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VOLUME XLII.

Developments in Powdered Fuel Practice for Marine Service

READ

BY E. W. GREEN, O.B.E. (Member),

On Tuesday, May 13*th, at* 6.30 *p.m.*

CHAIRMAN: THE PRESIDENT.

The CHAIRMAN expressed pleasure at seeing such a large gathering present. He wished to take the opportunity to thank the Council and Members for the great honour they had conferred on him in asking him to become President for the ensuing year. He did not think that Mr. Green needed any introduction to the meeting as he was a member of the Institute, and was already well-known in connection with the subject of his paper, powdered fuel. It was a most interesting subject. We had a national asset in our coal, but we had no similar asset of oil, and in the event of war, the Navy was certain to want all the oil available, or all but a very small margin for the Merchant Navy, and the Merchant Navy was, therefore, ultimately dependent upon the coal supplies of the country. A large number of those ships which were now burning oil might, with some minor alterations, be adapted for burning powdered coal in the event of war.

Mr. E. W. GREEN: This country has been generously endowed by nature with vast stores of coal, the best coal in the world; it is the basis of all our important trades, the distribution of our population is largely determined by the distribution of the coal fields, and one-twelfth of the entire population of the country is dependent directly or indirectly on the coal mining industry, yet we import many thousands of tons of oil, a fuel which is more expensive than coal.

The principal users of this fuel are the shipping companies, not only of this country but throughout the world. The returns of Lloyd's Register show how rapidly oil is displacing coal for firing marine boilers, and it seems reasonable to suppose that if coal could be fired in a manner somewhat similar to that used in firing oil, we might yet recover this important market for our national fuel.

Nature perhaps was too lavish with her gifts, and while coal was easy to get and labour cheap, we were content to fire it wastefully on bars by hand. It had for long been known that theoretically coal could be burnt in the pulverised form more economically than by any other method, but the types of boilers generally in use in this country, the Lancashire and Scotch marine boiler, with small internal furnaces, did not seem to lend themselves to the requirements of pulverised coal burning. This country was far from taking the lead in the early experiments in this form of combustion, and it was not until very large power station units became necessary that pulverised coal was considered as a substitute for chain grate and mechanical stoking.

These early installations have very large brick-lined combustion chambers, in which the combustion is completed before the flame parts with any material portion of its heat. This arrangement was quite unsuitable for ships, and moreover, there were many ships which might be converted to burn pulverised coal if this could be accomplished in the small furnace of a Scotch boiler. It has been mentioned that the early installations had brick-lined combustion chambers. This fire-brick lining was fitted to protect the walls of the combustion chambers from the fierce heat of the flames, and to provide an incandescent surface for igniting the ingoing coal particles. It is hoped to be able to prove that far too much importance was attached to fire-brick linings when pulverised coal came to be applied to Scotch marine boilers.

When the author's firm commenced experiments in firing a Scotch boiler with pulverised coal, a considerable amount of fire-brick lining was fitted in the furnaces and the back of the combustion chamber lined with cast iron plates. Cast iron was purposely used because it was considered necessary to obtain an indication as quickly as possible of the amount of damage that might occur at that spot. The cast iron plates were removed after some six weeks and were found to be in as good a condition as the day they left the foundry, so it was decided not to replace them. We removed the refractory bricks cautiously, being still under the impression that the lining was for protection of the furnace tube. One-third of the refractory lining was removed from the bottom of the whole length of the furnace. This allowed the ash to fall on the bare furnace plates and prevented it from slagging, which was a great advantage. The refractory was then reduced in length to a short saddle only two feet long. By then it was realised that the refractory was not necessary as a protection, but it was also realised that some incandescent surface was necessary in proximity to the burner to promote rapid combustion, and that the cutting down of the lining had been overdone. We could burn some coals quite successfully with this short saddle, but others required more, and a ship is not always in a position to pick and choose its coal.

The author commenced this paper by giving a short history of the cautious start that was made in order to show that though the experiments were carried out in the belief that serious damage might be done to the boiler, such was not the case and the boiler remained unaffected by the rather rough experimental treatment it subsequently received. The water in the boiler is a far better protection to the steel plates than any fire-brick lining can be.

Combustion.—The combustion of pulverised coal is in appearance similar to the combustion of oil; there is, however, considerable difference in the two processes. Oil fuel is atomised in the burner and enters the furnaces in the form of small globules which are easily vaporised and burn as a gas. Pulverised coal enters in the form of a solid. Each particle of the solid is composed of two main constituents, the volatile matter and the fixed carbon. The volatile matter requires more heat to vaporize it than was necessary in the case of the globules of oil, hence the necessity of having the refractory saddle previously referred to round the burner to supply radiant heat; having been vaporized, the volatile matter burns as a gas in exactly the same manner as oil burns. The solid particle of coke becomes entangled in an envelope of carbon-dioxide, the most common component of the gases in which it floats at the end of the flame. The natural convection currents which, though small, are very violent, continually break down the envelope and allow the carbon to come in contact with oxygen until it is consumed or escapes beyond the end of the flame. Let us consider what this expression " the end of the flame " means. It is the boundary beyond which there is an insufficient number of particles of glowing carbon to maintain a state of active combustion. In the general mass of gases undergoing combustion, there is a well-defined portion which is rendered visible by the particles of glowing carbon floating in it. This portion is the flame, and it is important to consider some of the reactions which take place in it. The burning hydro-carbons raise the temperature of the fixed carbon particles until they in turn begin uniting with oxygen. Each particle of carbon as it burns radiates part of its heat to its immediate neighbours, and so the inter-action of these particles maintains combustion until there is an insufficent number burning to maintain the temperature necessary for chemical reaction.

We have then somewhere in the furnace a boundary up to which there must be a sufficient number of glowing particles, and a "sufficient number" means a "large number," and beyond it none. But if all these particles are to complete their combustion together, they must all be the same size on entering the furnace. Therefore uniform grinding is quite as important as fine grinding.

It is important to remember that the flame must fit the furnace. The fuel must be thrown from the burner with sufficient energy to reach the boundaries but not to hit them. This produces a furnace full of flame. The radiant heat has then the shortest possible path to traverse and the fuel is not extinguished by contact with the furnace walls.

Burners.—Of all the components that go to make a pulverised coal burning plant, none have been expected to play such an important part as the burner. Burners of elaborate and complicated design have been devised to do things which are not only unnecessary but impossible. Referring to the remarks on oil fuel burners, it will be remembered that these burners atomise the fuel as it leaves the tip, and good combustion depends largely on fine and uniform atomisation. But the pulverised coal burner does nothing of the sort. It delivers the coal as received, and its only function is to distribute the fuel evenly throughout the incoming stream of secondary air. It is interesting to reflect that it was the so-called turbulent or "short-flame" burners that appeared to make pulverised coal firing applicable to Scotch marine boilers, yet it is hoped to show that a burner can have very little, if any, effect on the length of flame. The flame, as previously defined, is that part of the gases in combustion which contains glowing particles of carbon. The volume can be calculated with a fair degree of accuracy, because it depends upon the time necessary for the complete combustion of the particles of carbon entering the furnace. Theoretically, this time is known with sufficient accuracy to serve our needs, then the weight of the combustible entering the furnace during this time, together with the weight of air necessary for its combustion gives us the weight of the products of combustion. Knowing the temperature of these products, we can calculate their volume, which we may say is the volume of the flame. This volume, divided by the cross section of the furnace, gives the length of the flame. The length found by this method is slightly longer than the true length, because the combustibles enter the flame as solids with practically no volume and are converted into gases during combustion. But this length agrees fairly well with the observed length of the flame. It will be noticed that the path of the particles plays no part in this calculation; no rotary or tortuous path will have any effect on the volume of the gaseous matter undergoing combustion. The size of the particles is the governing factor in this calculation, therefore fine grinding is necessary where a flame of small volume is required. Turbulence, however, is a different matter. It is present in all flames. It is set up by violent convection currents and is quite independent of the burner. Turbulence is not rotation, with which it is often confused, probably because of the similarity of the word "turbine" with which it has no connection. But if some form of rotation was advantageous to combustion, the burner could not impart it to the fuel. Each particle as it left the burner would have to travel in a straight line, and a straight line can form no part of a rotary motion. It might be inferred from the foregoing remarks that the burner might be eliminated altogether and the fuel discharged from an open-ended pipe. But if the fuel is discharged at a velocity greater than the rate of flow of the gases in the furnace, much of it would pass beyond the end of the flame without being burnt. If the pipe was increased to reduce the velocity, the flame would flash back against the fuel stream. The burner has simple but necessary functions to perform and it cannot be dispensed with.

The Howden-Buell burner shown in Fig. 1 is designed to work on these principles and to distribute the fuel over the

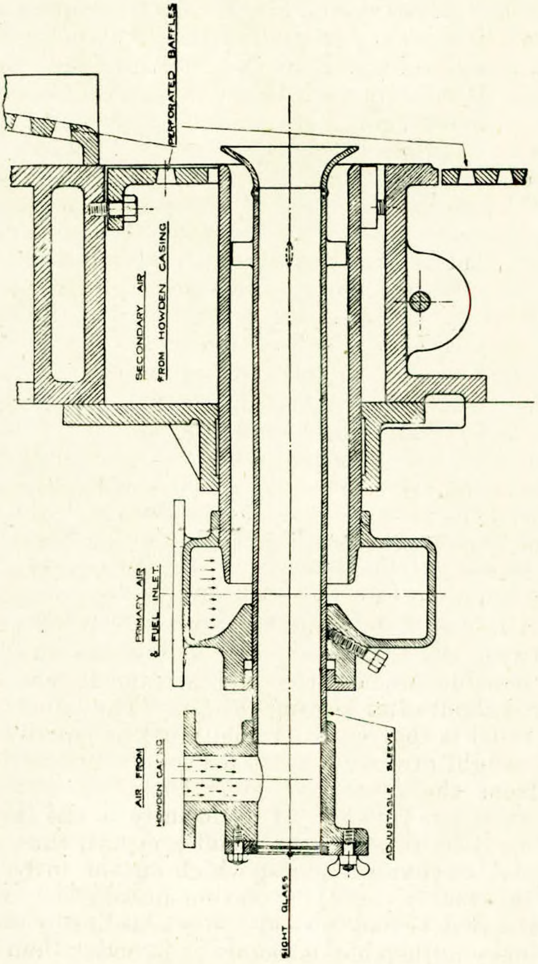

Fig. 1. The Howden-Buell Triple Flow Dispersive Type Burner.

cross-section of a circular furnace flue as evenly as possible. It is placed on or just above the axis of the flue. The fuel enters the burner through a helical shaped body (the snail) which discharges into an annulus formed by two concentric tubes, the discharge end of the inner tube being bell-mouthed. The purpose of the snail is to give the fuel stream a rotary motion while passing along the annulus, and so maintain a uniform mixture of air and dust after the stream has turned into the burner. The rotary motion is maintained to the outlet of the burner and causes the fuel to be discharged at a tangent to the annulus. If the annulus had an open end, the resultant velocity parallel to the axis of the furnace would be higher than the rate of flow of the furnace gases; the bell-mouth is introduced to divert the fuel so that its path forms a hollow, flattened cone, through which the secondary hot air from the furnace front passes, carrying forward the fuel as combustion proceeds. The centre portion of the furnace forms a blind spot in this flow and is caused by the obstruction of the burner itself. This want is supplied by the slow stream of air from the centre tube. This, combining with the lighter particles of coal, which have not sufficient energy to travel far from the burner, forms a mixture easily ignited.

