vaga,
todo murmullo se apaga
y el cuadro se desvanece.
Con el abla que aparece
le procesión se evapora,
y mientras la blanca aurora
esparce su lumbre escasa,
a lo lejos silba y pasa,
la rauda locomotora.
Gaspar Nunez de Arce.

Plane Trigonometry and Logarithms.

Tuesday, May 13th, 1930. 2 to 3.30 p.m.

Only six questions may be attempted, four from Plane Trigonometry and two from Logarithms.

Plane Trigonometry.

1. If A, B, C are the angles of a triangle, show that

(*a*) $\sin. A = \sin. (B + C)$
(*b*) $\sin. C = \sin. (A + B)$
(*c*) $\cos. B = -\cos. (A + C)$
(*d*) $\cos. A = -\cos. (B + C)$

2. Solve

$$(a)\ \sin.\ \theta - \operatorname{cosec.}\ \theta + \frac{3}{2} = 0$$

$$(b)\ \operatorname{cosec.}\ \theta - \cot.\ ^2\theta + 1 = 0$$

3. Show by means of diagrams the full algebraical solution of the equation, sin. $\theta = a$.

4. In any triangle ABC, show that

$$\frac{\sin.\ ^2A - m.\ \sin.\ ^2B}{a^2 - mb^2} = \frac{\sin\ ^2C}{c^2}$$

5. From the top of a cliff H feet high the angles of depression of ships at sea in a line with the cliffs are X and B respectively. Show that the distance between the ships is H (cot. B − cot. X)

6. The distance between two mountain peaks is known to be 4,970 yards, and the angle of elevation of one of them when seen from the other is 9°14′. How much higher is the first than the second? (sin. 9°14′ = 0·160455).

7. A and B are two positions on opposite sides of a mountain: C is a point visible from A and B. AC and BC are 10 miles and 8 miles respectively, and the angle BCA is 60°. Find the distance between A and B.

8. Find the angles which a tunnel going through the mountain from A to B in question 7 would make with (1) the horizon, and (2) the line joining A and C, having given that B is one mile higher than A.

Logarithms.

9. Give the definition of the term "Logarithm" and explain why more than one system of logarithms are in use, also what is meant by a "system of logarithms."

10. Show that

$$\log.\ s + \log.\ (s + a) - \log.\ b - \log.\ c = 2\ \log.\ \sqrt{\frac{s\ (s - a)}{bc}}$$

11. Logarithms are in general said to be incommensurable numbers Explain fully what this means.

12. How may a system of logarithms to a given base be transformed into another system with a different base? Given that $\log_{10} 8 = 0{\cdot}9030900$, find the value of $\log._{12} 8$.

Practical Engineering.

Tuesday, May 13th, 1930. 3.30 to 5 p.m

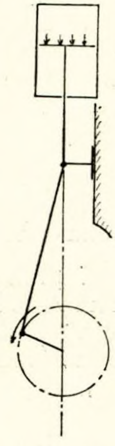
Answer not more than six questions.

1. Describe the apparatus used aboard ship for supplying pure feed water for boilers ; also for drinking.

2. Describe various types of electric lamp. Which type uses least current ? Where would you use each type ? What is meant by candle-power ?

3. Show by sketches what is meant by grooving.

   Under what conditions will this occur at the shell seams of a marine boiler ? How may grooving be prevented or retarded and what would be the result if neglected ?



4. Why are ammonia refrigerating plants seldom used on board ship ? What type is used, and why ?

5. Describe one method of preventing leakage in a steam turbine.

6. Referring to the sketch, it will be seen that steam is acting on the top of piston during the down stroke. What are the stresses in the different parts of the engine ? Reverse the action and with steam underneath state the stresses. Indicate forces on your sketches by means of arrows.

7. A rectangular oil tank is 3·2 ft. by 2·75 ft. and 2·8 ft. deep. The level of oil falls 14 inches in six days. What is the rate of consumption in gallons per day. One cubic foot = $6\frac{1}{4}$ gallons.

8. Describe with the aid of sketches any boiler with which you are familiar.

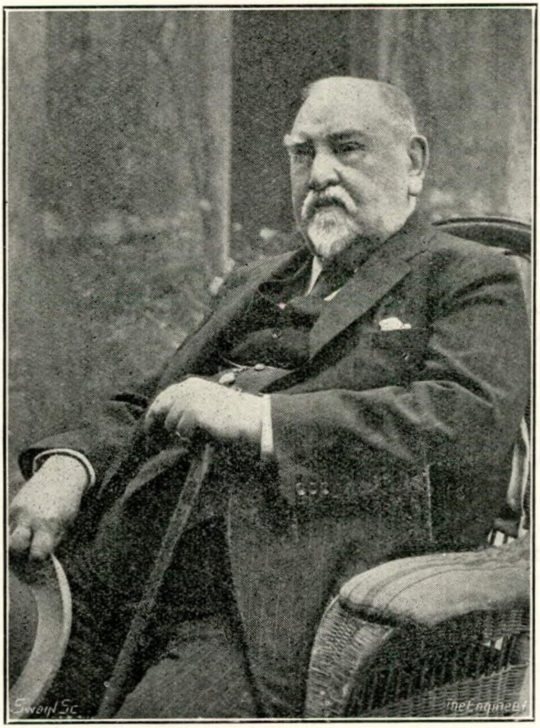
9. Describe with the aid of sketches a repair job of which you have had experience.

10. Explain the uses of a crank, an eccentric and a cam.

ALBERT EDWARD SEATON.

"The Engineer," 15th August, 1930.

It is with great regret that we have to record the death, on Friday last, August 8th, of Mr. A. E. Seaton, who died at his home, Lawn Park, Hemel Hempstead. Mr. Seaton was known throughout the world among marine engineers as the author of "A Manual of Marine Engineering" and other works, and he possessed an intimate personal knowledge of the progress made in marine engineering during more than sixty years.



ALBERT EDWARD SEATON.

Albert Edward Seaton was born at Padstow in 1848 and was the son of a shipowner, Thomas L. Seaton, one of whose ancestors was Captain Scoresby, of Polar exploration fame.

Young Seaton decided to enter the Navy, and he received his early engineering training at Devonport Dockyard and Keyham College, where he spent the years between 1864 and 1868. On leaving Keyham he gained a scholarship at the Royal School of Naval Architecture and Marine Engineering at South Kensington, where he remained for a further two years. The Principal of the School at that time was Dr. W. C. Unwin, and among Seaton's fellow students there were several men who afterwards rose to high places in their profession, one of them being Dr. J. T. Milton, who became the Chief Engineer-Surveyor of Lloyd's Register of Shipping. In 1872 Mr. Seaton gained a Whitworth Scholarship, and for a year he served on the staff of the late Sir E. J. Reed as technical secretary, engineer officer and inspector. In 1873 he left London for Hull, where he took up the position of chief designer in the engineering department of Earle's Shipbuilding and Engineering Company. In 1879 he was appointed engineer-manager of the firm, and became general manager in 1882. From 1885 to 1901 he served the firm in the joint capacity of general manager and director.

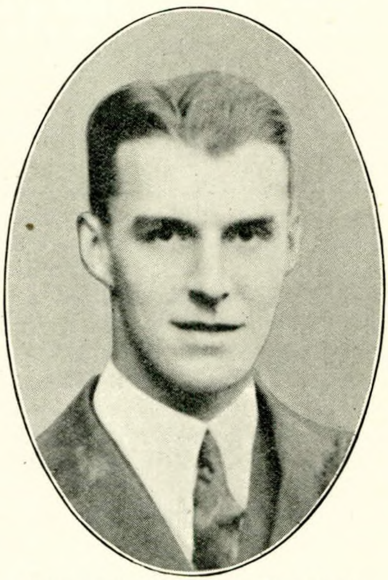
About that time the Admiralty decided to start an engineering course at Greenwich College for the instruction of junior engineers in the Navy, and Mr. Seaton was invited to give a series of lectures on marine engineering practice. The notes of these lectures, often written in the train when travelling between Hull and Greenwich, formed the basis of his first "Manual of Marine Engineering," which book is now in its twentieth edition. In 1902 Mr. Seaton returned to London and began practice as a consulting marine engineer in Victoria Street. About the same time he was elected President of the Iron Trades Employers' Insurance Association, a body which, under his guidance, rose from very small beginnings to a position of considerable importance, and of which he was later made a consulting director. In London Mr. Seaton again identified himself closely with the work of the leading engineering institutions and was a valued member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institute of Marine Engineers. Naturally, his main interest was in marine engineering, and his principal work was done in connection with the two last-named bodies, although in 1904, jointly with Mr. A. Jude, he read a paper on "Impact Tests on the Wrought Steels of Commerce," before the Institution of Mechanical Engineers. He did valuable work on various committees, and almost up to the time of his death he was Chairman of the Consultative Committee of Shipbuilders and Engineers, which was appointed to confer with the Marine Department of the Board of Trade and which dealt with the new instructions for the survey of passenger ships. Another important committee of which Mr. Seaton was the Chairman, was the British Marine Engineering Design and Construction Committee, which formulated rules and standard conditions for the design and construction of marine boilers and shafting. These rules were later adopted by several countries. On the various committees of the British Engineering Standards Association Mr. Seaton's authoritative knowledge of marine engineering problems was greatly appreciated, and he was usually the representative of the Institution of Naval Architects and the Institute of Marine Engineers on such work. He was one of the older members of the Institution of Naval Architects and was a member of Council for many years, being elected a vice-president in 1919. Many of the technical papers which he read at different times bore directly on special aspects of marine engineering work and gave an account of the work done by some of the committees to which reference has been made. For several years Mr. Seaton was closely identified with the work of Lloyd's Register of Shipping, and he was Chairman of the Technical Sub-committee. On the manufacturing side, he was a chairman of Belliss and Morcom Ltd., and a vice-president of the British Electrical and Allied Manufacturers' Association. As a mark of honour he was elected an Honorary Fellow of the North-East Coast Institution of Engineers and Shipbuilders, and also of the Institute of Metals. Among his published works, which were very widely known and appreciated, there was the "Manual of Marine Engineering," already referred to, and the equally well-known "Marine Engineering Rules and Tables" of Seaton and Rounthwaite, besides a treatise on "Screw and other Propellers."

Apart from his very busy professional life, Mr. Seaton found time for further public work as a Justice of the Peace and a member of the Hertfordshire County Council. He had very wide and varied interests and was a recognised authority on many subjects. His charm of personality will be greatly missed by a large circle of personal and business friends.

WILLIAM EDWARD WOODESON.

"Shipbuilding and Shipping Record," 14th August, 1930.

Mr. William Edward Woodeson, a director of Clarke, Chapman and Co., Ltd., Gateshead-on-Tyne, and eldest son of Mr. W. A. Woodeson, chairman of that Company, has died after a long illness in a London nursing home. He was 29 years of age. Though a young man, Mr. Woodeson had made great strides in the engineering world since he commenced with his firm in a junior capacity seven years ago. Clarke, Chapman and Co. have pioneered in this country pulverised-fuel installations for both marine and land work, and it was to pow-



THE LATE MR. W. E. WOODESON.

dered fuel and its possibilities that Mr. Woodeson had devoted a great deal of thought and work. On this method he was an authority, though so young a man with few equals in the country. He took the first British ship to sea fitted with pulverised-fuel plant. It was with a paper on this subject, read before the Liverpool Engineering Society in 1928, that he won Lord Derby's gold medal for the best paper of the year. His investigations and research work upon both steam and electrical ships' auxiliary machinery had resulted in some of the latest improvements to this class of plant. On Tyneside he was regarded as one of the foremost of the younger generation of electrical engineers. He was a member of the North-East Coast Institution of Engineers and Shipbuilders, the Institute of Marine Engineers*, and other bodies. Mr. Woodeson was a native of Gateshead, and after completing his education at Oundle School, Northants, served his apprenticeship at the Neptune Works of Swan, Hunter and Wigham Richardson Ltd. Subsequently he took his B.Sc. degree at Durham University in 1921-22. After engineering experience in France, he commenced with Clarke, Chapman and Co. There he made rapid progress. He was appointed departmental manager after serving some years, and later general manager, and finally, last year, was elected a director.

**Members will recall the spirited debate between the late Mr. W. E. Woodeson, jun., and Mr. J. S. Gander on "The Relative Merits of Pulverised Fuel and Mechanical Stoking, and their Application for Marine Purposes," which took place at the Institute on April 9th,* 1929, *and was published in the Transactions for June,* 1929.—*Ed. Transactions.*

SHIPBUILDING IN AMERICA.