Problem of Distribution.—One of the many obstacles that has had to be surmounted in the application of pulverised fuel to ships has been the question of distribution of the pulverised fuel to the burners. The pulveriser, operating on the unit system, has to deliver coal to any number of burners at a rate equal to the demand of the steam raising unit; since three or more furnaces may be operating from one pulveriser, means had to be devised to separate the coal stream into three or more streams, in such a manner that each furnace receives its correct supply of coal dust. It is desirable to divide the carrier air equally between the furnaces as well as the coal dust, but this is seldom possible because the fuel stream is not of equal density throughout after leaving the fan. The important point to bear in mind is that the coal dust must be equally divided; the correct weight of air necessary for combustion will be made up later from the secondary air. Distributors have been devised to overcome this lack of uniformity in the fuel stream by re-mixing it by rotary or pneumatic means, thus introducing additional mechanical parts, which appear to be unnecessary. In the fuel pipes of a marine installation conditions remain constant over long periods, thus enabling a distributor with stationary adjustable deflectors to be used. Such a form of distributor is shown in Fig. 2. The coal and air is conveyed along the rectangular pipe in which a system of small blades is arranged, these blades being mounted in such a manner as to permit an alteration in the angle of each, relative to the direction of flow of the stream of pulverised fuel and air. These blades can be adjusted to create considerable distortion of the main stream, and in order to make as much use as possible of this condition the mixture is immediately subdivided into separate streams by means of the hinged flaps arranged within the body. It is also possible to prevent, if

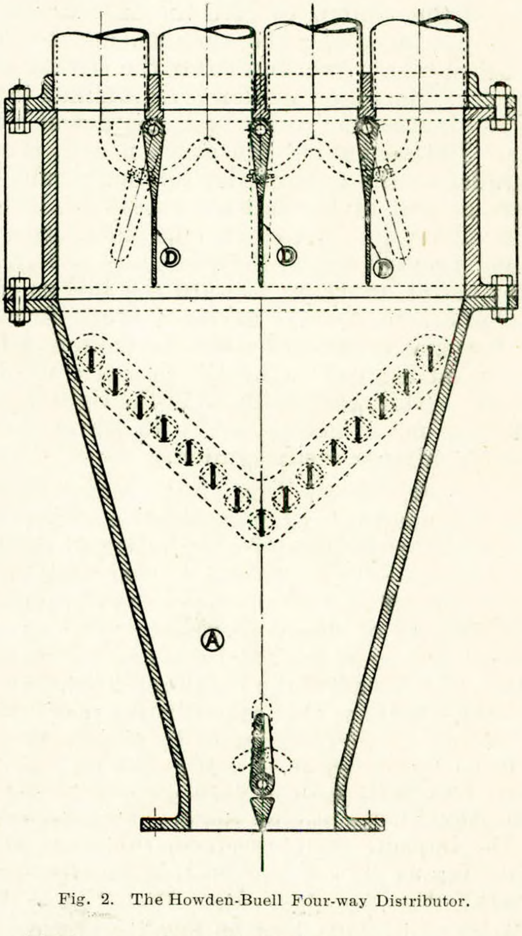

Fig. 2. The Howden-Buell Four-way Distributor.

necessary, the passage of fuel and air into any one or more of the pipes leading to the burners. By this arrangement, it is possible to control the flow of fuel to any particular burner and, within limits, to select the proportion of the main stream to be conducted to each burner, thus enabling the best efficiency to be obtained from a group of burners fed by the pulverisers.

The most important component of a pulverised fuel installation is undoubtedly the mill. Accuracy of distribution depends largely upon the fineness of the product of the mill as already shown, and fineness is the all-important factor in determining the volume of the flame. Coarse particles cause heavy wear on fan blades and are not completely burnt in the furnace. Therefore the product of the pulveriser should be both fine and uniform. Fineness is, however, a relative term, and it is necessary to establish some standard of fineness which is desirable, because the cost of grinding may well be carried beyond the economic limit and must be suitable for the application under consideration. The author suggests that 97% of the product should pass a 100 I.M.M. screen and not more than 12% remain on a 200 I.M.M. screen. This is a product that can be easily burnt in the furnace of a Scotch boiler; it is not a high degree of pulverisation, and these figures are put forward as the minimum below which pulverisation should not fall. Here attention is called to the standard screens mentioned. These are the screens adopted by the Heat Engine Trials Committee of this country. These screens pass a finer product than the American (A.S.T.M.) screens of the same nominal mesh. Fig. 3 gives a table of comparison of the two standards and may help to explain why American pulverisers appear to produce a finer dust than British. From among the many and varied types of pulverisers available, marine engineers seem to have selected generally one of two types, impact pulverisers or ball mills. In the first-named, the falling coal meets a body travelling at a high speed and is shattered by the violence of the impact. Pulverisers of this type always embody the fuel fan as part of the mill, generally mounted on the same shaft as the pulverising element. This is not a good arrangement because there must be some best speed at which the pulveriser should run, and this will be constant for all rates of output although it may vary with different types of coal. The speed of the fan, however, should vary with output or the primary air will be too high at low rates of feed. Throttling the primary air at the intake will not meet this objection, because it will upset the conditions of the separator. However, there is another and equally important reason why the mill and fan should not be combined in one machine. It will generally be found convenient to group all the pulverisers of a marine installation together under one crushed coal hopper. This will not be the best position for all the fans, which should be near the boilers which they are serving. In the ball mill the coal is rumbled with steel balls until it is ground to the necessary fineness. This type was fitted in the original installation of the S.S. *Hororata* after considerable experience of its performance in our power station at Falmouth. This mill is reliable but heavy, and requires too much space and power for marine work. The wear on its grinding parts is negligible and it is not damaged by tramp iron. It is, however, a mistake to suppose that tramp iron forms additional grinding material. It interferes with the action of the balls and should be cleared out at intervals. The product of this mill is not fine enough for marine work. The S.S. *Hororata* was originally fitted with three of these ball mills, firing three of her six boilers. The installation has now been increased, five of the boilers being fired by pulverised coal from five mills of a new design. These five mills occupy the same space as the original three ball mills. This mill is shown in Fig. 4. It is of the type known as ring and ball mills, with the lower or grinding ring rotating. The top or pressure ring is spring loaded by means of springs disposed at fixed distances along the outer cover of the mill. The ring is prevented from turning by two projections, but is otherwise free to accommodate itself to movement of the balls. The coal which has been previously crushed to pass through a ½in. mesh enters the small

BRITISH (I.M.M.)		AMERICAN (A.S.T.M)	
Mesh. Per inch.	Aperture. MM.	Nominal Mesh. Per inch.	Aperture. MM.
30	0·421	40	0·420
40	0·317	—	—
50	0·254	50	0·297
60	0·211	—	—
80	0·157	70	0·210
90	0·139	—	—
100	0·127	100	0·149
120	0·107	—	—
150	0·084	140	0·105
200	0·063	200	0·074

receiving hopper attached to the mill and arranged above the feeder. The feeder screw which is operated by a rocking lever driven from the central shaft can be regulated by holding out the driving pawl during the first part of the rocking lever's stroke, and a large range of variation of feed can thus be obtained. From the feed screw the coal falls into a sizing crusher; this reduces all the coal to a size such that it will pass through a $\frac{1}{8}$in. screen. The coal on leaving the crusher rings falls partially by gravity and partially by centrifugal force into the grinding ring. The grinding ring contains 15 steel balls, but there is sufficient space to accommodate 16

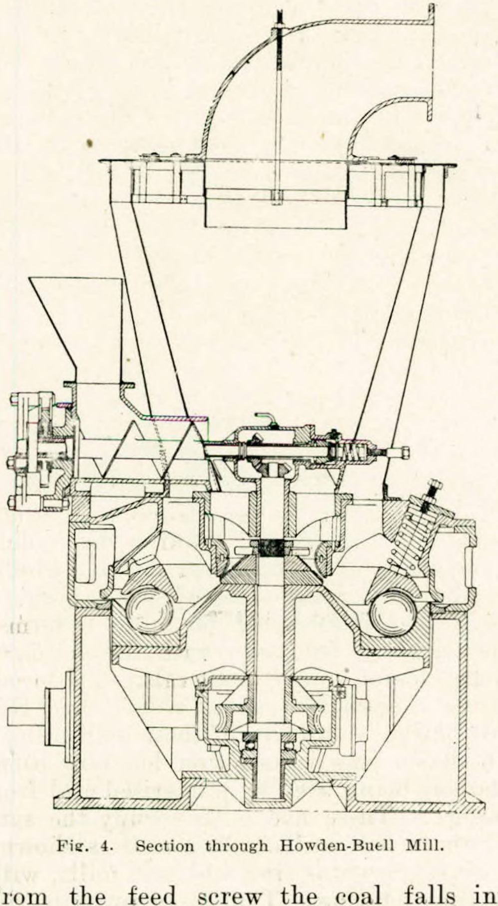

Fig. 4. Section through Howden-Buell Mill.

balls. The balls naturally arrange themselves so that there is only one gap between them. The coal in the ring is constantly being thrown out at the gap between the balls and is replaced by fresh supplies of coal. The entry port for the primary air is arranged round the grinding ring. This port is adjustable. The air enters in an upward direction and with sufficient velocity to carry away all the coal which is thrown out of the grinding ring. As this air passes over the presssure ring it turns vertically upwards and this change of direction allows the heavier particles to escape from the air stream and to fall back again into the inner side of the grinding ring, to pass through again. The fine coal dust passes through the separator and is classified again there. It will be seen that the coal only remains a very short time in the grinding ring before being thrown out to have the fine particles classified in the separator for passage to the burners. When the coal is thrown out of the grinding ring and blown back by the air current, particles which have a higher specific gravity than the coal pass out into the air belt and are removed at intervals by means of inspection doors arranged around the outer body of the mill. Coal which has been carried in the air stream and therefore dried, mixes with the incoming coal and thereby tends to reduce the moisture both in the grinding ring and crushing ring. Fig. 5 is a list of some of the coals which have been pulverised by this mill.

Ash.—When we commenced experimenting at Falmouth, we expected the ash to give us a lot of trouble. Slagging in the furnace was the most serious trouble we expected, and we certainly got it. The ash might be as liquid as water until the ashpit door was opened to remove it, when it turned into a sticky substance which can only be compared to toffee. The removal of the refractories from the bottom of the furnace completely cured that trouble. The return tubes were easily kept clear by steam tube blowers, but a large proportion of this ash remained in the smoke boxes. This presented a problem of no little difficulty. It was easily removed when the smoke-box doors were opened, but it blew all over the place and smothered everything in the stokehold. We easily devised an ejector to deal with a substance so susceptible to draught, but it is amusing now to remember what a long time we took to decide where it should be ejected—obviously, up the funnel is the correct place. We have never been troubled with ash in the uptakes. The S.S. *Hororata* has ash ejectors fitted in her uptakes, but they have never been used. We have never found

FIG. 5

FUEL ANALYSIS. HOWDEN-BUELL EXPERIMENTAL PLANT. BLACKWALL YARD, E.14.

	(1)	(2)	(3)	(4)	(5)	6)	(7)
Date	1/1/30	31/1/30	6/2/30	10/2/30	11/2/30	11/2/30	12/2/30
Coal	Townley Main	Jharia	Jharia	New Zealand	Jharia/Deshurghar	Jharia/Kankani	Deshurghar
Quality ...	—	No. 2 Grade	No. 1 Grade	—	65% 35%	50% 50%	McNeil's
Labelled ...	—	Batch No. 6	Batch No. 4	—	Batch No. 1	No labels	Batch No. 2
Moisture ...	3·0%	2·92%	3·0%	8·3%	2·2%	1·8%	4·4%
Volatile Content	23·75%	21·08%	18·0%	22·7%	29·8%	20·2%	27·6%
Fixed Carbon ...	69·25%	58·0%	69·0% dry	62·0%	56·0%	66·0%	56·0%
Ash	4·0%	18·0%	13·0%	7·0%	12·0%	12·0%	12·0%
B.T.U's per lb.	12,650 dry	11,200	12,250	12,875 dry	12,085	12,380	12,030

	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Date	18/3/29	18/3/29	18/4/29	11/3/29	11/3/29	11/3/29	11/3/29	29/4/29
Coal	Nigerian	Low Temp. Product	Durham Furnace Hards	Bothall	Nixon's Duff	Powell Duffryn	New Zealand Black Ball	S. African "Whitbank"
Quality ...	—	—	—	—	—	—	—	—
Labelled ...	—	—	—	—	—	—	—	—
Moisture ...	8·05%	·250%	0·825%	5·525%	·925%	1·05%	2·275%	1·025%
Volatile Content	39·05%	14·050%	28·375%	27·075%	12·235%	17·75%	31·125%	26·725%
Fixed Carbon ...	45·20%	85·7%	63·800%	47·000%	71·940%	72·90%	63·200%	55·350%
Ash	7·70%	Nil	7·000%	20·400%	14·900%	8·30%	3·400%	16·900%
B.T.U's per lb.	11,780	—	—	12,120	12,860 dry	13,260 dry	14,230 dry	—

any sign of ash accumulation round our experimental boilers, either in Falmouth or London, nor on the deck of the *Hororata*. Fig. 6 depicts the ash ejector referred to.

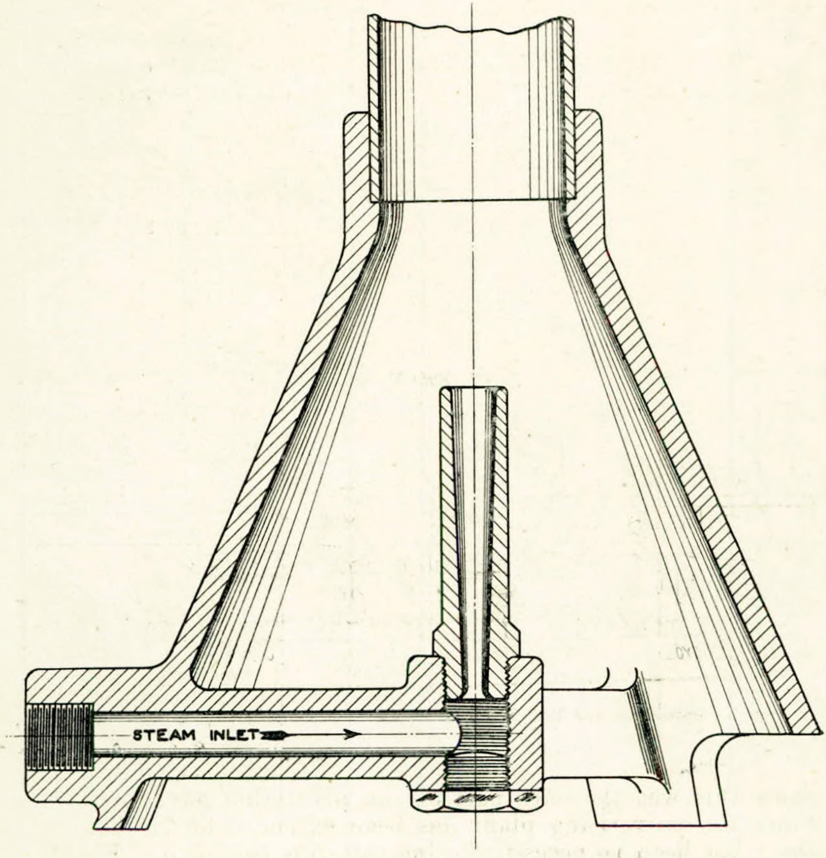

Fig. 6. Dust Ejector for Smokeboxes.

Elevators and Crushers.—The coal handling plant on the *Hororata* shown in Figs 7 and 8 has often been criticised as being unnecessarily elaborate. It has even been suggested that it is totally unnecessary. It is therefore advisable to give some explanation of its function. For the efficient operation of the pulveriser, it is important that the rate of feed shall be quite regular; this can only be accomplished by using crushed coal through a mechanical feeding device. Crushed coal is therefore stored in a ready-for-use hopper above the mills. This hopper may be any size so long as it maintains a steady supply to the feeders. The *Hororata's* hopper holds 65 tons, because it was considered advisable to have a large stock of crushed coal in hand in case of a breakdown in elevators or crushers. For the same reason, the elevating and crushing plant is in duplicate. Our caution was justified on the first voyage, because this was the only part of the plant that gave trouble. Since the pulverising plant has been extended to five boilers there has been no necessity to increase this part of it. Fig. 8 shows the experimental plant at our Blackwall yard.

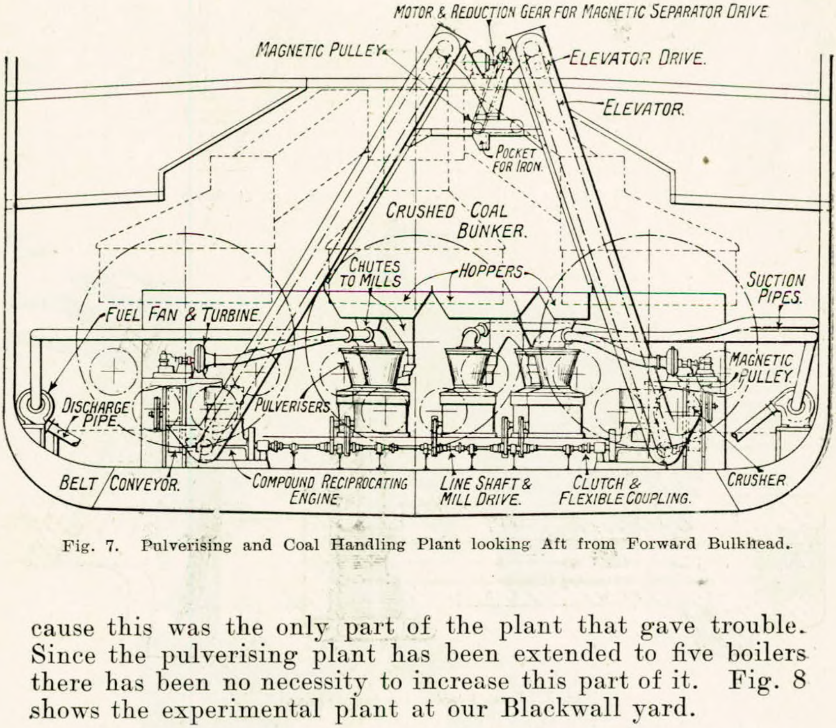

Fig. 7. Pulverising and Coal Handling Plant looking Aft from Forward Bulkhead.

The S.S. *Hororata* left Panama on April 15th on her third voyage to New Zealand under pulverised coal firing. She unfortunately experienced very heavy weather during her crossing of the Atlantic, and we do not expect to obtain any useful data from this part of the voyage. We hope that the voyage will be completed under more favourable climatic conditions.

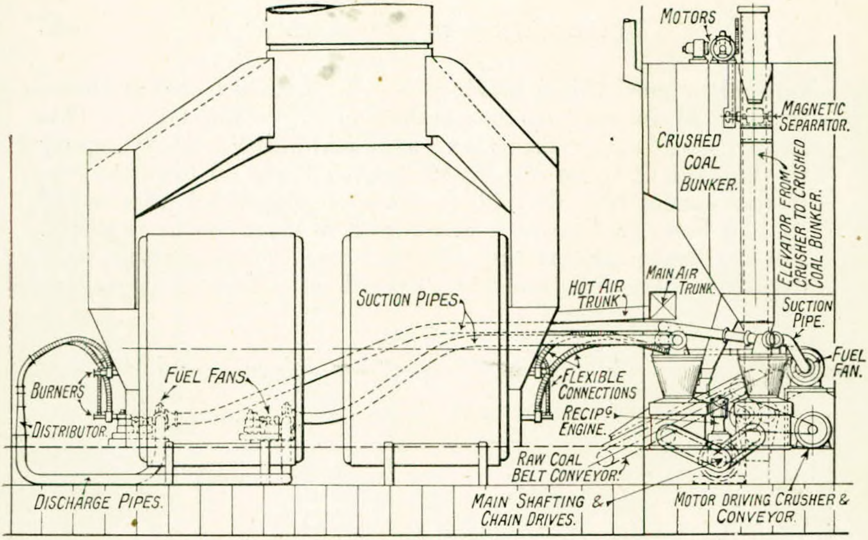

Fig. 8. Arrangement of Pulverising Plant looking from Starboard to Port.

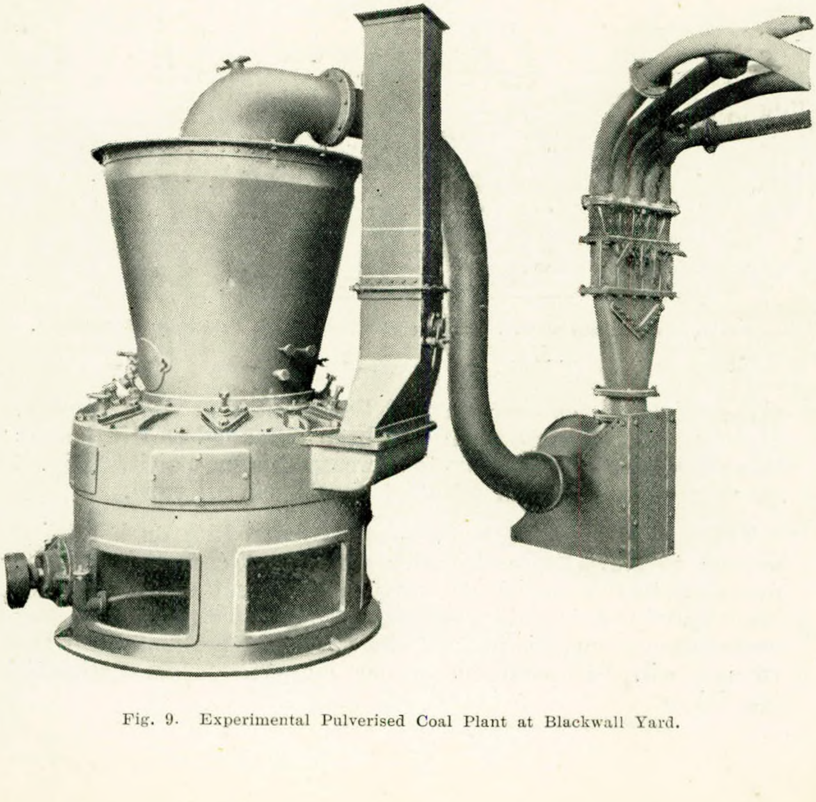

Fig. 9. Experimental Pulverised Coal Plant at Blackwall Yard.