American "Motorship," August, 1930.

Motor passenger liners under construction throughout the world at the present time total 24, and their aggregate tonnage is 335,100 gross tons. Similar vessels in operation total 58, and their aggregate tonnage is 854,940 gross tons. When the motorships under construction are completed there will be in service 82 passenger motorliners totalling 1,190,000 gross tons. In order to make it quite clear that we do not include vessels of moderate dimensions, when we mention "passenger motorliners" we hasten to explain that reference is made to nothing but ships of more than 9,000 tons gross with accommodation for more than 100 passengers. This automatically shuts out all American motorships, notably the Grace Line's *Santa Barbara* and *Santa Maria* and the American South African Line's *City of New York*, all of which have been looked upon as rather extraordinary passenger motorships.

Evidently someone is making a sad mistake in the choice of power for ships. It is either the United States or the rest of the world. What reason is there to believe that the rest of the world is wrong? In the years before the war we gained comparatively little practical knowledge of ship construction and marine machinery development.—In our frantic effort to produce a huge merchant fleet during the war it was necessary to install machinery that we knew how to build. At the close of the war our shipbuilding stopped and the development of marine machinery almost ceased. Since then we have devoted our attention to " sending the central power station to sea."

There is no denying the progress which has been made in adapting land power plant practice to marine service. American engineers have so impressed the world with their work that some of the other nations have cautiously followed their example, but in the big majority of instances they find their own methods more satisfactory. How true that is may best be shown with Lloyd's latest returns which state that 63 per cent. of the world tonnage under construction is motorships, and if we exclude American figures the percentage is 75 of motor and 25 of steam.

Other countries of the world were active shipbuilders and operators before the war. During the war they—except Germany—continued active but seemingly made no more engineering progress than this country. The post-war period, however, has been different. For almost ten years the United States remained a wall flower, a very indifferent observer and by no means a shipbuilder. Other countries started building ships right after the war. First they did as we are doing; they built steamships and experimented with a few motorships. They gradually increased the percentage of motorships and decreased that of steamships until the present 25-75 steam-motor figure was produced. Although experience has taught them that the Diesel is superior, they still have the courage to continue the steam experiment so that no bet may be overlooked.

The American shipowner and particularly the Government which is a heavy stockholder in shipping, is putting all of his eggs in one basket. It is a dangerous procedure because the margin of the profit in ship operation is very small and failures may occur if the most economical and efficient type of machinery is not employed. In the event of such failure it would become necessary that the Government take possession of the ships in order to protect its heavy loans. The ships would be sold again, of course, at a tremendous loss and the new owner would have cheap vessels which he could operate at a profit because of their cheapness, just as many owners of former Shipping Board vessels now make a profit with ships cheaply purchased.

THE PLIMSOLL MARK.

American "Motorship," August, 1930.

The nineteenth century reformist enthusiasms of Samuel Plimsoll achieved another triumph when on July 12th, the representatives of the maritime nations signed at London the first international load-line convention. The American Act requiring that load lines be carried on all ocean-going ships out of American ports will take effect next September, and the Plimsoll mark—the familiar barred circle with its accompanying ladder-like series of lines painted upon the side of a ship to indicate the depth below which she must not be loaded—will become a legally required decoration on all American vessels in the ocean trades. Most of the other maritime nations already have such laws, but each has been free to make its own rules for determining the positions at which the marks are placed for the various types of vessels and services. If the present convention is ratified a uniform rule will be established for all vessels of all nations laid down after July 1st, 1932.

The published summary indicates that the convention rules will differ only in detail from most of those now in force, which are generally based upon the rules worked out through long experience by the British Board of Trade. Our American Bureau of Shipping has used not only the Board of Trade rules but the identical form of the British Plimsoll mark. Countless travellers have seen it; not all of them, perhaps, have realised its esoteric significance. The top edge of the bar which passes through the centre of the twelve inch circle is the load line. The permitted depths vary, however, with the service in which the ship is engaged, and these are indicated by the five horizontal lines beside the load line. The lowest, marked "WNA," indicates the maximum the ship is allowed when loading for a winter passage of the North Atlantic; the next, "W," is the mark for winter passages elsewhere; the third from the bottom, "S," is the mark for summer service and is level with the load line proper; above that there is a fourth mark, "Is," indicating the greater depth permitted to vessels navigating the Indian Ocean in summer.

The fifth and uppermost horizontal line is marked "FW," and indicates the depth to which a ship loading in fresh water for a sea voyage can be brought in order that she will rise to the true mark when she reaches the heavier salt water of the ocean. To a layman the difference between the marks would seem, compared to the great bulk of the ship which carries them, so small as to be negligible. But their value has been proved by bitter experience in North Atlantic ice and gales or in calmer waters elsewhere, and in adopting them the nations have paid their tribute to Mr. Plimsoll. Yet there is a touch of irony in it. Plimsoll was neither a shipping man nor a seafarer; he was fired by the passion of a social reformer, and his aim was to save the lives of seamen sent to sea in overloaded ships by owners desirous of collecting the insurance. Shipping interests fought him bitterly, only to learn when he had beaten them that his reform was all to their own advantage. Plimsoll's mark has probably done much more to save ships and cargoes than to save life; but at all events he has left it permanently upon the tall sides of the ocean-borne tonnage of the world.

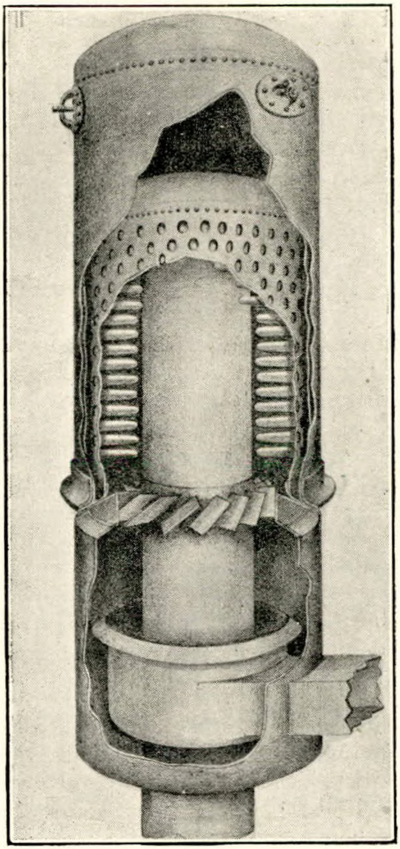
EXHAUST-GAS BOILERS COMBINED WITH SPARK ARRESTORS.

"The Motorship," September, 1930.

One of the most interesting of the many recent developments with exhaust-gas boilers is the combination of the Clarkson plant of this type with a Vortex spark arrestor, such as is being fitted on some of the large new tankers which have recently been ordered in this country and abroad for the Standard Oil Co.

The sketch shows the principle of operation of this boiler. The centre tube is the continuation of the engine exhaust pipe which conveys the gases to the top of the inner shell, after which they pass downwards among the thimble tubes to the guide vanes of the spark arrestor, where the gases are centrifuged and the sparks and dust are thrown to the outer casing of the arrestor, allowing the clean gas to pass down the inner hopper and thence out to atmosphere. Several inspection doors are arranged at the lowest point of the spark arrestor, these being provided for cleaning purposes.

Six of these boilers will be fitted on three of the Standard Oil Co.'s tankers ordered by the owners some time ago, each having two two-stroke engines of 2,500 B.H.P. each. The other three ships will have the Clarkson contra-flow boiler, arranged without the spark arrestor, as one of a German make is being supplied and fitted into the funnel. The *Calgarolite*, to which the new ships are similar, was the first tanker to have silencer boilers fitted to the exclusion of ordinary silencers. This installation has proved successful and the vessels now building will also have silencer boilers only, and being of the contra-flow type they can be run wet or dry according to requirements without detrimental results.



The combined boiler and spark arrestor has a diameter of 5ft., with a height of 5ft. 6in., plus 5ft. 3in. for the combined spark arrestor and exhaust-gas inlet and outlet box. Each boiler is designed to generate 800 lb. to 850 lb. of steam per hour, with an exhaust-gas temperature of not less than 500° F., this being about a normal figure for two-stroke machinery.

It is of particular interest that these boilers are being fitted in ships equipped with propelling machinery of the two-stroke single-acting type, where the exhaust gas temperatures are moderate compared with those of four-stroke motors. In fact, it is now becoming almost as common to use exhaust-gas boilers on two-stroke-engined vessels as on ships in which the four-stroke type is utilized.

THE "SIR JAMES CLARK ROSS." Completion of the Largest Motor Parent Ship for Whalers. A 20,300 ton Whale-oil Tanker with Elaborate Factory Equipment. Twin-screw Airless-injection Burmeister and Wain Machinery of 4,600 i.h.p.

"The Motorship," September, 1930.

Completed last month, the whaling tanker *Sir James Clark Ross* has attracted as much attention as any ship, apart from big passengers liners, placed in service this year. She is the largest vessel of any type hitherto launched from the Tees. Considering her remarkable capacity—the ship carries over 20,000 tons of whale oil, including the most elaborate factory equipment—a record has, it is believed, been established in the time occupied over her design and completion. Further, she is equipped with twin-screw four-stroke airless-injection propelling machinery, which drives the ship at full speed from Norway to the Antarctic and back, her yearly period of service extending for 11 months, eight months being spent in attendance on half a dozen whalers. She leaves her home port as a 20,000 ton tanker and returns as a 20,000 ton whale-oil carrier.

The *Sir James Clark Ross* has accommodation for 225 persons, including whalers' crews and factory staff. She has a length of 550ft., the breadth being 74ft. $3\frac{1}{2}$ins. and the depth 48ft. 9ins. When fully loaded the draught is 28ft. Allowing two per cent. deduction, the dead-weight capacity is 20,301 tons, and the fuel bunkers carry 1,750 tons. The vessel will proceed out and home at a speed of 11 knots, but while the season's whale catching is in progress she will be required to maintain much lower speeds, and there is a specified minimum rate of revolutions for the machinery, viz., 45 per minute, the normal full speed being 125 revolutions per minute. The engines are of the six-cylinder type with a diameter of 630 mm. and a stroke of 1,300 mm., the total output being 4,600 i.h.p.

The Whale-oil Factory.

Each whale, weighing, perhaps, from 70 tons to 100 tons, is hauled on to the upper or cleansing deck through a skidway in the stern. Then it ceases to remain a whale. The skidway is clearly shown in the illustration. It is about 18ft. wide and 15ft. deep at the opening. The cleansing deck, where the whales are handled intact, is comparatively free from obstructions, as another view indicates.

Basin trials with the starboard engine.

Efforts are concentrated on obtaining the maximum quantity of whale oil. One power-driven bone saw is arranged on the starboard side aft, while forward are three more, the port and starboard saws forward facing each other. The saws are carried in reciprocating frames, one of which is illustrated separately. About 90 per cent. of the whale oil produced is effectively dealt with by the boilers on the factory deck below, and the remaining 10 per cent. is passed through a large battery of centrifugal purifiers.

These purifiers are arranged in a compartment on the starboard side of the cleansing deck. Seven machines are installed, specially constructed for the purpose, the rated hourly capacity being five tons apiece. They deal principally with any water remaining in the oil. Below the factory deck are the main tanks, which, as the fuel is used therefrom, are cleaned out for the reception of the liquid cargo.

Searchlights are fitted on the wings of the bridge, and there are seven flood-lights on the cleansing deck of 1,500 c.p. capacity. A wireless direction finder is provided. Wireless communication can be continuously maintained between Norway and the Antarctic, a 3 kw. long-range set being installed of the Norske-Marconi type. Moreover, there is a Sperry gyro-compass with repeaters on the bridge and in the wheelhouse. Thrige all-electric steering gear is fitted, the motor, of 29 h.p., being direct coupled and working through contactors arranged in the engine-room. Space for an aeroplane, to be used for sighting whales, is provided on the forecastle.

Steam is used for many important purposes, and an illustration appears of the two 40 ton steam winches which haul each whale up the skidway. Adjacent are eight smaller winches. Two more are located on a platform at the forward end of the boat deck. Forward of the cleansing deck are two 5-ton winches and centrally arranged a 10-ton winch.

The Boilers and Conveyor Gear.

Four main boilers supply the steam; each is 12ft. 3in. long and 13ft. 9ins. in diameter. The total heating surface is about 10,000 sq. ft. On the boiler flat are located two Engisch evaporators, with a total capacity of 150 tons. These supply steam to the factory and replenish the quantity lost when the refuse is blown out. The main distilling plant has a capacity of 150 tons per 20 hours. In the engine-room there are two high-speed rotary pumps, each driven by a 5 h.p. motor. These pumps are located alongside the Diesel-engined generators and their duty is to take the condensate from the evaporators and return it to the main boilers.