The CHAIRMAN said that on behalf of those present he would like to congratulate Mr. Green on his most excellent paper and illustrations, which would certainly help many of them to understand powdered fuel practice more closely. He now called upon Admiral Scott Hill to open the discussion, but must at the same time express regret that owing to a prior engagement he had to leave before the discussion began.

Mr. H. J. VOSE (Chairman of Council) said that he was sure that they would excuse the President leaving as he had another engagement to fulfil, and that they would like to accord him a hearty vote of thanks for coming to preside during the reading of the paper.

The vote of thanks was carried with enthusiasm, and on the President's departure the chair was occupied by Mr. Vose.

DISCUSSION.

Engineer Rear-Admiral W. SCOTT-HILL (Visitor) said that there had been many papers on powdered coal, but it seemed to him that Mr. Green's paper marked a very definite change in the situation. Powdered coal-burning was no longer a new departure but established practice, and was on its way to improvements. It was interesting to see that Mr. Green's experience bore out the opinion that the mill was of very much more importance than the burner. Also it seemed to him that the designers of mills had now got a clear object and ideal to aim at. He noticed that Mr. Green's figure as to desired fineness of grinding was very close to the American figure given by Mr. Anderson MacPhee, of 97 per cent. through a 100 mesh and 88 per cent. through a 200 mesh. It might be said that the two sides of the Atlantic agreed, so that the mill makers could now go ahead with a definite knowledge of what was required. He questioned whether the battle of the high speed versus the low speed mill was quite over. He had heard the previous day of a low speed mill which claimed to use 7 k.w. per h.p. which was as good as the lowest speed mills of the "Hororata." It would be interesting to have the figures of the "Hororata" when she returned and they could be made public. It had also been interesting to hear how very easily the ash trouble had been overcome.

Engineer Captain J. HOPE HARRISON, R.N. (Member) said that they appeared to be getting a new line in papers nowadays, which was all to the good. They were now getting experts to come forward and tell them about their troubles and failures, whereas a short time ago papers only recorded successes. It was interesting to hear about the refractories in the furnace. Members would recollect that similar trouble had been encountered with oil fired furnaces. Was it necessary to secure the bricks round the mouth of the furnace, and were they special bricks with a high fusing point? It seemed to him, looking at the matter as one who did not know much about the practical side of this problem, that there was a lot of plant required for a small boiler. Could Mr. Green give a figure for the power absorbed in working mills, fans, elevators, and crushers? He had not mentioned what the coal consumption per H.P. was. How many firemen could be dispensed with when burning powdered fuel? Could Mr. Green say whether any special precautions had to be taken to ensure the efficient lubrication of the mill spindle and if excessive wear of journals, due to coal dust, was anticipated?

Mr. T. A. BENNETT (Member) said that judging by the criticisms which we read and heard about the burning of powdered fuel, there were evidently many difficulties associated with its application. If engineers visited one of the power stations equipped for burning powdered fuel and saw the large plant which was necessary, then tried to imagine putting a plant into a ship to do the same work with the small space available for the gear and the small volume of the furnace to burn the coal, they would realise the difficulty of the problem.

Considering the size of the combustion chamber which was necessary in a shore plant with water tube boilers, it was evident that a long flame was necessary to burn the coal completely. If the fuel were discharged straight into the furnace of a multitubular boiler from an open pipe the larger particles would pass beyond the limits of the flame without being burned. It required a flame 40 feet long to give complete combustion of pulverised coal, and this length could be obtaned in a furnace of a multitubular boiler only by fitting a snail in the burner to give rotation and make the path of the flame a helix. He was pleased to note that the author referred to the difference between turbulence and rotation. Turbulence only was necessary for burning oil fuel but coal must have rotation, and some turbulence was desirable.

In the paper it was stated that it was not possible to obtain rotation in the furnace. While agreeing with this statement in respect to the rectangular combustion chamber of a water-tube boiler he considered that rotation could take place in a cylindrical furnace, as the furnace could be considered simply as an enlargement of the burner.

With regard to the question of distribution, the arrangement in the "Hororata's" installation appeared so simple that there must be a "snag" somewhere or where did the difficulty of distribution arise? Powdered coal did not behave so regularly as diagrams seemed to indicate; sometimes the coal took one path and the air another, then without any apparent reason the paths were reversed.

Then there was the mystery of the disposal of the ash. All lecturers on powdered coal seemed to do a conjuring trick with the ash. It did not slag, it did not remain in the back ends or tubes and it was never found on the decks or around the station. He wondered where it did go. He had not heard much about the burning of powdered coal in water tube boilers on board ship. He thought there were possibilities in that direction which might be developed.

Mr. S. B. JACKSON (Member) said that he thought the paper was extremely interesting in its opening remarks. It went directly to the point that engineers should attempt at all costs to conserve the fuel of this country. For the reason alone that it had drawn attention to that problem, it was very useful indeed. It was distinctly within the sphere of an engineer to solve the problem. As a control engineer atttached to a power system which comprised in one station five 150,000 lb. per hr. boilers, and in another two 75,000 lb. per hr. and one 80,000 lb. per hr. boilers, he was not in full agreement with the Author. The implication in the paper was that powdered fuel firing was superior to any other method of firing. That was quite true as far as the process of combustion was concerned, but his experience was, through tests which had been very carefully conducted and the results of which could be substantiated, that despite his optimism three or four years ago he could not feel the same optimism to-day. The tests referred to the boilers he had just mentioned and were comparative with mechanical stoker-fired boilers. Their experience had been substantiated by the similar experience of Mr. Lamb of Manchester, where they had two precisely similar boilers, one operating under powdered fuel conditions and one under ordinary conditions. The powdered fuel fired boiler came out with an efficiency of over 0.5 per cent. less than the stoker-fired-boiler. This percentage on the boilers of the capacity of those at Manchester is actually equivalent to 5000 lb. steam per hr. at 350 lb. per square inch pressure. The tests were very carefully conducted, and were very convincing in that meticulous care and a period of six months was taken in order to form a definite conclusion. It seemed to him that before powdered fuel definitely substantiated its claim they would have to have boilers of not less than 250,000 lb. per hour.

Referring to the table given by the Author relating to classes of fuel used, one of the claims of the powdered fuel boiler manufacturers was that powdered fuel enabled a very great variety of fuels to be burnt, but a careful examination of the table in the paper revealed that there was very little variation between the fuels which had been used on those tests.

With the 75,000 lb. boilers in particular they were trying their utmost to secure for the manufacturers their claim that this low grade fuel can be economically and satisfactorily used. One of the fuels they were continually using was one having a calorific value of 9,500 B.T.U.'s and an ash content of 26 per cent. As far as his experience went he could say that they would not fail for lack of trying. Another important factor was the dryness of the coal, and it would be seen that the highest moisture content was 8.3 per cent. Now the question arose from the point of view of marine practice as to the necessity of taking special precautions in order to ensure that only very dry coal was taken in the ship's bunkers. The objection to that was that it would require very close sealing to avoid risk of danger in the bunkers.

On the question of efficiency, he remarked that although the paper gave some very useful information it did not give any data as to what efficiency had been attained, nor did it give the number of units per ton for the electric auxiliaries required to inject the coal into the furnace and to pulverise it. That information would be extremely useful. In his own experience the bin and feeder system was perhaps the most advantageous as far as the electric auxiliaries were concerned. In that system they had got down to 19 units per ton, but on the direct-fired system or the unit system they could not get lower than 22 units per ton. It was a remarkable fact that the units per ton were a direct function of the moisture content of the coal. In one case the units per ton had risen to 30. If they did not know what classes of fuel they were to be supplied with on leaving port it was of great importance to know that that fuel was going to be as dry as possible. With regard to the fineness, the Author had said that fineness was a relative term, and " that it was necessary to establish some standard of fineness which was desirable, because the cost of grinding might be carried beyond the economic limit." What was the economic limit? The term seemed very loose, and he would like some elucidation on the point.

He wished now to be congratulatory on the extreme simplicity of the installation described by the Author and on the success which had been secured by the removal of the refractories from the bottom of the furnace. Judging by the success which had been obtained it occurred to him to wonder why they had not tried that method before. After one week's operation on the coal which he had described it occupied sixteen men for eight hours to remove the slag from the bottom of the furnace. That was a very serious maintenance charge, when one had to determine the labour costs for the removal of such slag. He might add that he was closely associated with a system in which they were trying for the first time in this country the electrical precipitation plant. Perhaps on a later occasion he might be able to tell the members how it operated. The grit nuisance was a very serious problem and he hoped that Mr. Green had been as successful in solving that problem as he had been in solving some of the others.

Mr. T. CLARKSON (Member) said that it had really been a great pleasure to listen to such a practical paper as Mr. Green's. Although congratulations were usually "taken as read," he thought that a great tribute was due to the Author both for the paper and the way in which it had been delivered. He would like to ask for some information as to the amount of power or the steam consumption required in operating the auxiliaries, in other words the efficiency. Also he asked what percentage of moisture was permissible in the coal which a ship might be going to use. He was interested to see that Mr. Green had emphasised the importance of arranging for the flame to fit the combustion chamber. That was an important point. In the case of water-tube boilers, marine practice went up to 8 lb. of oil consumed per cubic foot of furnace volume. It would be interesting to know how much coal could be burnt per cubic foot of furnace volume with Mr. Green's plant. By judiciously shaping the flame he had been able to burn 26 lb. of oil, and in some tests over 50 lb. without any local cutting action. He asked, was the Scotch boiler the ideal boiler for powdered fuel? It was a very good practical boiler and it had stood up to the requirements for many years, but after all, was it the ideal boiler for this different system of combustion? He recognised one difficulty in its relatively small furnace volume, which of course meant a higher degree of pulverisation and power to break the coal down to the necessary degree of fineness. He did not think one need assume that the Scotch marine boiler was the one boiler to which the powdered fuel system was necessarily wedded.

Ash and slag had been one of the principal difficulties in the past. Referring to Fig. 8 and the number of horizontal pipes conveying the coal from the mill to the burners, there would be times when the fans were stopped; accordingly this would result in an obstruction, due to a reduction of the effective area, and the natural result would be that due to accumulation of pressure, coal would be swept through and there would be a liability of a blow back. Coal was not like a gas or a liquid; it had ways of its own. Mr. Green had indicated some of the difficulties due to segregation in the pipes. He (the speaker) put forward a suggestion which he thought might be useful, based upon a machine which he designed some years ago for sampling purposes, namely, that of feeding the coal through a rotating hopper and thence through radial knives with sharp edges which would slice up any segregations and maintain accurate proportions from the separate outlets.

Mr. ANDERSON MACPHEE (Member) said that with reference to the ball mill which Mr. Green had mentioned, he would like to ask him whether he meant a tube mill. The Author had said that in a ball mill the coal rumbled around with the balls and was thus pulverised. If Mr. Green meant a tube mill he thought his conception of a ball mill was somewhat wrong. The balls were picked up to the crown of the mill and dropped, giving a true inpact blow.

Another point mentioned by the Author and also by Admiral Scott Hill was the comparison between American mesh and British mesh in fineness of pulverisation. Neither the Author nor Admiral Scott Hill went as far as American practice went. Their degree of fineness was 65 per cent. to 75 per cent. through a 300 mesh. There was a great quantity of the product which would go through a 500 and probably a 1000 mesh, and it was this quantity which gave such a good flame propagation. Mr. Green had said that the ball mill did not give a product fine enough for marine work, and yet a ball mill installation in the ss. "Mercer," after the fourteenth trip, was still operating successfully. He thought the first ship to be fitted with powdered fuel was the ss. "Illinois" on the Mississippi River, which had now been operating successfully for five or six years, so that it did not appear that the tube mill was so unsatisfactory after all.

Referring to the question of space occupied, he happened to have been figuring that day on a proposal for a ship, and in order to put in a three-unit tube mill the actual space occupied by the mills was between 3 per cent. and 5 per cent. of the existing bunker space, showing a total saving of 20 per cent. bunker space, i.e., if one took off the 3 per cent. to 5 per cent. occupied by the mills, the actual saving was about 20 per cent.

With reference to tramp iron in the tube mill, that not only did not do any harm, but was actually a benefit. Where one was using wet coal the tramp iron counteracted the tendency to sticking in the tube mill. The Camden

Forge Company on the Delaware River had stopped using balls and were using scrap iron found about the Works! With regard to wet coal, Mr. Harold Yarrow had stated that he had used a tube mill and had successfully handled coal containing up to 25 per cent. of moisture. At that moisture content the capacity of the mill was reduced by 30 per cent. One was not likely to get 25 per cent. of moisture in coal supplied to a tramp steamer; one might get 12 per cent. to 14 per cent. He had recently spent about three months in Spain installing a Kennedy plant. In that installation they had burnt Scotch washed coal, Welsh steam coal, and the native Spanish coal of about 12,000 B.T.U.'s and ash 12 per cent. to 20 per cent., quite successfully. That coal was exposed to the atmosphere the whole of the time. It was thrown off the tip and left exposed to the terrific rain for which the locality was notorious. He estimated that there was 12 per cent. to 14 per cent. of moisture in the coal.

In connection with turbulence in the furnace produced by rotation of air in the burner, as to whether this is beneficial or not, he referred to the peculiar type of boiler known in America as the Brady Scotch boiler. It was similar to the Scotch boiler with which they were all familiar at sea. The furnaces, however, were from two to three times as long. He had seen one where the furnaces were 18ft. long. The Kennedy Company had installed powdered fuel on one of these boilers and the burners were similar to the one which Mr. Green had shown them on the screen. These burners had what Mr. Green called a "snail" in the primary air division. However, both the primary and secondary air were brought to the burner tangentially and by this means a rotating motion was given to both the coal and the air entering the furnace. Contrary to Mr. Green's statement this rotating motion was maintained right to the end of the 18ft. furnace, and he did not see how there could be any question as to whether there was turbulence or not with this rotation. He found that in order to get the correct amount of turbulence it was necessary to maintain two velocities, to bring the primary or fuel-carrying air at one velocity and the secondary air at another velocity. That gave the necessary scrubbing action and complete combustion.

As regards the question of ash, he had noticed that it always created amusement. The Scotch boiler to which he had referred, in Philadelphia, was operated from the first week in June to the first week in October and no ash was taken out. Where there was correct fineness of pulverisation there was no ash problem. That had been borne out by his experience in Spain where the Kennedy Company had equipped a water tube boiler at the Rio Tinto Mines. At the final inspection and test one of the directors asked where the ash was and stated that the furnaces must have been cleaned out in preparation for this inspection. On the contrary the boiler had been working continuously for a matter of eight to ten weeks consuming over 4,000 lb. of coal per hour, and practically no ash had been removed. The only place where there was any accumulation of ash was at the back of the boiler where there was a matter of 5in. or 6in. This back pass had never been cleaned out and probably has not been cleaned to date. If the pulverisation was fine enough there was neither trouble from ash nor slagging.

Mr. W. McLAREN (Member) endorsed previous speakers' complimentary references to the opening remarks in Mr. Green's paper as to the importance to this country of the efficient exploitation of the nation's coal reserves, particularly in view of the inevitable increase in the cost of coal as the mines become depleted while the demand for fuel for the nation's industries continues to grow. Paradoxically it appeared that the more the engineer succeeded in his efforts to burn the low grade qualities of coal, the higher went the price. He mentioned a test carried out 27 years ago with a core mill, which gave an output from a 6in. mill of 2 cwt. for an expenditure of 2 h.p. A similar 11 in. mill gave about 7 cwt. for a power consumption of 7 h.p. Those mills would run for about 4,000 hours before replacement of the core became necessary, which was an expensive matter, being about one-third the initial cost (£130) of the mill. He would like to know what would be the cost of the Howden-Buell mill described by the Author, and what would be its power consumption. He quoted some figures obtained from his experience in connection with the manufacture of cocoa powder; a mill of the "Attritor" type had taken about 15 h.p. to crush 500 lb. of cocoa, whereas the Beater mill which he was using for sugar required about 30 h.p. for the same output. These mills had to run at about 3,000 r.p.m. He asked whether the mills which were used in marine installations caused any trouble through vibration. Also what was the size of the balls used? Were they all in motion when the pan was running? And was any means provided to keep them separate and prevent jambing?

Mr. D. LAUGHARNE THORNTON (Member) (by correspondence): On page 395 of Mr. E. W. Green's paper, one is informed with regard to certain comments on the size of the flame, "that the path of the particles plays no part in this calculation; no rotary or tortuous path will have any effect on the volume of the gaseous matter undergoing combustion." This statement would appear to require modification in so far as, in general, the more tortuous the path of a particle of fuel, the more fresh oxygen it will encounter inside the combustion space; therefore, the character of the path taken by a particle affects in a marked degree the *rate* of combustion. With the present trend of boiler plant design, this aspect of accelerated combustion is an important one. In view of the later remarks concerning turbulence, the quotation in question would possess a better interpretation than it at present suggests if it were incorporated into these subsequent observations on turbulence.

Engineer Rear-Admiral W. M. WHAYMAN (Vice-President), Messrs. Babcock & Wilcox, Ltd. (by correspondence): I agree with Mr. Green that the most important component of a pulverised fuel installation is undoubtedly the mill.

Mr. Green has given us some information in respect to the pulverising mills originally fitted in the "Hororata" but it is desired to differ from him in his opinion that the product of this mill is not fine enough for marine work. The fineness of grinding depends on the rate at which, as well as the way in which, the mill is operated. I have not in my mind the output for which the mills originally supplied to the "Hororata" were intended, but it has just occurred to me to suggest that they were used for outputs above their intended capacity, and some information from

Mr. Green as to this capacity on service would be very welcome.

For an output of 1,500 to 2,200 lb. of coal there has been installed at the Renfrew Works for experimental purposes a mill of next larger size than the ones that were originally installed in "Hororata." The weight is only about a ton heavier and the space about 10in. greater on the major axis but it has an increased capacity of about 50 per cent. Recognising, however, that the Fuller-Bonnot mill is regarded as too heavy and occupying too much space, during the last 2½ years a ball mill, in some respects similar to the type now installed in "Hororata" by Mr. Green, has been in process of development. On 33in. diameter, however, an output of 10 tons is aimed at as compared with say one ton in "Hororata."

Some members who took part in the discussion have raised the question of the amount of power required for working the pulverised fuel plant. In my paper before the Institute of Fuel in October last, I gave figures for power required for working the ball mill, such as originally used in "Hororata," a fuel fan and air fan, as 3.75 per cent. of the steam output per hour. This was based on the assumption that the plant was electrically driven and that the power could be obtained at the rate of 12 lb. of steam per k.w. hour. In some recent results obtained at Renfrew a figure as low as 2.5 per cent. of the steam output on the same basis of 12 lb. of steam per k.w. hour has been recorded, and this may be regarded as a not unsatisfactory figure.

Swirling is commonly used to produce turbulence, and manufacturers making swirling types of burners have created the impression that swirling is the only means of producing turbulence and that burners having no swirling are not turbulent. This is not always true, for while some swirling burners are turbulent, others tend to segregate the coal into streaks and fail to accomplish the mixing desired. In general, swirling of the secondary air is good, at least not harmful, but swirling of the primary air while still within the burner tends to segregate the coal.

I should like to express my thanks and congratulations to Mr. Green on a most informative and instructive paper.

Mr. E. F. SPANNER (Member) (by correspondence): I regret that circumstances prevented me from attending the discussion on Mr. Edward Green's paper.

In the first place I should like to congratulate Mr. Green and those who have been associated with him in the production of the pulverised fuel installation which is now functioning on the "Hororata." I have been a careful student of pulverised fuel firing propaganda for some time, and, of all the systems which have been put forward, that on board the "Hororata" appears to me to be greatly in advance of any of the others. It appeals to me for several reasons:—

Firstly. As a naval architect I believe that the "Hororata" installation from the crushed coal bunker onwards is on the right lines. From a survey of the bunkering problem, i.e., the problem of loading and carrying fuel suitable for burning as pulverised coal, I have always been strongly inclined to the view that the final development of this type of installation will see ships bunkering coal in crushed form. I do not think it is economical to carry crushing plant on board the ship, and consider that this preparatory work on the coal should be carried out on shore. It could be done much more economically there, for several fairly obvious reasons.

From the naval architect's point of view it would appear desirable that the end to be arrived at so far as marine work is concerned should be the bunkering of ships with crushed coal, passing $\frac{1}{2}$in. mesh, this coal being placed on board by mechanical means, through enclosed trunkways passing through the ship side and not overside, and being distributed to bunkers once it was within the ship by a combination of mechanical and gravity operated apparatus. The mechanical portions of the bunkering plant would, in the ideal, belong to the shore plant, and be available for all ships requiring crushed coal.

On the ship the crushed coal would be stowed low down, in more or less ordinary type bunkers, being fed mechanically from these bunkers to small ready-to-use bunkers serving the pulveriser hoppers by gravity. The increased danger of gassing and spontaneous combustion in the bunkers due to the small size of the coal will probably be solved, not by the use of airtight bunkers filled with inert gas, but by some method of arranging continual flow of slightly warm, dry, inert gas through the bunkers, this serving to dry the coal and maintain it dry, as well as to " kill " the combustible gases given off by the coal. When steaming, the supply of inert gas would be easily obtainable from the funnel; when in port it might be necessary to seal the bunkers practically airtight, or else to go to the other extreme and pump relatively large supplies of fresh air instead of inert gas into the bunkers. Certainly with any inert gas system special attention would require to be paid to the problem of protecting the stokehold personnel, but I believe this problem is not one particularly difficult of solution. There are several ways of tackling it.