A long line of special boilers extends from forward to aft on the factory deck. These boilers are partly of the horizontal type and partly vertical. Conveyors run in opposite directions and meet at a central point, both port and starboard. The refuse is discharged from the boilers on to the conveyors, and when it reaches the central point it falls on a discharge apparatus turning at right angles to the conveyors and passing the refuse overboard. It will be seen, therefore, that on each side of the ship on the factory deck the discharging gear forms three units, the refuse travelling from forward to aft, from aft to forward, meeting at the central point, and finally falling over the side.

Driving Gear for the Factory.

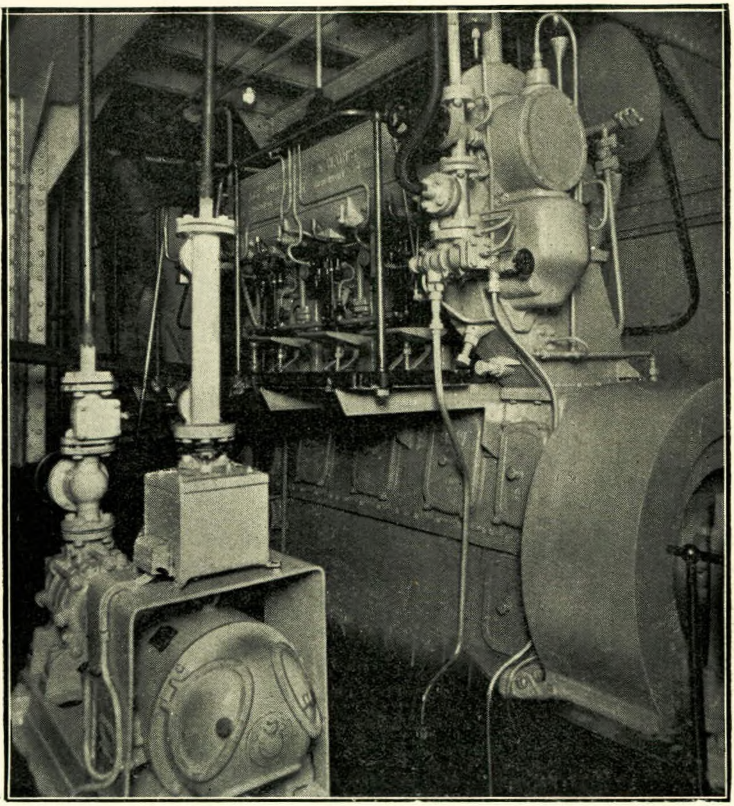
Much of the apparatus in the factory requires a mechanical form of drive, the horizontal boilers and their accessories having circulating arrangements, clearly shown in one or two of the illustrations. Several lengths of shafting are disposed in suitable positions and practically all of the equipment has a belt drive. For example, the buckets for the overboard conveyors are operated by Allen steam engines, each running at 400 r.p.m., but off the same shafting are taken other drives for various purposes. The whole layout, in fact, savours much more of a factory than a ship, and a fully equipped workshop is provided, entirely apart from the workshop in connection with the main and auxiliary engines.

In the factory workshop is a 20 h.p. electric motor supplying the drive for the different machines, whereas the engine-room workshop machinery is driven by a 5 h.p. motor. This indicates the difference in the size of the two shops. The engine-room workshop is provided with a lathe, a shaping machine, a drilling machine and a grinder. There are four whale-oil transfer pumps at each end of the factory deck. Apparently only six of the pumps are normally in use, as at the time of our inspection one pump in each set was blanked off.

Current is supplied by two airless-injection Burmeister and Wain engines located at the forward end of the main engine-room. An illustration shows one of these engines; the fuel pumps are vertically arranged below the camshaft—a design which differs entirely from that of the main engine. Each auxiliary unit drives an air compressor of the three-stage type for charging the starting-air bottles, the pressure being 25 kg. per sq. cm., or about 355 lb. per sq. in. The three working cylinders have a bore of 310 mm., the stroke being 350 mm., and the speed of rotation 400 r.p.m. Thrige dynamos are installed, each supplying 100 kw. at 220 volts. As a reserve there is a 44 h.p. steam-engine-driven dynamo running at 500 r.p.m.

The Main Engines.

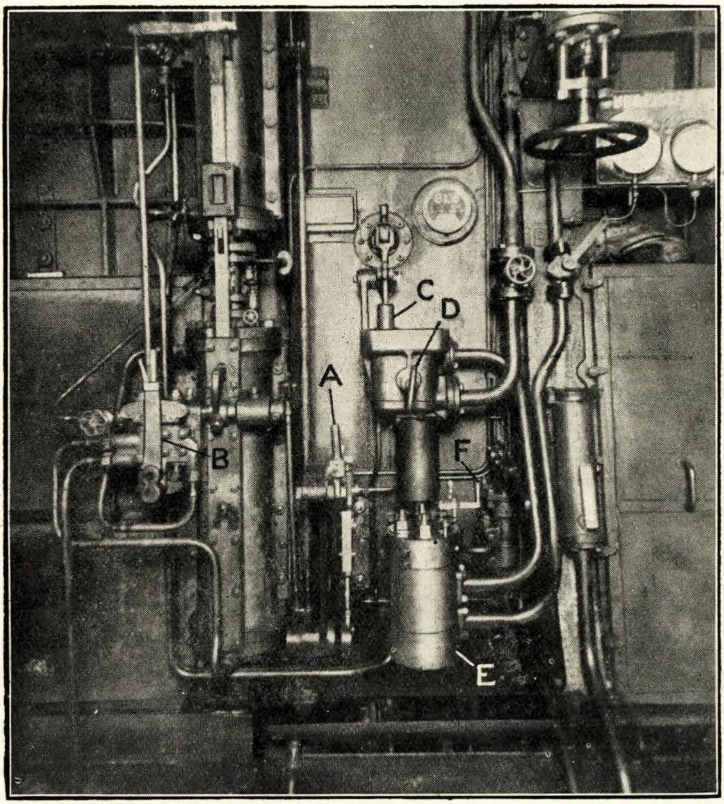
With the airless-injection design there are, of course, no fuel-valve cams. The usual inlet, exhaust and starting valves are provided and the reversing mechanism follows standard B. and W. practice.



One of the airless-injection auxiliary engines.

An unusual appearance is given by locating these fuel pumps at the top of the engine, in comparison with the usual air injection design, the circular steel expansion boxes being a noteworthy feature. Surplus fuel is returned to a settling tank. Small levers are arranged on the left of the pumps in the illustration above. These levers are coupled to the manœuvring lever at the control station. They alter both the quantity of fuel and the time of injection.

The usual lever is provided for starting the engine on air, passing over to fuel and subsequently regulating the speed.



A control station view.

A lever on the left is for the servo-motor control, moving the camshaft fore and aft for ahead or astern and clearing the rollers from the shaft while the motion is being effected. There is a pump for raising a slight pressure on the suction system of the fuel pumps, which take fuel at about 20 lb. to 30 lb. per sq. in., whilst a priming pump is operated by a handle. Below is a circular steel box. This houses a set of fuel strainers, which may be changed over if necessary by means of a lever.

Although the auxiliary plant below is partly steam driven, when the vessel is under way this machinery may be entirely electrical in the method of drive.

On the trial trip the maximum speed attained was 11·92 knots at 133 r.p.m., while the mean speed was 11·26 knots at 132 r.p.m. The ship was in full laden condition.

It will be a source of satisfaction to the owners and builders alike that she has been placed in service with unusual promptitude, and although the ship represents a big proposition from many points of view, we believe that there are not the least doubts entertained of her success.

WHEN AND WHAT TO BUILD.

"The Motorship," September, 1930.

It is usually when the present phase of a depression is reached (namely, after about a year of poor trade) that the shipowner remarks the depression is the worst or one of the worst that he has experienced during his connection with shipping, and that the shipbuilder states the present time is the most advantageous possible for ordering vessels, because all shipbuilders are hungry for work and are quoting lower prices than will be available directly the shadow of depression begins to lift.

Such comments have, in fact, in practically these words, recently been made in various directions and we do not intend any irony in associating them. For they are both—each in its way—correct and the shipowner whose resources are large and whose vision and experience are considerable, would agree, at least in principle, with the shipbuilder. But as each depression comes, we are inclined to consider it as based upon different foundations from the last and possibly to forget the experience of previous difficult periods over which we have tided, as we shall emerge from the difficulties with which we are now surrounded.

The proof of the shipbuilder's point of view scarcely needs emphasizing, and indeed some of the most successful shipping businesses have been built up by those owners who have been able to build tonnage during periods of the deepest depression. Such few orders as have been placed during the past month or two have been at prices which will certainly not be repeated. The contracts for the propelling machinery of some of these ships have been made at figures which are extraordinarily low, and already many builders are refusing to approach them, preferring to wait until owners will offer better terms.

The time for this will probably not be far distant, and it is the invariable experience that when a few contracts are placed by owners with greater temerity than their competitors, the others follow until ultimately prices reach a figure above that which the average shipowner will pay. Consequently some owners miss the right period for ordering and suffer very considerable loss.

Considering only the position in this country, during the past eight months, and excluding the large Cunard liner, the tonnage ordered has probably not exceeded 200,000 tons. A normal figure would be 600,000 to 800,000 tons, merely for replacement of existing ships, apart from any question of actual increase in tonnage. It is clear, therefore, that if an efficient mercantile fleet is to be maintained, we are already several hundred thousand tons behind the normal level which must, sooner or later, be made up, in addition to the other orders that must follow to account for obsolescence of existing tonnage.

An example of contracting for many new ships at a period when it is considered that prices are lowest was afforded last month in the new tankers for the Standard Oil Co., which were certainly placed at figures much below those which will be current when delivery is taken, and it is significant that some of the ships will not be completed for a period of nearly three years.

After a slump such as that through which we are now passing it often happens that conditions of shipping become modified and new policies have to be developed. It will probably be found that the tendency which has been growing during the past year or two, for the cargo liner to displace the tramp, will become even more pronounced, and we are unlikely to witness a somewhat extravagant contracting for cheap but uneconomical steam-driven tramp ships such as occurred a few years ago after a severe shipbuilding slump. The 12 to 14 knot motor cargo liner is likely to prove a more popular type. At the present time over 60 per cent. of the ships of this speed now on the stocks is for foreign ownership, and if it represents a class of tonnage which will appeal to shippers at the expense of slower ships, it is imperative that a larger proportion of fast vessels be ordered by British owners.

AN ACTIVE MONTH.

"The Motorship," September, 1930.

Were it not that every ship completed leaves a blank which the builder finds it difficult to fill, recent activity would be more than encouraging. Last month, more motor vessels were commissioned from British shipyards than has ever previously been the case, numbering 14 of 90,000 tons gross. Abroad, there were 9, giving a total of 23 for the world, of 150,000 tons gross. Of these ships, tankers numbered 13 of 102,000 tons gross, 9 of 67,000 tons gross being built in British yards. Eight of the 14 British-built vessels were, however, for foreign owners.

When it is recorded that 14 motorships of 160,000 tons gross were ordered during the month, it would appear that the motor shipbuilding position is satisfactory since the tonnage to be laid down is larger than that turned out. This is indeed the case, but the remark does not apply to the United Kingdom, where orders have been completely absent, for all the ships in question are to be built in foreign yards.

Against this moderately large tonnage of motorship contracts, the number of steamers ordered is neglible, since only one or two vessels appear to have been contracted for either by British or foreign owners. From present indications it would seem that when a revival occurs in the demand for cargo and passenger tonnage, motor vessels will have an even greater preference than was the case before.

THE PRICE OF TANKERS—AND THE AMERICAN SHIPPING SITUATION.

"The Motorship," September, 1930.

The bulk of the orders for motor tankers placed with European yards during the past nine months has been contracted at a price varying from £14 10s. to £15 10s. per ton deadweight for vessels between 9,000 tons and 16,000 tons d.w.c. It is understood that the contracts for the nine large tankers which were ordered by the Standard Oil Co., last month were given at a slightly higher rate, but their speed is somewhat above the normal—namely, 12 knots. In America the corresponding figure is in the neighbourhood of £26 per ton deadweight for ships of equal specification to those built in Europe.