Secondly. The practical and theoretical investigations which have led to the discovery that the Howden-Buell burner is satisfactory for use with pulverised fuel appear to be very encouraging, for the reason that the form of this burner is extremely simple. It is notable that many strikingly successful inventions are those which are simple and direct in their design and operation, and Mr. Green has made it clear that from both the theoretical and practical points of view the Howden-Buell burner is substantially free from complications.

Thirdly. It seems to me probable that the Howden-Buell distributor will prove efficient in solving the problem of obtaining satisfactory distribution, although I should be glad if Mr. Green would tell us to what extent the steady flow of fuel to the burners is affected by extraneous circumstances. It would be interesting to have a brief outline of the nature of the factors which interfere with steady flow, and the effect of such interference on conditions in the furnaces.

I hope that, even if the data obtainable from the third voyage of the " Hororata " during very heavy weather is not encouraging, purely as regards the comparison of figures for fuel burnt and distance covered, we may yet be given such extracts from the logs as will satisfy critics of the Howden-Buell pulverised fuel system that the vessel suffered no greater setbacks owing to weather than would have resulted to a vessel fired by hand.

In conclusion I should like to say that this is the most satisfying paper on pulverised fuel that I have yet read.

The AUTHOR'S REPLY.—The Author, in reply, thanked Admiral Scott Hill and the other speakers who had taken part in the discussion.

Captain Hope Harrison had asked how the refractories were secured. They used short angles of heat resisting steel about 12 ins. or 15 ins. long; two of these were fitted on each side of the furnace. These carried three arches of refractory bricks; each arch was composed of three sections of ordinary flue linings 2 ins. thick and 12 ins. long, 3 ft. long in all. The angles became covered with ash which in practice was never removed, so that they were not exposed directly to the radiant heat of the flame. They lasted very well, much longer than he had originally expected. He doubted whether any were left which were fitted in January of last year. The studs holding those angles which passed right through and were in contact with the water on the other side did not seem to require renewal at all, although he had anticipated that they would. If they had to remove those studs too often there might be trouble, but fortunately this did not occur.

Captain Hope Harrison also wanted some data regarding power consumption. When he wrote the paper, the *Hororata* was only ten days out from London, and he could not expect to give much data after such a short run. Since then he had had reports from Panama. The ship had experienced terrible weather and consequently he had no data of any value. He would like to state that though much useful knowledge was being gained from this voyage, it was unlikely that it would provide any data of a sufficiently reliable character to be published.

Mr. Bennett had spoken of flames 40 feet long. Surely he was referring to rotary kilns where long flames were advantageous. It was not stated in the paper that it was impossible to obtain rotation in the furnace, but that the burner could not impart rotation to the fuel. It was quite possible to inject the fuel in a tangential direction; the furnace walls would then divert the stream and caused the whole mass to rotate. It was the furnace walls and not the burner which produced the rotation; the burner imparted only the initial straight line motion. In a later reply the author explained why, in his opinion, this was in the first place not permissible, and secondly, produced no useful result. With regard to the application of powdered fuel to water-tube boilers for ships, he (the Author) had had no experience of that so far. He would expect that a somewhat larger combustion chamber would be required for water-tube boilers than was required for Scotch boilers, but Admiral Whayman, who was an expert on that subject, was seated in front of him, and perhaps they might persuade him to read a paper on the subject.

Mr. Jackson had certainly given them a great deal of information. In the paper he had said that it had long been known that theoretically coal could be burnt under the best conditions in the powdered state. He should think that the results obtained by Mr. Jackson as between powdered coal and coal burnt in chain-grate or mechanical stokers might be described as a dead heat if there was only 0·5% difference in the comparative efficiences. Powdered fuel practice was very young yet, whereas the chain-grate stoker had had a long start. They hoped soon to catch up. He hoped that no shipowner was so unwise as to use coal of the quality Mr. Jackson had mentioned. Coal used in a ship had to be carried, and he did not think shipowners were going to carry ash round the world and think they were saving money. He was no advocate of cheap inferior coals for use in ships though they might be used advantageously on land. The table giving the classes of coal used was not intended to indicate the variety which could be used, but rather to show that suitable coal could be obtained where required. The expression "economic limit" was intended to be loose; time and experience would show what this limit was, and the Author gave an indication of what it might be.

With regard to Mr. Clarkson's question concerning horizontal pipes, there was a special note in the reports which he had received from the *Hororata* from Panama, that the long pipes had given no trouble whatever. Mr. Clarkson had asked whether the Scotch boiler was the ideal boiler for pulverised coal. In view of the fact that it was developed for hand-fired-coal firing it was unlikely to be ideal for a totally different system. On the other hand it had stood the conversion to oil without any alteration in design, and except in a very limited field it was likely to remain the marine boiler for some time yet. The smallness of the furnace volume had a compensating advantage in the nearness of a large mass of water to the hottest part of the flame. This not only received great quantities of heat under favourable conditions, but by keeping down the temperature of the flame adapted it to the small combustion space. Its principal handicap was that access could only be obtained to the combustion space through the furnace front, a consequence of its virtues. Mr. Clarkson's feeder appeared to be adapted to a storage system, but would not distribute air-borne fuel.

Mr. MacPhee had objected to calling the mill a ball mill. He (the Author) thought that that was the term used by the Patent Office in this country. He had no objection to calling it a tube mill, if it was preferred. The Author was not unacquainted with the theory of the ball mill given in the publications of Mr. MacPhee's firm. The word "rumble" ("to treat in a tumbling barrel," Webster) was purposely used to describe this process because it appeared to avoid any criticism of the theory.

Mr. MacPhee had given cases of marine boilers successfully fired by ball mills. These ships were, however, engaged on short voyages with opportunities of cleaning out the mills if required. The *Hororata* was away for five months or more without any such opportunity, and on her return to this country the mills were found to contain much tramp iron and rock dust, which, in the Author's opinion, impeded the action of the balls. The Author had not tested pulverised coal through a sieve of more than 200 wires because there was no finer standard mesh. With over 90% passing a 200 mesh a considerable percentage would pass the finer mesh.

In reply to Mr. McLaren, the balls were 6 ins. in diameter. They rotated continuously at one-half the speed of the turn-table. Mr. McLaren's comments on the paradoxical vagaries in the price of low grade coal had been noted by other engineers. The two small mills mentioned by Mr. McLaren were interesting; their efficiency was very high, especially the smaller one, but perhaps they were fed with very finely crushed coal. The "Attritor" mill referred to would of course include a fan, and its power should not be directly compared with the others. The same remark probably applied to the "Beater" mill.

Mr. Laugharne Thornton's letter was typical of many queries the Author had received on the same subject. These overlooked the fact that the fuel was air-borne, and whatever path it might follow through the furnace was determined by the air, or gas, current in which it floated. The fuel particle therefore encountered no new gases by virtue of the length of its path;

it must be blasted out of its state of comparative quiescence by a neighbouring particle which had met oxygen, this neighbour having met similar treatment from another, and so combustion was maintained so long as this interchange of disturbance was continued. It had been suggested that lengthening the path would give more time for these chance encounters to take place; this, however, was not the case, because the fuel was always being displaced by the arrival of fresh material in the furnace, therefore the time that any particle could remain in the flame could only exceed the average time, which was less than one second, at the expense of some other particle which must be driven out to make space for it.

It had been argued that the lengthening of the path even without an increase of time would give greater opportunties of these meetings. The Author agreed that this would be true, but asked "What was this path to be?" The simple rotation of the whole mass of gases and fuel would not change the relative positions of its parts, and was therefore of no value. The records of the Patent Office showed many efforts to produce interlacing streams, but always overlooked two vital factors. These were firstly that the fuel must never touch the boundaries of the combustion space or it would either be extinguished by the cold steel of the furnace plate or would stick to the hot refractory brick, and secondly that the ignition of the fuel as it entered the furnace amounted to a mild explosion which entirely obliterated any predetermined streams set up by the burner. There remained then the possibility of setting up artificial turbulence by subsidiary streams of air introduced into the furnace after combustion had commenced. This was an arrangement which was used in the furnaces of water-tube boilers; it was, however, difficult to apply to internal furnaces and would probably produce no material improvement in the small combustion space of a Scotch boiler. In the Author's opinion, the simple axial flow of the gases and fuel offered the best solution of the problem.

In reply to Admiral Whayman, the Fuller-Bonnot Mills fitted in the *Hororata* had a maximum output of 2,000 lb. per hour. The normal consumption of the boilers was 1,500 to 1,700 lb. per hour; the mills were therefore not overloaded. The Author could agree with the Admiral that swirling of the secondary air was at least not harmful, but he could not agree that swirling the primary air while still in the burner tended to segregate the coal. The Howden-Buell burner swirled the fuel while it was still within the annulus, but it was thrown from the lip of the cone with no tendency to segregation.

The Author agreed with Mr. Spanner's comments on crushed coal for bunkers; such supplies were, however, not yet available, therefore an ocean going steamer must be equipped to handle run-of-mine coal. The danger of spontaneous combustion was not as serious as Mr. Spanner thought; the conditions necessary for combustion rarely existed and took some weeks to develop. While funnel gases were warm and inert, they were not dry and were not a good coal-drying medium. As Mr. Spanner said, there were other ways of tackling the problem.

Mr. Spanner asked what were the factors which interfered with steady flow to the burners. The flow in the fuel pipes was not steady (stream line); it was always turbulent, to prevent the fuel dropping out. It was possible that Mr. Spanner meant "continuous." Lack of continuity of the flow of the fuel would be a very objectionable feature, but fortunately it was very uncommon. The Author knew of no extraneous circumstances which might produce it.

In conclusion, the Author expressed appreciation of the kind way in which his paper had been received and discussed.

Mr. J. HAMILTON GIBSON (Vice-Chairman of Council) proposed a hearty vote of thanks to Mr. Green for his most interesting paper. For his own part he had read the paper with extreme interest, particularly the first part, as he did not think he had seen the position as regards powdered fuel stated more concisely from a historical point of view. He admired the literary merit of the paper almost as much as the information given. They must all bear in mind, he thought, that powdered fuel was going through its teething troubles. Many of them were old enough to remember the troubles attending the burning of oil fuel 25 to 30 years ago, and naturally powdered fuel had to tread something like the same difficult road. They must also remember that the burning of powdered coal was after all a much more difficult matter than burning oil, because the correct mixture of coal and air, as had been mentioned by several speakers, was an extremely difficult thing to follow up and to govern. This was the last paper of the session and he certainly thought that it was one of the most valuable and important of the series.

mony assisted by all the members of the Government, Ambassadors, Ministers and Charges d'Affaires, and the chief delegates from the various nations were all on the platform. It was a very interesting ceremony and passed off extraordinarily successfully, commencing with the Japanese National Anthem, followed by an address from Prince Chichibu (who mentioned that the Emperor wished the Congress every success), the Prime Minister and the President of the Congress. Shortly afterwards a special meeting was held, when rules and regulations were passed in order that the business of the Congress could be properly conducted.

The following day we commenced work. The Congress meetings were held in the Houses of Parliament. They were well arranged and organised. The sessions were from 9.30 a.m. to 12.15 noon, and from 2.30 to 5 p.m.