The enormous saving which the owners effect by building in Europe is apparent, for the difference is approximately £10 per ton deadweight, or £1,458,000 for the nine ships. Had the vessels been constructed in America, therefore, it would have been necessary to debit them with annual standing charges for interest, depreciation and insurance (say 15 per cent. on capital cost) to the extent of £220,000 more than will be the case in the existing circumstances.

It is thus not difficult to understand why American owners cannot profitably run American-built ships in competition with those constructed in foreign yards, nor why they demand subsidies from the Government if they place their orders with home yards. There is no indication of shipping being an economically self-supporting profitable business in the United States and that it must continue indefinitely to be assisted by the State. In other words, it must live to a certain extent upon other industries, and possibly the widespread industrial depression now being experienced in America may cause a halt to be called to the further projected subsidisation of the United States mercantile marine.

THE UNIVERSAL ENGINE.

"The Motorship," September, 1930.

On the occasion of the launch of a motorship last month, Mr. Lawrence Holt again referred to a subject which he and Mr. Sterry Freeman have both previously brought forward He suggested the desirability of builders of oil engines pooling their resources with a view to the production of a common engine embodying the advantages of all the numerous types now produced.

But as each month passes the possibility of such an ideal seems to become more remote. In this issue are given descriptions of two new engines, neither of which has yet been installed in a ship, but which will undoubtedly be built to a considerable extent for this purpose. It is true that from time to time Diesel motors, which have been developed on a substantial scale, have subsequently been discarded; but the number is small in comparison with the new types that are brought forward and there are now more marine oil engines of various designs on the market than was the case a few years ago.

The probability is that whilst there will now be a slowing down in the production of entirely new models, the existing types will continue to be the subject of improvement and that the actual number of different classes of motor will not diminish—at any rate, until a considerable period has elapsed.

THE MARCH OF AIRLESS INJECTION.

"The Motorship," September, 1930.

It appears that nothing will stop the rapid adoption of airless injection for Diesel machinery. Already, probably 50 per cent. of the motor tonnage now being built will be fitted with compressorless machinery and in this issue we record the adoption of airless injection with two types of engines that have previously been manufactured as a blast-injection design. The first is a Sulzer motor, of which a description is given, and the second the Fiat engines ordered for some of the Standard Oil Co.'s tankers.

Both of these classes of motor are of the two-stroke type, and it may now be stated that the majority of the leading Diesel engine manufacturers of the world are standardising airless-injection engines, for the most part building them in larger quantities than those of the blast-injection type. This is a position which could scarcely have been visualised in the past, when most builders were opposed to airless-injection engines.

This change of opinion is largely due to the continued success achieved by the one or two Diesel engine manufacturers who staked their reputation and business life success upon airless-injection machinery. At first it was considered that such plant would not prove so satisfactory as engines with blast-air injection, but experience has shown this idea to be fallacious. The result was, naturally, that shipowners ultimately demanded the adoption of similar principles by other builders.

THE CONVERSION OF THE S.S. "INCEMORE." The Todd System of Pulverised Coal-firing with a New Type of Pulveriser, installed in a Furness-Withy Vessel.

"The Shipbuilder," September, 1930.

The Todd system of pulverised coal-firing is now well known, particularly the installation in the steamship *West Alsek*. A further advance has now been made by the employment of an entirely new type of pulveriser, which has been fitted for the first time in a British ship—the steamship *Incemore*, owned by the Johnston Line, Ltd., of Messrs. Furness, Withy and Co., Ltd. Through the courtesy of the owners and of Mr. W. E. Keller, the London representative of the Todd Dry Dock, Engineering and Repair Corporation (a subsidiary of the Todd Shipyards Corporation, of New York), who has supervised the installation of the equipment, we were able to inspect the plant under running conditions at her berth in the East India Dock. The conversion has been carried out by Messrs. R. & H. Green and Silley Weir, Ltd., of Blackwall.

The *Incemore* is a single-screw vessel having a gross tonnage of 4,098, and the following are her moulded dimensions:—

Length	359ft. 7in.
Breadth	51ft. 9in.
Depth	26ft. 9in.

The triple-expansion engine has cylinder diameters of 26, 43 and 73in., and a piston stroke of 48in., and the maximum indicated horse-power developed is 2,750. There are three cylindrical boilers, each having three furnaces. Table I gives the capacity of the bunkers, based on a rate of 45 cu. ft. per ton.

Table I.

	Before Conversion.	After Conversion.
Cross bunker	125	
Coal trunks	14	
Coal bin		40
Lower 'tween decks	310	276
Bridge 'tween decks (port)... ...	269	269
Bridge 'tween decks (starboard) ...	212	212
Total (tons)	930	797

In addition, after conversion, there is a cross-bunker reserve, which may be hand-hoisted when necessary, of 68 tons.

The Conversion.

The arrangement of the pulversing machinery in the *Incemore* is shown in Fig. 1, which gives a view looking to port. The constructional alterations to the vessel necessary for the installation consisted chiefly of partially dismantling the watertight bulkhead at the forward end of the stokehold and re-erecting it five frames further forward, the new bulkhead being carried to the main deck. As the ship was fitted with two deep tanks at the port and starboard sides immediately forward of the stokehold, it was only necessary to fit fore-and-aft bulkheads between the lower and upper 'tween decks in order to complete the watertight division to classification requirements. The space thus allowed for installing the pulverisers was 15ft. by 11ft., and this has proved ample.

The space immediately above this recess, extending to the upper 'tween deck, has formed a bin for crushed coal, from which the pulverisers are fed. A recess has been built into this daily-supply bin, on the deck of which has been placed a primary crusher, illustrated in the "bird's eye" view in Fig. 2. The daily supply bin is fed by coal from the upper and lower 'tween decks through four $\frac{7}{8}$in. mesh grizzlies; and a 6in. mesh grizzly has been fitted for feeding run-of-mine coal to the crusher, which discharges to the lower part of the daily-supply bin. No elevators or screw conveyors have been fitted, as the position of the ship's bunkers has made it possible, with this arrangement, to dispense with their use.

The Burners and Furnace Fronts.

In the view of the stokehold reproduced in Fig. 3, it will be seen that the original Howden furnace fronts have been adapted to take the pulverised coal-burners, and that each burner is equipped with a pilot oil burner. The oil burner has been designed to burn heavy fuel oil, and is required when starting up the boilers in order to raise the necessary pressure of steam for the turbines driving the crusher and pulverisers. It is possible to fire the boilers entirely or partially with oil, and no changes are required for the oil-firing operation. Under certain operating conditions, such as in port, where the steam requirements do not justify the running of the pulveriser, the oil-burner can be economically cut in. The pulverised coal-burner is of the standard Todd design.

The secondary air is provided by the Howden system previously existing, and the control is effected with the regular Howden checks in the usual manner.

It will be seen from Fig. 3 that the flexible metal pipes conveying the coal from the pulverisers to the burners are raised high enough to allow a perfectly clear stokehold. The pipes have a diameter of 4in.

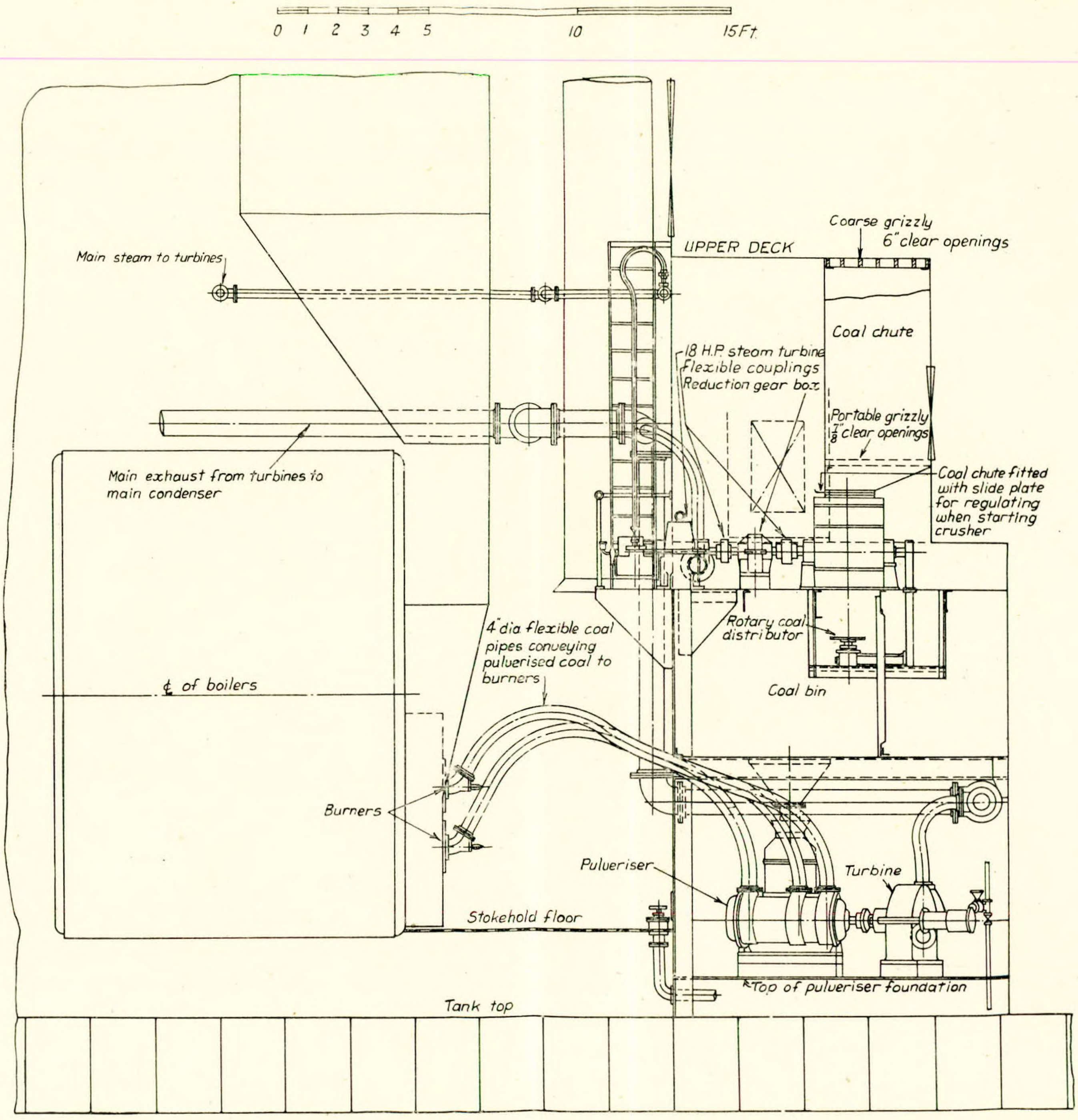


Fig. 1.—Arrangement of Pulverising Machinery in the "Incemore." View looking to Port.

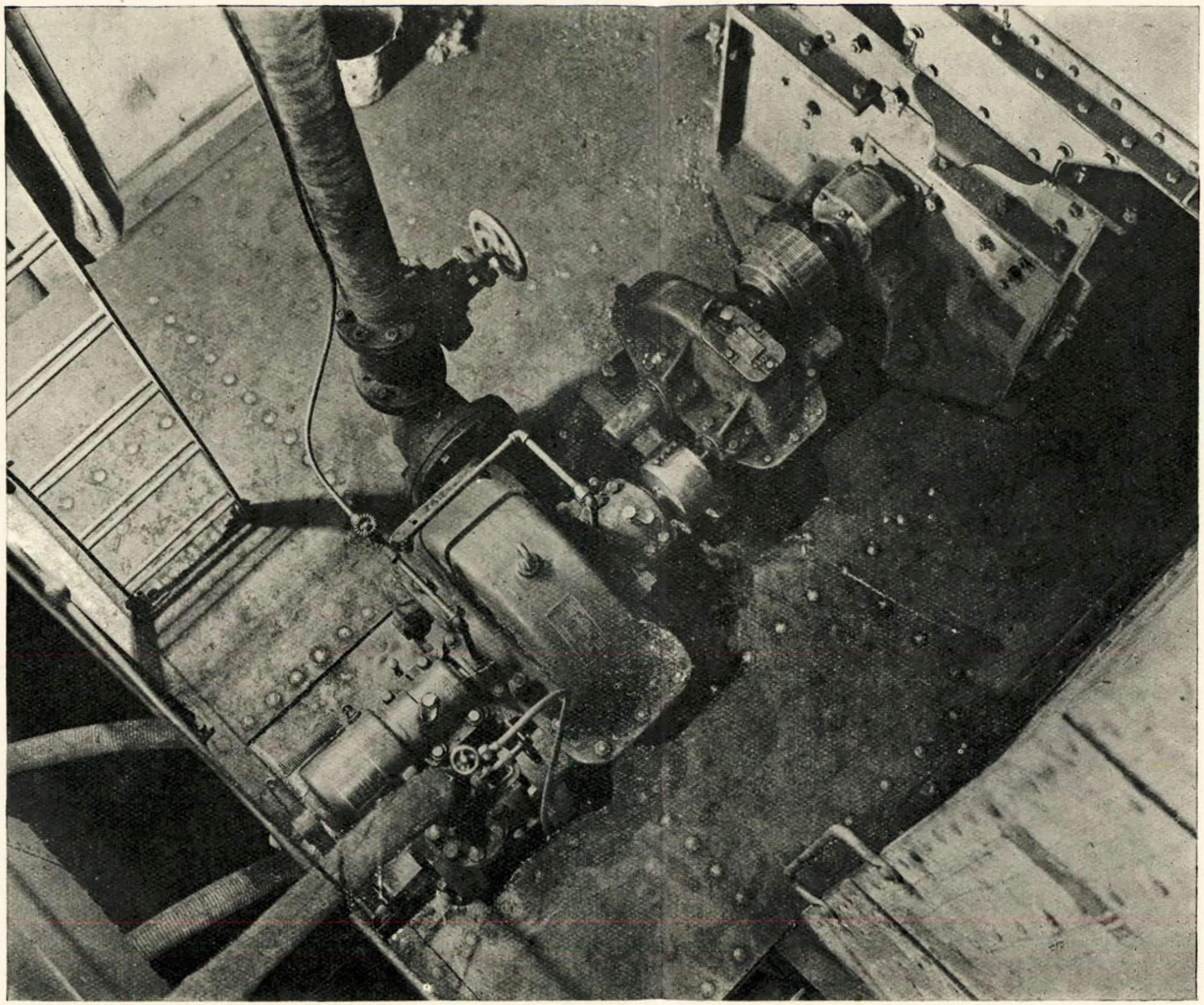


Fig. 2.—The Primary Crusher, driven by Steam Turbine through Reduction Gearing.

The Crusher.

The primary crusher required for crushing run-of-mine coal to a size which the pulverisers can handle has already been referred to. It is illustrated in Fig. 2, and is of the rotary

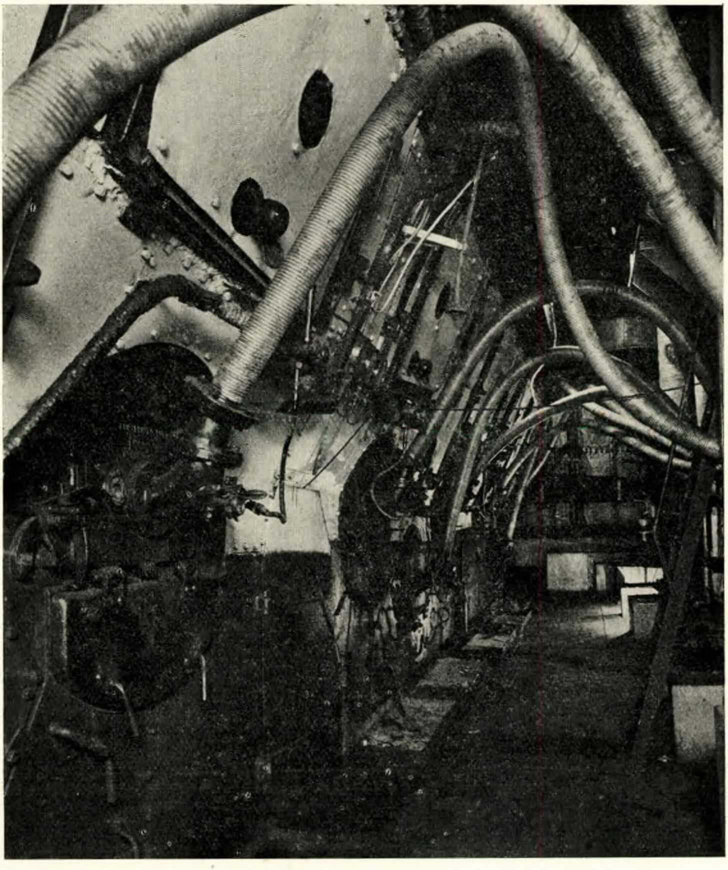


Fig. 3.—The Stokehold.

type having a maximum capacity of 10 tons per hour, and driven through enclosed herringbone reducing gears by a 15 h.p. steam turbine, supplied by the More Steam Turbine Corporation, of New York. The couplings between the turbine and the gearbox, and between the gearbox and the crusher, are of the flexible type, to allow for misalignment; and the crusher is equipped with a centrifugal tramp-iron throw-out pocket, which separates any iron which may be in the coal, and deposits it on the floor.

The New Triplex Pulverisers.

In the *West Alsek* and other vessels, one pulveriser was supplied for each burner; and in order to reduce the space taken up by these units, duplex and triplex pulverisers have been designed. Where the boilers have three furnaces, as in the *Incemore*, the triplex type is used; and in this vessel there are three such pulverisers, situated on the level of the stokehold floor. The design of the new unit is illustrated in Fig 4. It will be seen that it consists of three pulverisers in one casing, and that each pulveriser is of the two-stage type.

The unit pulveriser consists of two sets of paddles and a fan, mounted upon a common shaft, and encased in a housing so divided that the coal entering the pulveriser is diverted to the axis of the first set of paddles. The coal is then picked up by the paddles and is whirled out to the periphery, where it is subjected to abrasion against the paddles and the casing, resulting in the reduction of the coal to a powder. The exit from the first stage is also at the axis; and only the finer fractions of the coal, by virtue of their greatly reduced weight, are able to float upon the air stream induced by the fan, and so oppose the centrifugal force which tends to keep the coal at the periphery.

From the first stage the powdered coal passes to the second set of paddles. In this stage the conditions are similar, and the coal is still further reduced in size by the second treatment. The exit from the second stage is also at the axis of the paddles; and again only the superfine fractions are able to ride the air stream, leaving the heavier particles in the beating zone until they are reduced fine enough to float in the air current. Here the air and coal enter the fan, and sufficient velocity is imparted to carry the mixture through the flexible metallic hose to the burners.

The new triplex pulveriser is merely a repetition of this unit mounted on a common shaft and housed in the same casing. Two bearings only are employed, and the pulveriser is driven through a flexible coupling by a 30 h.p. steam turbine of a type similar to that driving the primary crusher.

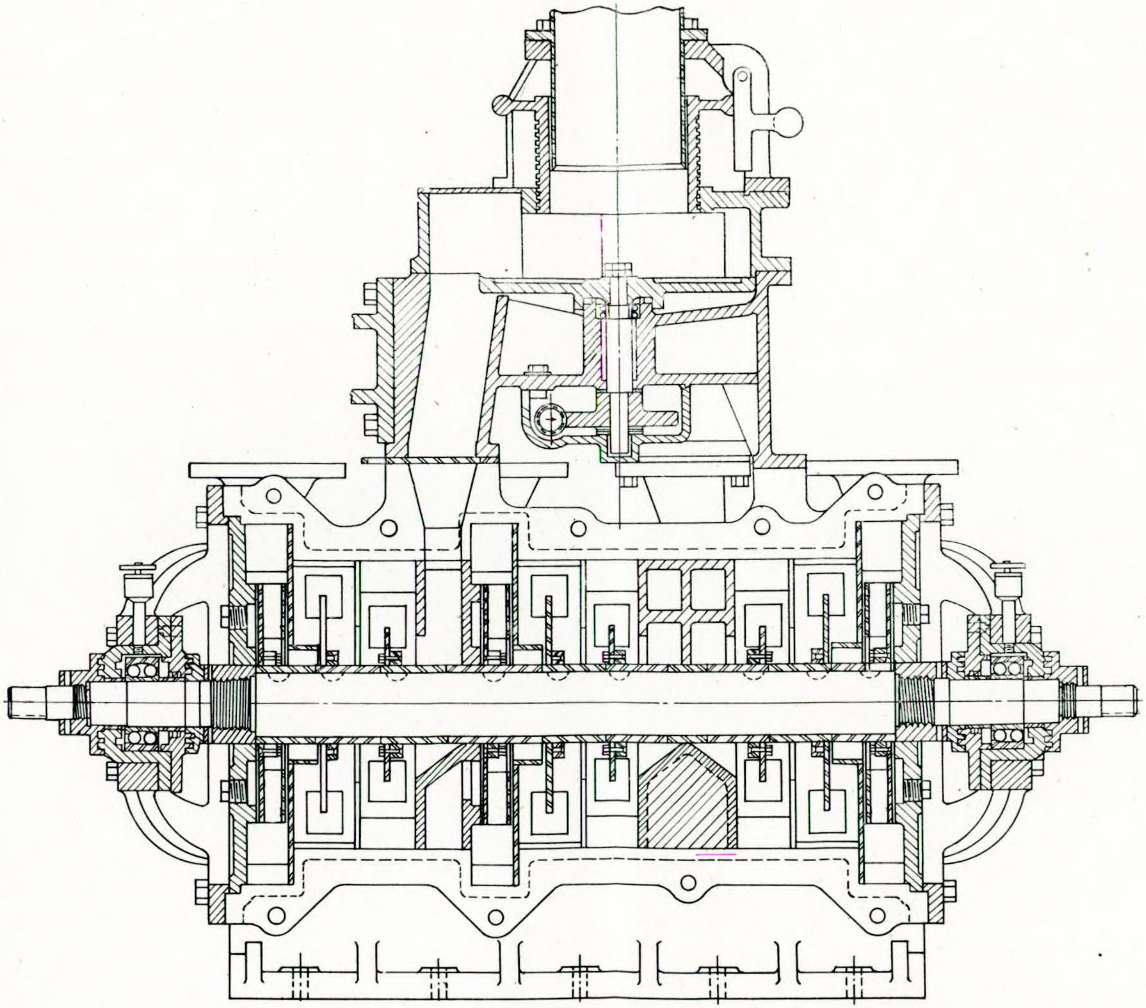


Fig. 4.—The new Todd Triplex Pulveriser.

The speed of rotation is in the neighbourhood of 3,450 r.p.m., and the pulveriser units are statically and dynamically balanced, so that there is very little vibration at this speed. We were able to confirm this by our own observation at the trial which we witnessed. The paddles are of a simple design, and are manufactured of a special hard alloy. The diaphragm separating the stages are made of steel plate. The housing is arranged so that the surfaces subjected to the abrasive action of the coal are easily removable and cheaply replaced. The whole of the working parts may be inspected by the removal of the cover. The two bearings are of the ball type, lubricated with grease, and the supporting spider is heavily constructed and fastened permanently to the standing part of the body, so that the removal of the cover does not affect the alignment.

The distribution of the coal to the burners is an interesting feature in the design of pulverised-coal equipment. In the Todd installation the distributor is incorporated in the pulveriser, where it is mounted above the crushing units. It consisting of a slowly rotating table on a vertical axis, which may be driven either by gearing from the pulveriser itself, or independently from a small electric motor. The last-named method is that adopted in the units supplied to the *Incemore;* and the motor, which develops $\frac{1}{2}$ h.p. is driven from the ship's lighting circuit. The raw-sized coal is delivered to the centre of this table from an overhead funnel, the height of which is adjustable. A truncated cone of coal is thus maintained at the centre of the table, and the diameter of the base of the cone can be varied within the limits of the table dimensions by raising or lowering the coal-feed funnel. Adjustable scrapers or knives, pivoted in the casing and capable of projecting across the face of the table at varying angles tangential to circles drawn upon the table, chisel off the base of the coal cone and divert streams of coal to the edge of the table, where they fall off into ports leading to the first stages of the pulverisers. The coal thus removed from the coal cone is instantly restored by the gravity head of the coal in the funnel, which is unsupported when the angle of repose of the coal on the rotating table is cut into by the knives.

Advantages of the New Type of Pulveriser.

The following advantages are claimed for the new type of triplex pulveriser, as compared with those of the earlier Todd units as fitted in the *West Alsek* and other vessels:—

(1) The space required is reduced.

(2) The weight of the installation is reduced.

(3) The weight and cost of the foundations are less.

(4) There is one feeder instead of three, and the power required for this is consequently reduced.

(5) The power to operate the pulverisers is less.

(6) The number of bearings has been reduced from six to two.

(7) The incidental lubricating apparatus and the cost of lubrication are reduced.