800 papers were presented and a special committee, appointed about 14 days before the Congress, made a selection of the papers to be read and discussed. Naturally, the question of precedence of the various delegates in the opening, closing, and all the other ceremonies was a very important matter, but this was settled in a friendly way by alphabetical order. America came first, Great Britain second, and so on.

There was a notice board giving all directions for the 12 sections for each morning and afternoon session, and the names of the authors and titles of the papers in the sections, so that all who were interested in any particular subject knew where to go.

A number of papers were contributed by Japanese engineers on highly technical subjects, amongst them being one on the construction of steam turbines in Japan for naval and mercantile marine purposes; another paper on the largest steam turbine constructed in Japan, and the third on the theory of torsional vibrations and oscillations in turbine rotor shafts. These three papers were of a very high standard. This in itself shows the rapid progress of engineering in that great country.

I contributed a paper on the education of an engineer, tracing our experience over the last 25 years. The discussion was extraordinarily good. A number of the senior professors from the Universities took part in the discussion, and one professor pointed out that he would like us to realise that a Japanese was at a disadvantage, because he had first to learn English, as there were no textbooks from which to read other than English, and that added another four years to the period of training. That is one lesson which came out of the paper. It was very interesting when various papers were read by either Germans, Swiss, Italian, British or Japanese authors, to see all these delegates one after the other, going up to the rostrum and debating in English. It was really a remarkable revelation of how the English language is to-day spreading all over the world.

There were nine papers selected for each morning and afternoon in every one of the sessions. When these 800 papers are printed, which will be in about a year, the Japanese people will obtain a profound knowledge from this great collection of engineering technology. I do not suppose that ever before have so many eminent engineers been brought together with this one common object, and certainly there never has been such a record of technical papers.

Apart from the technical side, there was the social side, and that was the most difficult of the two. The hospitality was simply overwhelming. The luncheons, garden parties, tea parties, dinner parties, and evening receptions hardly allowed us time to sleep. One met the same people at each function. The garden party which the Emperor gave in his marvellous garden was really a wonderful picture, with the rockeries, waterfalls, pines, chrysanthemums and other lovely flowers all growing in profusion, and the ladies dressed in the beautiful national Japanese costumes added to the scene. It was really a memorable sight and such as we could not repeat in this country. The official dinners were very interesting, but there was always a penalty when at the last minute one was commanded to respond for the British Empire.

The question has been asked: " What is the use of this Congress? " It has been of the greatest use; most important of all it brought representatives of all nations together. As an illustration, the German delegates were all of high intellect; humorous and good fellows. The Italians sent their greatest engineer of to-day—Senatore Luigi—a man of great experience who had a fine voice and could be both rhetorical and humorous. It was a privilege to hear him. The same remarks apply to our friends from Sweden, Denmark, and other countries. The Chinese delegates were also interesting. I was absolutely taken in at one luncheon party. Beside me sat a man immaculately dressed, who spoke beautiful English, and I happened to say to him " Where do you come from? " " China, I belong to the Nanking Government; I am chief engineer to the Nanking Railway " he answered. " How is it you speak English so well?" I asked. " Oh, I was educated at Oxford," was his reply.

The delegates from the United States of America were the most numerous. Their leader, Dr. Sperry*, well known in Japan, was very prominent. He took a leading part in all the ceremonies, and a fatherly interest in all the delegates.

A General Committee established in the United States of America, and presided over by Mr. Hoover, had worked for about two years, looking after the interests of the delegation, formulating a policy, and preparing a general scheme for the Congress. The result was that all the delegates travelled to Japan together in specially chartered ships, with an organised Committee and staff; everyone knew each other, and each delegate had his prescribed duties formulated. The Committee had offices in the Imperial Hotel, Tokyo, where any information could be obtained from specially appointed secretaries. Their organisation was well thought out and complete in every detail.

As regards the British Delegation, while we were represented by men of outstanding ability, we had no organisation, no plan of campaign, no office, no committee, no headquarters, consequently opinions were expressed, especially by those British delegates from Overseas Dominions of the want of co-ordination and organisation. As a matter of fact, the British delegates did not meet as a body during the whole of the Congress. It is obvious to me that if we are invited again to attend a World Engineering Congress, then we must adopt the American method of setting up a National Committee and think out every detail and go prepared with a pre-arranged scheme setting forth the duties of the various delegates and leaving nothing to chance.

I think the fact that delegates of all nations visited Japan on this occasion has given the Japanese great encouragement in engineering. There were many who had never visited Japan before. It is a very good thing that the East and West should mix a little more, and there is no doubt that this Congress will have a very far-reaching effect on all peoples. We had the advantage of seeing how the Japanese live and how they bring up their families. The Japanese pick up new ideas very

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*Dr. E. A. Sperry died on June 10th, 1930.

quickly. If they can build a battleship, a 20,000 ton merchant ship, locomotives, aircraft, and huge hydro-electric power stations, they can do anything.

Japan has looked on Great Britain as her friend and guide; she has adopted some of our laws and curricula in her schools, while some of the most distinguished Britons have occupied professorships at the Japanese Universities. The Japanese Navy has been founded on British lines, and the same remarks apply to their Mercantile Marine.

The present Emperor came to London some six years ago, and he was entertained by the Japan Society; that was the first time in the history of Japan that a member of the Imperial House had ever sat down with commoners. Subsequently his brother, Prince Chichibu, came to Oxford to be educated, but owing to the illness and death of his father he had to return to Japan. During the Congress, Prince Chichibu gave a garden party in his palace grounds, and it was just like friends sitting down to tea. Such a thing had never happened before in Japan. His Royal Highness the Prince of Wales visited Japan in return for a visit of the present Emperor, and they were astounded to think that the Prince of Wales would play golf on the Japanese courses; consequently His Royal Highness set the fashion. The episode which brought a climax was when the Duke of Gloucester went quite recently to confer the Order of the Garter on the Emperor. For the very first time in their history the Emperor left his Palace and went like an ordinary mortal to the railway station to meet His Royal Highness.

The Japanese are a highly intellectual and noble people, and we have a lot to learn from them. It is a country I advise everyone to go to who can, as they will thoroughly enjoy the trip and will come home with a wealth of lasting information.

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ABSTRACTS.

OIL FROM COAL.

"The Motor Ship," June, 1930.

The production of oil from coal has been a continued source of disappointment for many years past to those who believe that a good deal of the hope for the future for the coal industry rested upon the development of a satisfactory and economic system of producing oil from coal on a very large scale.

It is at least gratifying to know that attempts have not been given up, and Lord Melchett last month, in his speech before the shareholders of the Imperial Chemical Industries, stated that great progress had been made in the field of the conversion of coal into petrol and fuel oil by hydrogenation, and that intensive work was being carried out on the subject. He had "every reason to hope that under favourable conditions we shall be able to produce high-class petroleum products on a commercial basis."

It is as well, however, not to be too optimistic regarding the possibilities of a development of this nature which, if effected, would naturally be welcomed as a partial solution of the problems of the coal industry, whilst it would afford desirable competition in the oil market.

SPACE ECONOMY IN ENGINE-ROOMS.

"The Motor Ship," June, 1930.

Changes in propelling-machinery types lead to modification in the design of auxiliaries. In some respects the developments thus reflected are almost fundamental. When Diesel motors were first used, steam auxiliaries were often retained, but they have almost wholly given way to electrical plant, with Diesel-driven generators to supply the current—a system which has now to be adopted even on high-pressure turbine steamers if reasonable economy is to be achieved in the overall consumption of fuel.

In the design of engine-room auxiliaries another change has gradually occurred in motor ships in the utilisation of electrically-driven direct-coupled vertical pumps, in place of the horizontal design, with a consequent economy in valuable engine-room floor space. This has extended from circulating water pumps to bilge, ballast, emergency, sanitary, fresh water, fuel, brine and other plant, even to lubricating oil pumps. To such an extent has the policy been developed that in some vessels there is scarcely a pump in the engine which is not vertical and direct-coupled to a fast-running electric motor.

THE WASTE OF EXHAUST GASES.

"The Motor Ship," June, 1930.

The efficiency of the recovery of a fair proportion of the heat in the exhaust gases of Diesel machinery has now been established, and where there is a suitable use to which steam can be put, there appears no longer to be an excuse for not installing waste heat boilers, at any rate with four-stroke machinery; there is also a good deal to be said for it with two-stroke-engined ships.

It is surprising, therefore, to find in one or two new vessels that the advantage thus to be gained of this means of increasing the overall efficiency of a ship is not taken. A case in point is seen in the *Lafayette* the new French liner with auxiliary Diesel machinery of the four-stroke type of over 4,500 B.H.P. No doubt the average power developed will be over 2,500 B.H.P., and if the exhaust gases were passed through a boiler possibly more steam could be raised than is required on the ship. There is, perhaps, some excuse for not leading the exhaust gases of the two-stroke double-acting propelling engines through boilers, but in many of the latest liners equipped with two-stroke machinery this is done with obviously advantageous results.

ITALIAN FLOTILLA LEADER "NICOLOSO DA RECCO."

"Engineering," 2nd May, 1930.

In his paper, "Sea Trials of Flotilla Leaders," read at the recent meeting of the Institution of Naval Architects, Lt.-Col. F. Dondona, of the Royal Italian Navy, gave particulars of the trials of six vessels having a greater displacement than destroyers and known in Italy as *Esploratori*, or scouts. He stated that, although of larger dimensions, these vessels corresponded to what are styled flotilla leaders in this country. These scouts, of which 12 were ordered in 1926, belong to the *Navigatori* class (improved *Mirabello* type). The most recent addition to this flotilla, the *Nicoloso da Recco*, which is to be the leader of the *Navigatori* scouts, underwent her official speed trials on April 3rd, during which she attained a speed of 41·504 knots. The vessel was built at the Ancona Shipyard of Messrs. Cantieri Navali Rioniti, Genoa. She has an overall length of 352ft., a length between perpendiculars of 351ft., a breadth of 33ft. 6in., a depth of 20ft. 8in., and a displacement of 2,000 tons. The propelling machinery comprises two sets of geared turbines, together developing about 65,000 s.h.p. Steam is supplied by four water-tube boilers. The outstanding feature of the *Nicoloso da Recco* is that, with the speed attained during her trials, she appears to be the fastest ship of her type yet built. We believe that the previous record for destroyers was held by the French vessel *Bison*, which reached a speed of 41·2 knots in February last.

HIGH-PRESSURE VALVES WITH TOGGLE OPERATING GEAR.

"Engineering," 16th May, 1930.

The accompanying figures show an interesting application of the principle of the toggle lever to the valves of modern steam plants using very high pressures. The valves illustrated in Figs. 1 and 2 are made by Messrs. Schutte and Koerting Company, Philadelphia, U.S.A. Apart from the additional closing power given in ordinary working by this device it would appear that a contributory factor to the adoption of the design is the tendency of the present day to submit high pressure boilers to hydrostatic test with the various valves in place, when the power required to seat them, against the test pressure, is much more than normal. Another advantage claimed for the toggle gear is that valves fitted with it are much more suitable for situations having limited head room than those having the usual vertical spindle and horizontal handwheel. The general construction of the gear will be clear from the figures. The valve illustrated in Fig. 1 is a feed stop valve for a working pressure of 2,000 lb. per square inch, and is 6in. in diameter.