(8) The removal and replacement of piping, etc., in a converted vessel are reduced to a minimum.

(9) The operation of getting the coal from the bunkers to the feeders on the pulverisers is simplified.

(10) The whole operation is simplified on account of the compactness of the pulverisers.

The simplicity of the installation and the small amount of room required were commented upon by visitors during the inspection. In a converted vessel, it is expected that the stokehold will be more congested than when the ship has been designed to burn pulverised coal, but this cannot be said to apply to the *Incemore*. There is ample room around the various units and in all parts of the stokehold. The entire installation was working perfectly during our visit.

Tests on a duplex type of Todd pulveriser are being conducted by the technical staff of Messrs. Alfred Holt and Co. at their testing department at Birkenhead. The tests were commenced on the 14th May and are still proceeding. So far they have all been successful; and boiler efficiencies of from 79 to 85·5%, with an average of 81%, have been obtained.

- - - - - - - - -

The *Incemore* left the Thames on the 29th August for Bermuda and the United States.

THE "DIONIC" WATER-PURITY METER.

"The Shipbuilder," September, 1930.

It is essential that the feed-water for ships' boilers should be as free from impurities as possible, particularly in the case of water-tube boilers, and it has been the practice of engineers in the past to make occasional tests to ascertain the purity of the water. There are obvious disadvantages in this system.

Firstly, it is tedious and takes up some of the engineer's time which could be more profitably employed elsewhere, and, secondly, because of the necessary interval between the tests. During this interval, a leak may develop in the condenser, which would not be detected until considerable damage had been done.

Messrs. Evershed and Vignoles, Ltd., of London, have recently introduced an instrument, which they have named the "Dionic" water-purity meter, to overcome these objections by indicating the quantity of the impurities in the water at any time. It provides automatically and without attention a continuous indication or record of the amount of inorganic impurity present in any dilute solution.

The principle upon which it is based is that the electrical resistance of a dilute solution is a measure of the inorganic impurities present. Fig.1 is an illustration of the instrument. The cover of the lower portion, known as the water-tube unit, has been removed, and a portion of the interior has been cut away to show the mechanism. At the lower end may be seen the unions for the inlet and outlet of the liquid to be tested. The resistance is measured in a tube, of which the upper and lower parts (A) are of glass, and the centre portion (B) is of a moulded insulating material, which carries one of the electrodes. The resistance measured is that of the liquid between the central electrode and the end castings. The tubes are of robust construction, and will withstand a pressure of 40lb. per sq. in.

Were it not for the fact that the electrical resistance varies with the temperature of the liquid, it would only be necessary to have an instrument to measure this resistance, and the equipment would be complete. As this variation due to temperature is as much as 2% per degree Centigrade, it is necessary to have a compensating device. This consists of bimetallic strips (E) immersed in the liquid. The strips are connected to the plunger, and move the plunger up and down in the "measured path" of liquid according to the temperature, thus altering the average cross section of the liquid under test. It will be seen that this compensating device is entirely automatic, and provides a continuous compensation for changes in temperature over the range desired.

The indicator consists of a specially constructed ohmmeter in a metal case, and the movement is shielded from the effects of external fields and from mechanical damage. As the instrument cannot discriminate between different types of impurities, it must be graduated for the particular impurity to be expected. For use on board ship, where the condensers are only liable to contamination by sea water, the indicator for

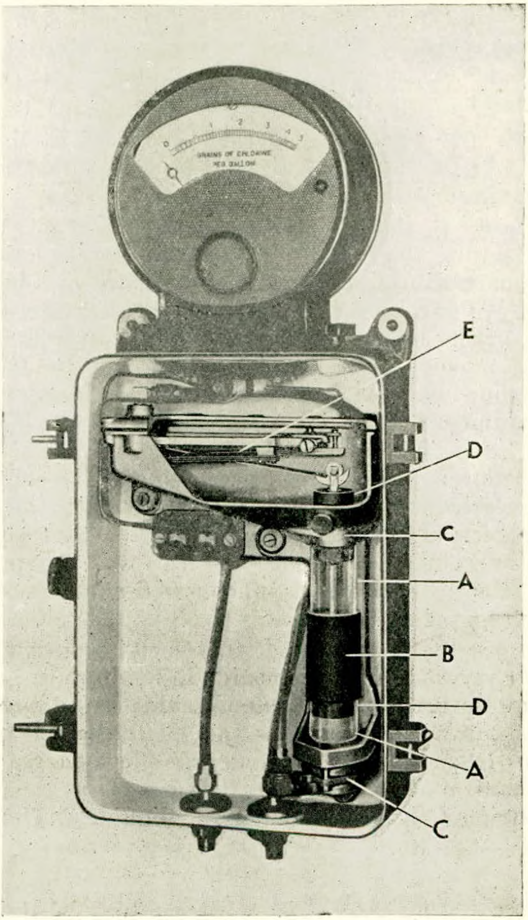


Fig. 1.—The Salinometer Type of Dionic Water-purity Meter, with Front Cover removed. Sectioned to show automatic temperature compensating device.

this purpose is calibrated to read in grains of sodium chloride per gallon, or grammes of sodium chloride per litre.

When water from several sources is to be tested, a mixing chamber can be supplied, so that the normal measurement is that of the impurity content of the plant as a whole, while any one source may be selected if the impurity content rises at any time.

The instrument in the form illustrated in Fig. 1 is known as the " Salinometer " type. It is recommended for ships' use on account of its simplicity and the ease of erection. All that is required is to make the connections to the water and electric circuits, and the instrument can be operated from any direct current of suitable voltage.

As the indicator is electrically-operated, it may be placed at a remote distance from the water-tube unit; and when this is desired, the two units can be supplied separately. If it is necessary to keep a permanent record of the impurities, the continuous recorder should be installed. The indicator may be incorporated with this unit, or may be separate, depending on the most suitable arrangement. It may also be fitted with an adjustable contact, which closes an alarm circuit, and thus gives warning, either by means of a Klaxon horn or a system of lamps, when a predetermined amount of impurity has been reached.

The recorder is shielded from the effects of external fields and from mechanical damage in the same way as the indicator. It is fitted with an eight or 20-day clock, and is supplied with a variable range of chart speeds. With the usual speed of 1in. per hour, the roll chart is sufficient for one month's run without change of chart. The pen is of the syphon type, and provides a record for several days without refilling.

Messrs. Evershed and Vignoles, Ltd., have a good many years manufactured a portable Dionic water tester which works on the same principle as the Dionic water meter, and this can still be supplied when it is not considered necessary to have a continuous indication or record.

Particulars of the instrument are published in the firm's list No. R—168, R.

MORE CHAPTERS IN NAVAL AND MARINE ENGINEERING HISTORY.

Extracted from an article by Engr.-Capt. Edgar C. Smith, O.B.E., R.N.

" Engineering," 15th August, 1930.

Introduction of the Screw Propeller.

Laid down at Sheerness in 1842 as the paddle vessel *Ardent*, the *Rattler* was altered for screw propulsion while on the stocks. No great haste was displayed in completing her, and she was turned over to Maudslays in the roughest possible state. A sloop of 1,078 tons displacement, the *Rattler* had a Maudslay Siamese engine of 437 i.h.p., driving the propeller shaft through gearing. Launched in the spring of 1843, she began her trials in October of that year, and these lasted till April, 1845, when the famous tug of war took place. Her chief competitor was the paddle sloop *Alecto* of 800 tons and 200 n.h.p. They had raced each other in the Thames and off the East Coast until, on April 3, 1845, the two ships were lashed stern to stern. With the *Rattler's* engines stopped, the *Alecto* was allowed to go full speed ahead, but on the *Rattler* going ahead the *Alecto* was brought to a standstill, and finally was towed astern at the rate of two miles and a half an hour, "in spite of all her attempts to run away." Though lacking all the exactness of modern trials, and possessing little scientific value, this demonstration caught the general fancy more than many columns of figures and sheets of curves, and from that trial dates the decision to adopt the screw for all classes of naval vessels.

As regards mercantile vessels, opinion on the relative merits of paddle and screw differed for some considerable time, but the superior advantages of the screw for naval vessels were acknowledged at once. The machinery could be placed below the water line and out of reach of shot; the decks would again be left clear for the armament; boarding enemy vessels again became an easier matter; the screw itself was not exposed to shot and the heeling of the ship when using steam alone, or steam and sail combined, did not affect the working of the screw as it did the paddle. Objections were raised on various minor points, but the trials of the *Rattler* definitely turned the scale, and though a few paddle frigates were afterwards constructed, screw propulsion was recognised as the most suitable plan for all classes of fighting vessels. No easy road was found to the design of propellers, and tedious and expensive trials had to be made. Both *Archimedes* and *Rattler* had been fitted with various screws; in 1845 the *Dwarf* was tried with 24 different screws, and a little later other trials were made in the gunboat *Minx*.

Effect of Form of Stern.

Of no less importance than the trials of propellers were the trials of ships with different forms of stern. To carry the heavy guns placed forward and aft, steam vessels had been built with full bows and sterns. In many vessels the bluff stern prevented the free flow of water to the propeller with resulting inefficiency. Scott Russell, it was, who once remarked that horse-power was not everything, and that shape largely determined speed. In the *Dwarf* it was found that by altering the stern, the speed could be reduced from nine knots to four knots. By altering the stern of the sloop *Rifleman* the speed was increased from 8 knots to 9½ knots, while in the gunboat *Teazer*, by improving the stern it was found possible to obtain the necessary speed with far less horse-power.

First Thrust-blocks.

When engine power was comparatively small and the screw shaft was separate from the crank-shaft, the thrust was usually taken by a plate opposed to the end of the shaft. The *Rattler's* thrust was of this description, and by a system of levers, a record of the variation in thrust was obtained. In the *Great Britain*, a gunmetal end to the shaft pressed against an iron plate 2ft. in diameter over which played a copious stream of water. With direct-acting engines, the propeller shaft was in direct line with the crankshaft, and the thrust was transmitted through the cranks. In the drawings of the arrangement in the *Ajax* there is a stout "pushing post" placed vertically, and fixed to keel and deck to take the thrust. Sometimes the thrust was taken on the stern post. Difficulties with such arrangements were bound to occur, and these led to the introduction of the multi-collar thrust placed between propeller and engine, which has been used exclusively until the introduction of the Michell thrust bearing.

Stern Bearing and Gland Problems.

Still more difficult of solution was the design of the under-water stern bearing, and the stern gland fittings were long a source of great anxiety. The copper sheathing and the iron shafts set up galvanic action; if shafts stood idle for any time there was rust; wooden ships worked in a seaway, and the shafts frequently were out of line. The early stern bearing was generally a long brass bush, and in vessels with copper sheathing the shaft had a brass sleeve. Bearing pressures were kept very low, but for all that the wear was abnormal, and in the sloop *Malacca* the brass of the stern tube wore away at the rate of 5 lb. a day. In the "Life of Admiral W. R. Mends" is found a striking account of the voyage of the Royal Albert line-of-battleship, from the Dardanelles, when she had to be run ashore on the Island of Zee to prevent her sinking, through the flow of water through the stern tube. She was kept with her bow ashore for four days, the engine slowly revolving to pump out the water, while the carpenters built a cofferdam round the stern gland. This completed, the ship was towed off and then proceeded to Malta under sail.

The introduction of the lignum-vitæ stern bearing was due to Penn, who was assisted by Smith, and this highly successful invention was the outcome of experimental research. On a shaft running in a tank of water, Penn fitted bearings of various metals, alloys and wood, and he found that with iron working on lignum-vitæ under water, the bearing pressure could be carried up to 8,000 lb. per square inch. The invention, which is described in the "Proceedings of the Institution of Mechanical Engineers," 1854 and 1856, came at a critical time; there was little delay in adopting it, and within two years, 200 ships or more had exchanged their brass tubes for the new lignum-vitæ bearings.

INTERESTING GREAT WESTERN BROAD-GAUGE LOCOMOTIVES.

"Engineering," 15th August, 1930.

"Tiny," the only complete broad-gauge locomotive in existence, is one of the most interesting relics in the possession of the Great Western Railway. Built in 1868, it was recently taken from the Newton Abbot locomotive depot, in which, with one of its flanged wheels removed and a pulley substituted, it had for many years done duty as a spare stationary engine working the pumps in the boiler house. At the present time, this locomotive occupies a prominent position in Newton Abbot station. It stands at the centre of the last section of the Great Western main line to be converted from the broad to the standard gauge. A model of another interesting old locomotive, the "North Star," is now located at Swindon. This was the Company's first locomotive, and was used on the occasion of the preliminary opening of the line between Paddington and Maidenhead on May 31st, 1838. It was reconstructed in 1925 from many of the original parts, one of which a buffer stuffed with horsehair, was being used as a piano stool at Bath. This locomotive was sent to the

United States in 1927, on the occasion of the Baltimore and Ohio Railway Centenary, as companion of the King George V locomotive.

THE OXYLENE FIREPROOFING PROCESS.

"Engineering," 15th August, 1930.

An interesting demonstration was carried out recently at the works of Messrs. The Timber Fireproofing Company, Ltd., Market Bosworth, Leicestershire. Two wooden huts, of identical dimensions and materials, had been built, the materials of the first being unpainted and unproofed, while those of the second hut were also unpainted, but they had been fireproofed by the Oxylene process. In this process, it should be explained, the timber is enclosed in a cylinder in which it is subjected to a series of actions which remove the air and moisture from the pores of the wood and replace them by fireproofing and preservative chemicals. These penetrate, under pressure, into the pores and fibres of the material. After being taken from the cylinder, the wood is subjected to further treatment, to ensure the fixation of the chemicals. At the demonstration, fires were lighted underneath the two huts described above. The untreated hut was completely destroyed at the end of 30 minutes, while, except for the blackening of the outside of the walls by smoke and some slight charring, no damage was done to the outside of the treated hut. Moreover, the inside of the hut, together with the furniture, was undamaged. We understand that, apart from building construction, the process is employed for timber used in H.M. ships and in shipbuilding, in coach building, in the scenery and furnishings of theatres and kinemas, in furniture and fittings for offices and houses, and in electric power stations.

BOILER EXPLOSIONS IN 1929.

"Engineering," 22nd August, 1930.

The annual report of the Board of Trade upon the working of the Boiler Explosions Acts, 1882 and 1890, for 1929, gives a tabulated statement of the 88 inquiries held during the year. Altogether, the accidents resulted in the loss of nine lives and injuries to 57 persons, the average number of lives lost during the preceding 47 years being 22. The total number of accidents is somewhat higher than for some years past, but this appears to be largely accounted for by the severe frost early in the year leading to explosions of heating apparatus in factories and institutions. The plants which failed, and to which the report refers, can be roughly divided into five fairly equal groups: (1) land and marine boilers and economisers; (2) steam and feed pipes and stop valves; (3) factory and laundry appliances, such as drying cylinders and calenders; (4) steam-heated bakers' ovens, and (5) heating apparatus for buildings. The causes of the failures include corrosion and wastage, excessive pressure, overheating, shortage of water, water hammer, unsuitable material, and undiscovered flaws. About half the plants which failed were neither insured nor inspected by any Company or Association. Considering the very large number of boilers in use afloat and ashore, the extensive use of steam in industries, and that inquiries are held even on such matters as the failure of a wooden barrel used as a sump in a vulcanising plant and the bursting of a cooker for poultry, the total number of accidents does not appear to be large. In all steam plant, however, there is need for constant vigilance, and this is emphasised by the fact that some of the worst explosions took place in works where it might have been thought the supervision was of such a character as to preclude the likelihood of an accident.

THE TEMPERATURE OF SHIPS' HOLDS.

"Engineering," 29th August, 1930.

A few years ago "The Times" published a letter from Lord Harris. It described how, after having renewed his youth for some weeks on a diet of paw-paw in the island of Jamaica, he had been returned to his normal age because supplies of that tropical product could not be secured in this country. With the natural instinct of a Briton, he called upon the editor of "The Times" to give him back in England the peace of mind and body he had enjoyed in Jamaica. Whatever may have been the ultimate result of the appeal, paw-paw does not seem yet to have become accessible to the general body of the British community. It may be that the shipping interests of Jamaica are employed too profitably in the banana trade to make it worth their while to study whether and how paw-paws can be carried safely and economically.

Whatever the reason, the general public of this country remains without what is considered an unequalled source of *bien-etre*, or well-being, and there is no evidence that any systematic attempt has been made to ascertain whether this desirable product could be put on our market.

It is undoubtedly a difficult fruit to deal with, and present practice is far from sufficient to secure what may be regarded as reasonably complete freedom from wastage with products much easier to handle. The normal changes of condition in the paw-paw during its life-history, on and off the tree, are much more extensive and rapid than, for instance, those that occur in the apple; but in spite of the large amount of work which has been done, and the considerable progress which has been made, even the transport and distribution of apples in sound condition is not performed with the certainty which is desirable. Presumably because the changes in apples during ripening are less extensive than those in other fruits and because of its popularity, more study has been given to ascertaining the causes of wastage of this particular fruit than to others. It has been shown that even in this case much depends on a variety of biological and horticultural factors; but when provision has been made for all these, there remain physical conditions of satisfactory transport which must be provided for mechanically. Of these by far the most important is temperature, but no one class of measure can wholly replace another, and other physical circumstances, such as atmospheric humidity and ventilation, have to be likewise controlled.

A preliminary difficulty in connection with the problem is that the most desirable temperature is not known with certainty for all species, and still less for all fruits, while the knowledge of the degree of humidity and extent of ventilation that are most favourable are not even as complete. It is known that for most species the optimum temperatures lie within a very narrow range, often as little as 2° F., and storage at either too high a temperature or too low may in different ways cause wastage of the product. The range of variation between the optimum temperatures for different fruits is very imperfectly known, but on present practice it may be as low as 30 to 32° F. for pears and as high as 54° F. for bananas. For apples the usual range aimed at is from 32 to 34° F., though there seems reason to believe that some varieties would avoid diseases which they show a disposition to develop at these temperatures if they were carried at perhaps 36 to 38° F. The action of these physical conditions in the extent to which they can be safely applied appears to be essentially either to retard or to stimulate the maturing of the fruit or the progress of a disease, but not to arrest it. A satisfactory practice would, therefore, have to take account of all of them, and of the circumstances in which the course of transport and distribution enables them to be controlled.

Before, therefore, any final practice can be defined for even the best-known fruits, and still more before it can be developed for the more difficult but possibly not less valuable fruits, the necessary biological data will have to be ascertained with certainty. This is a long and difficult task, but we have now made considerable progress in realising that merely empirical records of existing practice do not afford sufficient assistance. The circumstances of the fruit at every stage from the orchard to the consumer are all material to the result, and each has to be studied scientifically so that we may learn not only what happens at each stage, but also what is the effect of each change. There seems to be no doubt that ultimately such a body of knowledge will become available. It is being sought, not only for fruits but for meat, fish and other perishable commodities, in the preservation of which the control of temperature is used, and already sufficient is known to provide a use for a perfected practice of such control, if it were available. The most recent observations, however, go to show that as yet there is no such settled practice, and even the bases of those methods which have given the most successful results are far from having been definitely established.

The latest accounts of the investigations now in progress on the subject are contained in two reports by Dr. J. Barker, to the Food Investigation Board of the Department of Scientific Industrial Research (Technical Papers Nos. 38 and 39), which contain respectively a general summary of knowledge in regard to the nature, extent, and methods of preventing wastage in imported fruit, and a particular account of an investigation into the prevention of wastage in New Zealand apples, carried out over a period of two years by the joint staff of the Dominion and British Research Departments in co-operation with certain shipping companies, the Empire Marketing Board, and other public bodies. These documents record observations made in the field, the store and the ship, and researches in the biological, chemical and low-temperature laboratories and they show more clearly than is seen in an account of many similar subjects how each aspect has an immediate bearing on the practical problems in question.

From the engineering point of view their most notable moral is that the demands for the control of temperature during transit are much in excess of the control that is usually practised. It seems clear that, unless, in some way as yet not quantitatively defined, the permissible range of optimum temperature for a given fruit can be extended, the variations often found in the temperature of different parts of a ship's hold at one time, or in the average temperature at different times of a journey may be several times as large as the range within which they ought to be restricted.

Instances are found of methods of cooling ships' holds in which the arrangements certainly give a much closer result. In one, for instance, quite satisfactory control seems to have been obtained by lining the hold with brine-cooled coils and passing a flow of air over the whole of the coil-lined side before allowing it to escape into the cargo within. Here, however, the use of more powerful fans introduces a much larger air-supply than is provided in earlier systems, in which the air is allowed to escape through perforated screens running in front of the coils, and it cannot be said how far the mere increase in the volume of refrigerant air is responsible for the improvement, and not the larger refrigerating surface over which the air has to pass. There is, in fact, no evidence of a systematic attempt having been made to analyse the working of refrigerating surfaces, analogous to the investigations that are being made in various countries into the action of the heating surfaces of boilers. With so much uncertainty regarding the exact requirements of the traffic, it is perhaps intelligible that this work has not been undertaken, but the progress which is being made in acquiring exact knowledge of the other factors of wastage seems to show that it is now time for it to be considered. It is essentially an engineering question, calling for accurate enquiry into the operation of physical laws in practical conditions, and the importance of the subject seems to be sufficient to warrant an enquiry planned and carried out by engineers.

In two ways the importance is perhaps wider than the mere solution of the problem in question, considerable though that is. On the one hand any success would be of material assistance to inter-Imperial trade, and on the other hand the course which has been taken of late years in these investigations has included some intimate co-operation between the corresponding authorities in this country and the Dominions. The advantage of increasing inter-Imperial trade is nowadays a commonplace, and probably the removal of technical obstacles which obstruct progress, difficult though it may sometimes be, should certainly be effective to this end. The successful issue of a co-operative effort between corresponding workers on both sides may have scarcely less value.

To increase the extent of co-operation in scientific and industrial investigation would doubtless lack the publicity and spectacular attraction which attend other more popular enterprises, but it would certainly give opportunities for more constant relations between a much larger number of men in the parts of the Empire concerned, and the material results which could be expected with confidence from the systematic and determined working of a mechanism to that end would constantly extend the disposition to further co-operation.

Future Responsibilities of the Engineer.

"The Engineer," 29th August, 1930.

For the Commencement Address, delivered before the Worcester (Massachusetts) Polytechnic Institute, in June last, by Brigadier-General Robert Irwin Rees, who is Vice-President of the American Telephone and Telegraph Company, the speaker chose for his subject "Future Responsibilities of the Engineer.'" Never in all history was there, he said, a time when working and living conditions were better, or when education, the necessities of life, and even luxury, were so abundantly available. For any one mind to grasp more than a small portion of the rapidly accumulating body of engineering knowledge so basic to our present civilisation is almost impossible.

"Little more than fifty years ago," continued General Rees, "in a period of discovery and invention enriched by the knowledge physical science had uncovered, engineering education was born, to change and uplift the whole tone of American life. All the conveniences of transportation, communication, light, power, and a host of things too numerous to mention, are monuments of the material achievements which have resulted. While we may be mystified by the multiplicity of accomplishments in the world's progress, there will most probably be a quiet and continuing evolution, accompanied by certain powerful social changes. It is inevitable that engineering must change also, because it is an instrument of social as well as of material progress. If engineering is to fulfil its promise and its possible destiny, it must share the responsibility for control of the social consequences which its conquest of material things has created.

"The public admires the spectacular works of the engineer but too rarely has he been recognised in determining the policies of our great industrial enterprises. It is inevitable, however, that many successful engineers will become executives.

"While no claim is made that engineers are going to usurp all or even a major portion of the positions of management, although this observation reflects the tendency of the times, yet in the future it is quite assured that more of the administrators of business are going to come from the engineering profession. No other education gives more of that kind of training which is so easily adapted to the appreciation and the solution of management problems. While formerly industry looked to the engineering schools for men merely as technologists, expecting them to deal solely with the material things, growth of responsibility placed upon young engineers in industry has brought forward the necessity for their appreciation of the principles of management, economics, and labour relations. But it is not desired to leave the impression that the field for the more purely professional applications of engineering is being restricted in any way. In fact, the field is constantly growing in research, design, and technology.

"Our future industrial life and economic life demand an ever-widening application of engineering knowledge and method, and leave to the young engineer more diversified fields of usefulness than ever before. If engineering education is to realise its fullest values, it will not be restricted to the purely technical development of the profession, but will carry over into other fields that same engineering method of thinking that has brought about our material prosperity.

"These changing demands have influenced engineering education and to-day there are two broad trends in the development of the curricula. One of these is away from devoting too much time to application and specialisation, with a corresponding trend toward a more thorough grounding in the fundamental physical sciences, including mathematics. The other is the realisation that if a young engineer is to take his place as a citizen in the world of men, he must know something of the humanities. The engineering curriculum is to-day being liberalised through more emphasis on English, to develop clear expression, history, economics, and other social sciences, to impress upon the students responsibility in life toward human relationships. Out of engineering education is now being evolved a culture which enables a young man, not only to meet his obligations of future productive usefulness, but also to become an influential member of society and a representative citizen. These new conceptions have enabled you to fit yourselves better for your life's work.

"Many positions are being filled each year by men and women who, lacking formal training, have nevertheless, by hard work and self-development, won the confidence and respect of their fellow workers and are being assigned to leadership over them. In addition to this self-developed group, there is a general need in industry for people who, because of special education, training, and superior personal qualities, are able to do the task at hand better than those of limited preparation.

"Industry tries to select men who it thinks will succeed, and perhaps the standards employed in the selection will give you an insight into the manner in which experienced employers exercise their judgment.

"The first standard is that of character.

"The second is that of adaptability to the spirit and aims of the organisation, including interest in and devotion to the service, willingness to co-operate and to promote co-operation in others, ability to accept the social and economic philosophy underlying the organisation, and personal acceptableness to its present *personnel*.

"The third standard is that of personal capacity. Over half of the work for which college men are employed and developed is primarily administrative in character. Such work calls for men who can think analytically, plan constructively, use written and spoken English convincingly, organise men and facilities, and direct subordinates effectively. The other class of work for which young engineers are sought is staff service involving the use of expert knowledge and technique.

" The fourth standard of judgment is based on past performance. Employers are interested in knowing how well a man performed in his last job. Graduates are not selected for scholarship as such, but weight is given to scholarship as an evidence of definiteness of purpose, capacity for concentration, mental vigour, and ability to put first things first in the midst of distractions.

" I have tried to give you a small conception of what employers in industry are looking for in you as engineering graduates. I wonder if now I can put myself in your place, and see if we can determine the satisfactions which should come to you in the selection of your life's career. Most of you, no doubt, have secured your first position. Let us hope it is one which will satisfy the fundamental motives of your life. Surely it is a modest demand that you have interesting work, an adequate livelihood, and an opportunity for individual recognition. Because of the increasing size of industrial organisations, a large variety of interesting occupations are available in each of them. In making a decision in the choice of a Company, one should investigate the history of the organisation, its reputation, its financial strength, its aims ideals and policies. It is hoped that you have asked some or all of these questions: Is the Company progressive? Does it take care of its people? Does it have the type of work in which one is interested? In what capacity would one enter the business? What sort of associates would one have? What would be the compensation and prospects of advancement to a worth-while position of responsibility? You are entitled to know all these things, as they will have a decided effect on your future progress and ultimate success.

" Within my experience and observation, I should like to give you as true a picture as I can of what your experience in industry will be. While in our conscious selection of college graduates we are employing them for future leadership, please let me emphasise the word 'future.' We hope to be able to train you for real leadership in from ten to fifteen years; in fact, we are employing you for that future period rather than for the minor job which we have available for you today. But, gentlemen, we want you, from the very beginning, during the whole time that you are going through the grueling grind of monotonous routine and laying the foundations for your future responsibilities, to attack every problem in a thoughtful way; to consider what is the best way, in the light of your educational experience, for doing that job better and improving the technique, no matter how narrow is the work it is your lot first to carry on. We want you, when you come to us, to relate the little job which is assigned to you to those of your associates and of your superiors, so that you will grow in ever-broadening comprehension. Then, when responsibility comes to you, you will have the power, the vision, the ability, and the capacity, to do your particular job in management better than it has ever been done before. Because of the increasing complexity of our growing modern industries, that is what must be: every job must be done better than it has ever been done before. And when you come to that period, ten or fifteen years hence, when you have gone through your novitiate and emerged into an executive position, you will know how to respond to the heavy demands imposed on you, and be able to solve the serious problems which confront you.

"During all this early period of your career, you will find the engineering method of thinking a constant strength to you, and in increasing measure will the engineering knowledge you have gained in your courses here, be of value. These two combined, knowledge and method, will give you power for progress."

A FLOATING DOCK FOR NEW ZEALAND.

"The Engineer," 22nd August, 1930.

An order has been placed with Swan, Hunter and Wigham Richardson, Ltd., for the construction of a large floating dock for Wellington Harbour, New Zealand. The order, which, we understand, has now been under consideration for many years, has been placed by the Wellington Harbour Board. The dock will be built to the designs of Messrs. Clark and Standfield, of Westminster, and will have a designed lifting capacity of 17,000 tons. Its overall length, including the platforms, will be 584ft., with a clear width of 88ft., while the width overall will be 117ft. 6in. The work of construction, which will occupy a large number of men, will probably take about a year. When completed, the towing of the structure to its final destination will present an interesting problem, as the distance to be covered is over 12,850 miles, which will constitute a towing record for a dock. One of the last docks built by Swan, Hunter and Wigham Richardson, Ltd., was that for Singapore, which was safely towed in two sections a distance of over 8,500 miles.

OBITUARY.

Mrs. James Adamson.

It was with great regret that the Council heard of the death of Mrs. Adamson, the wife of the esteemed founder of the Institute, which took place after a long illness on September 11th. Mr. Adamson and his family will have the sympathy of all the members of the Institute in their loss. A wreath was sent from the Council and a number of members were present at the funeral. The following obituary notice appeared in the "Stratford Express" of September 17th:—

A former resident of Forest Gate, and very well known in the district, Mrs. Isabella Cowan Adamson, wife of Mr. James Adamson, died at her home at 84, Headstone-lane, Harrow, on Thursday. Mrs. Adamson, who had suffered a long illness, was born in 1856 at St. Quivox, Ayr, and before coming to London was an active worker in Glasgow, especially in connection with the Glasgow Foundry Boys' Society.

For the first thirty years of their married life Mr. and Mrs. Adamson lived in Forest Gate, and were members of the Maryland Point Presbyterian Church. Mrs. Adamson did much valuable work here; also on the committee of the Ladies' Guild of the British and Foreign Sailors' Society, the church suffering loss of a valuable worker when, with her family, she moved to Harlington in 1915.

When the Institute of Marine Engineers was founded in 1888 Mrs. Adamson, as the wife of its hon. secretary, and the most active of its founders, co-operated enthusiastically in the work. She not only took a great part in the social activities at the institute's first premises at 58, Romford-road, but her own house in Stopford-road was always open to engineer visitors from near and far.

The funeral took place on Monday at Pinner Cemetery. A service was first held at the house in Headstone-lane, being conducted by the Rev. Thomas Colligan. A number of relatives and friends were present, and there were many beautiful wreaths.

ELECTION OF MEMBERS.

List of those elected at Council Meeting held on September 8th, 1930:—

Members

Frank Chadwick, 107, Dogfield Street, Cardiff.
Barraclough Charles Cumberland, 19, Gillies Street, Wollstonecraft, Sydney.
Edward James Edwards, 37, Longford Street, Dingle, Liverpool.
Ernest Layzell Fitch, 11, Dalmeny Avenue, Holloway, N.7.
Joseph H. Hopwood, 11, Cressy Road, Roath Park, Cardiff.
John Ferdinand James, 70, King Street, Whitehaven.
Robert Longfield Jones, Sandoona, Rhosneigr, Anglesey, North Wales.
Hugh Quintin Kennedy, 176, Railway Parade, West Leederville, West Australia.
David Law, Rowanbank, Balnagask, Aberdeen.
Malcolm Lawson, 32, Anderson Street, East Malvern, Melbourne, Victoria.
George McDonald, *c/o* Law, 46, Elm Row, Edinburgh.
James Stevenson Peter, Dunragit, Wigtownshire, Scotland.
Walter Piercy, 12, Primrose Road, Birkenhead.
Eric Charles Preece, Ashlands, Billesdon, Leicester.
Willie Richards, 154, Mackintosh Place, Cardiff.
Frederick Earl Roberts, Tranby View, Anlaby Park Road, Hessle, East Yorks.
James Purves Robertson, 4, Cranford Street, South Shields.
Ronald Wilson, British Borneo Timber Co., Ltd., Sandakan, British North Borneo.

Associate Members.

John William Hall, 1, Kerrison Road, Ealing, W.5.
William Gladstone Menzies, *c/o* The Hooghly Docking and Eng. Co., 6, Howrah Road, Howrah, Bengal.
John Mitchell, 37, Royal Park Terrace, Edinburgh.
Philip Plunket, 1, Granville Road, Ilford, Essex.
Herbert Edward Thompson, 7, Portland Street, Aberdeen.
Ralph Frederick Williams, Bear Hotel, Cowbridge, Glamorgan.

Associates.

William Joseph Carleton, 10, Western Gardens, Willesborough, Ashford, Kent.

Harold Lyne Purcell, *c/o* Mr. Bracegirdle, 26½, Bland Street, Halifax, Canada.
Ernest Frederick Ryder Townshend, Llanvapley Rectory, Abergavenny, Mon.

Graduates.

Edward Eltenton, 225, Warbreck Moor, Aintree, Liverpool.
Charles John Gumbrell, 30, Elmhurst Road, Gosport, Hants.

Transferred from Associate Member to Member.

John Sutton Bathgate, 36, Moscow Drive, Liverpool.
Alexander Logan, 38, Gerard Road, Harrow, Middlesex.

Transferred from Student Graduate to Associate.

Henry Richard Tyrrell, 48, Windermere Road, Muswell Hill, N.10.

Transferred from Graduate to Associate.

Richard Leslie Holland, *c/o* Arthur Holland and Co., Ltd., 20, Billiter Street, E.C.3.

BOOKS ADDED TO LIBRARY.

Purchased.

International Load Line Conference, 1930. Report of the Delegation of the United Kingdom, July 5th, 1930. Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 1d. net.

International Convention respecting Load Lines, with Final Protocol and Final Act of the International Load Line Conference, July 5th, 1930. Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 3/- net.

"Refrigeration as applied to the Transportation and Storage of Food Products," by E. W. Shanahan. Published by Gee and Co., Ltd., 6, Kirby Street, Hatton Garden, E.C.1. Price 5/-.

"The Absorption Refrigerating Machine," by Gardner T. Voorhees. Published by Nickerson and Collins Co., Chicago. Price 20/10.

"Practical Refrigerating Engineers' Pocketbook," by John E. Starr. Published by Nickerson and Collins Co., Chicago. Price 10/6.

BOARD OF TRADE EXAMINATIONS.

List of Candidates who are reported as having passed examination for certificates of competency as Sea-going Engineers under the provisions of the Merchant Shipping Acts.

For week ended 6th September, 1930:—

NAME.	GRADE.	PORT OF EXAMINATION.
Robb, Duncan G.	1.C.	Glasgow
Wood, Robert C.	2.C.	,,
Turner, James	1.C.	,,
Findlay, Alexander S.	1.C.	,,
Simpson, James H.	2.C.	,,
Murphy, William A.	2.C.	,,
Macdonald, Arthur K.	2.C.	,,
Harrington, Henry M.	2.C.	,,
Nicol, Thomas	1.C.M.	,,
Skinner, William C.	1.C.M.	,,
Hamilton, Walter D.	2.C.M.	,,
Bingham, Harry B.	1.C.	Hull
Briggs, William C.	1.C.	,,
Atherton, George W.	1.C.	Liverpool
Crellin, John P.	1.C.	,,
Hales, Ralph H.	1.C.	,,
Jowett, Charles	1.C.	,,
Wilkie, William T.	1.C.	,,
Hobson, Frank B.	2.C.	,,
Speed, John P.	2.C.	,,

For week ended 11th September, 1930:—

Gemmell, Henry M.	2.C.	Newcastle
Lakeman, Robert A.	2.C.	,,
Matfin, Arthur H.	2.C.M.	,,
Burgess, Thomas S.	1.C.	Sunderland
Morton, William	2.C.	,,
Johnson, Albert E.	2.C.	,,
Crawford, James	2.C.M.	,,
Downing, Gordon W.	1.C.	Hull
Scales, William H.	1.C.	,,
Witty, John C.	1.C.	,,
Gilby, Norman	2.C.	,,
Jordan, Ernest	2.C.	,,
Lumb, Reginald	2.C.	,,
Proudfoot, Joe C.	2.C.	,,
Thorne, Ernest	2.C.	,,
Copeland, John A.	2.C.M.	,,
Venables, Thomas H.	1.C.M.E.	,,
Young, James T.	2.C.M.E.	Sunderland
Craig, James F.	1.C.M.E.	Glasgow
MacLean, John S.	1.C.M.E.	Liverpool
Richardson, William E. ...	1.C M.E.	London
Johnsone, George	1.C.M.E.	,,
Currie, Alexander	1.C.M.E	Liverpool