The valve illustrated in Fig. 2, is more elaborate as concerns its working parts. This type is known as the triple duty valve, and is so called as it acts as an ordinary screw-down stop valve; as a non-return valve functioning automatically when the pressure in the boiler falls below that in the pipe line, from a rupture in the boiler or a decrease in rate of evaporation from any cause; and as a positively closed valve when the non-return valve is to be prevented from rising due to, say, a break in the pipe line. This type of valve is, of course, used when boilers are connected in battery. The first of these functions is performed by holding down the disc of the valve by the toggle-operated spindle when the handwheel is turned. The automatic non-return action takes place independently of any movement of the toggle gear, and "chatter" is prevented, when the pressure fluctuates due to engine regulation, by the piston on the upper part of the valve spindle. This piston is very little smaller in diameter than the valve disc and, in consequence, the closing blow on the valve seat is kept small. The hole in the piston prevents it compressing the steam behind it, and so increasing the force of the blow, but it does not interfere with the balancing action, owing to its small area.

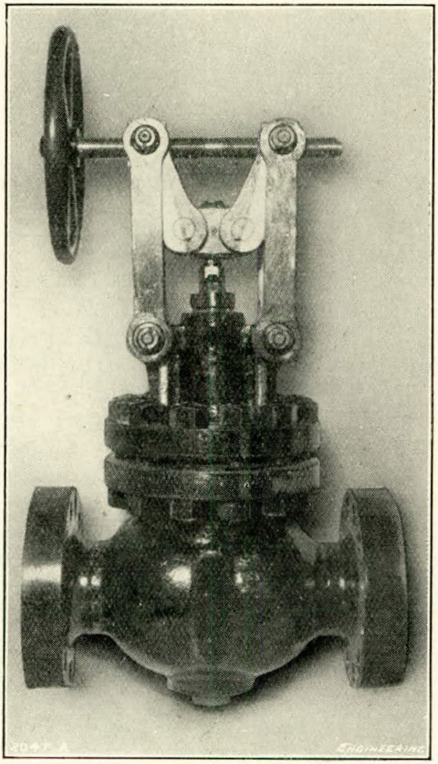
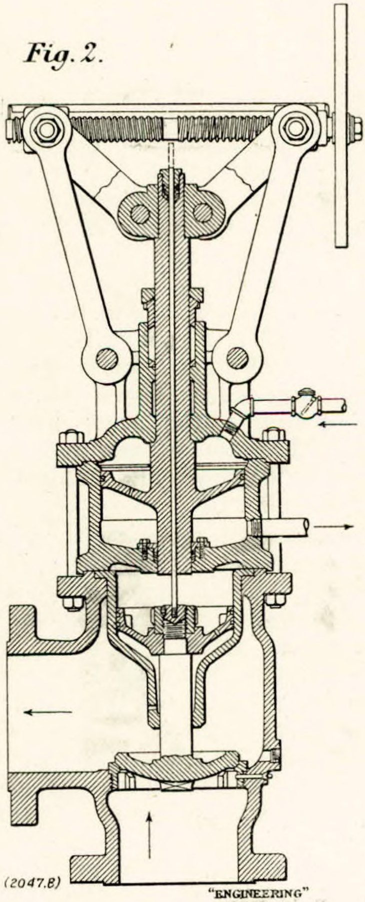


Fig. 1.

A counterbalancing effect is also obtained by the rod screwed into the end of the valve spindle and passing through the screw-down spindle. As its outer end is only subject to atmospheric pressure, as will be clear from Fig. 2, the arrangement gives an unbalanced area equal to the area of the rod, and, in consequence, the weight of the valve disc spindle, etc., when it is floating, is considerably diminished with a resultant decrease in the pressure drop of the steam passing the valve. Careful tests made on valves fitted with this un-

Fig. 2.



loading rod, as it is called, have shown that the pressure drop through them is 1 lb. less than through the same valves without the rods. The upper piston seen in Fig. 2 formed integrally with the screw-down spindle is the emergency device which performs the third function of the triple duty valve. This piston is larger in diameter than the valve disc, and is subjected to steam pressure from the boiler, thus giving a positive closing load on the valve as long as that pressure remains. When, however, the valve has closed in an emergency it is locked more permanently at leisure by the handwheel and toggle gear. The valve spindle is, of course, free to move downwards independently of the toggle gear when an emergency occurs. At each end of the cylinder in which the piston works is a small pipe. The upper pipe is either connected directly to the boiler or to some other point where it is anticipated that there will always be the highest pressure. The lower pipe communicates with the atmosphere through a valve. This valve is closed when the system is working normally, and the cylinder is kept full of steam on both sides of the piston by means of a small hole in the piston allowing steam to pass to its underside. There is thus no action on the main valve. The opening of the lower pipe to the atmosphere causes an immediate decrease in pressure on the lower side of the piston, which then descends and holds down the valve by means of the free spindle.

The release of the steam from below the piston is controlled in one of three ways. The first of these is by the use of a simple hand-operated valve. As this, however, is usually situated at some distance from the main valve a slight delay in the operation of the emergency piston, due to the time taken for a sufficient reduction in pressure to take place, is apt to occur. Control from a distance is, then, more often made by an electrically-operated pilot valve situated close to the main valve and actuated by push buttons. This system can also be modified so that automatic closing occurs when a fall of pressure to a pre-determined point has taken place at the outlet of the main valve. The third method, also automatic, is that of actuating a spring-loaded pilot valve by means of a diaphragm, on the upper side of which the boiler pressure acts while the pipe line pressure is admitted to the lower side. A fall of pressure on the latter upsets the balance of the diaphragm, and the pilot valve opens with a resultant release of pressure under the emergency piston followed by the closing of the main valve.

GRAVITY BOAT DAVIT.

"Engineering," 23rd May, 1930.

The gravity boat davit which we illustrate in Figs 1 to 3, 6 and 7, and which is known as the Taylor gravity davit, is noteworthy as combining a luffing motion with the outboard rolling motion commonly associated with the gravity method of launching. It has been recently introduced by Messrs. Samuel Taylor and Sons (Brierley Hill), Limited, Brierley Hill, Staffs, and was first fitted to the Union Castle Line motorship *Llangibby Castle*. A characteristic of the davit, as will be evident from the figures, is its simplicity of construction. This is, in part, attained by the use of steel plates and rolled sections, castings being entirely dispensed with. It will be necessary to examine Figs. 1, 2 and 3 together in order to understand both the construction and working of the davit. The lifeboat does not rest upon chocks but is suspended, when in a stowed position, by solid links from the luffing arm and lashed inboard by gripe gear of a somewhat conventional type. The luffing arm is of hollow rectangular section and has an approximately L-shaped contour. It is hinged near its lower end, between the sides of a carriage made of steel plate and of roughly-triangular outline. The carriage runs upon three pairs of flanged rollers, two pairs of which engage with the upper side of the channels forming the tracks, and the third with the lower side. The latter pair take the tilting moment due to the weight of the boat.

The lower end of the luffing arm also carries a pair of rollers which normally run inside the channels of the tracks as shown in Fig. 2. When in this position, the arm is virtually locked to the carriage and, being retracted, the weight of the boat is taken directly on the jaw at its outer end. This is clearly shown in Fig. 1, in which the course of the lowering rope from the boat to the winch can also be traced. The arm, as already stated, is held in position by the rollers on its lower end, and, therefore, the only pull upon the rope of any importance is that of the component of the weight of the boat and carriage tending to make them slide down the trackway. As long as the gripe gear, which also holds the carriage in place by a trigger, is in position, it follows then that the rope can be removed for examination or replacement without disturbing the boat.

In launching the boat, an operation shown in Fig. 3, the gripe gear having been released and the carriage tripped, the latter commences to roll down the track with a constantly accelerating motion, until it reaches a point where the lower flanges of the track channel are cut away. The luffing arm is then automatically released from its fixed position relative to the carriage, due to the rollers on the bottom end leaving the track, and the arm, by the weight of the boat, swings outboard as shown, transferring the weight to the rope. The speed of the arm and the boat increase as the arm swings over to its extreme position, while that of the carriage is checked. This deceleration of the carriage takes place with remarkable smoothness and it pulls up in its final position without shock or jar. The load on the rope due to the weight of the boat is almost constant, as the angle it makes between the top pulley of the luffing arm and the top pulley of the carriage is about the same on each side of a horizontal centre line through the latter. This is a valuable feature, as it is not necessary to make provision for a sudden increase in the pull of the rope.

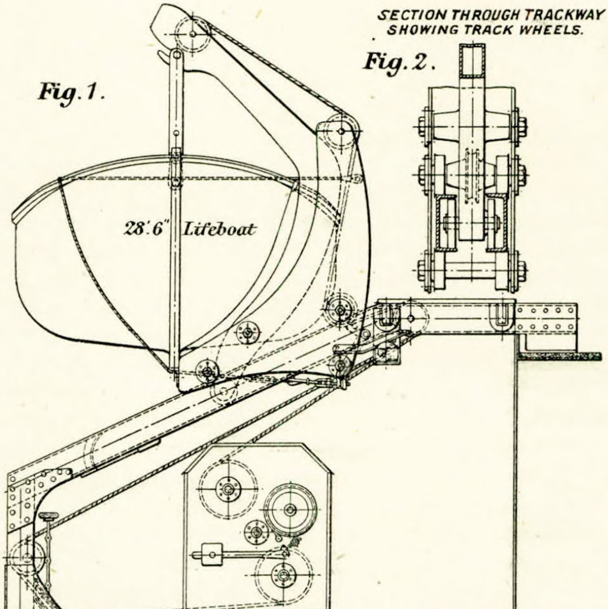
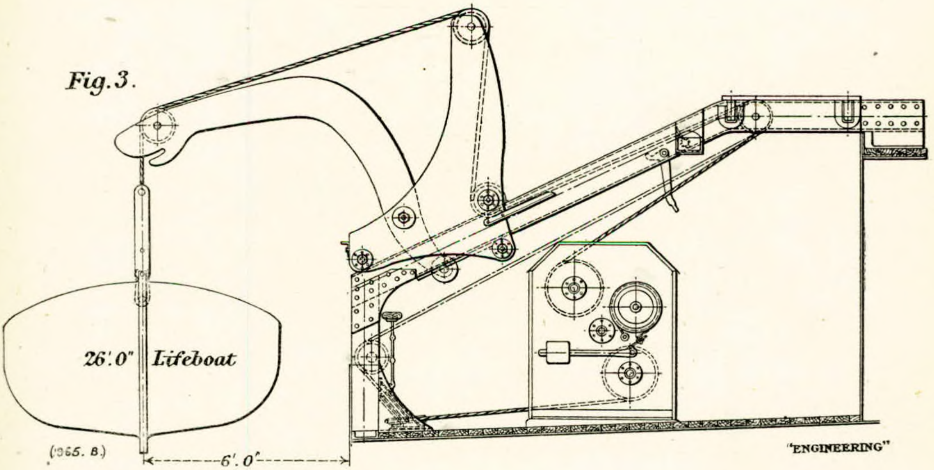


Fig. 1.

Fig. 2. SECTION THROUGH TRACKWAY SHOWING TRACK WHEELS.

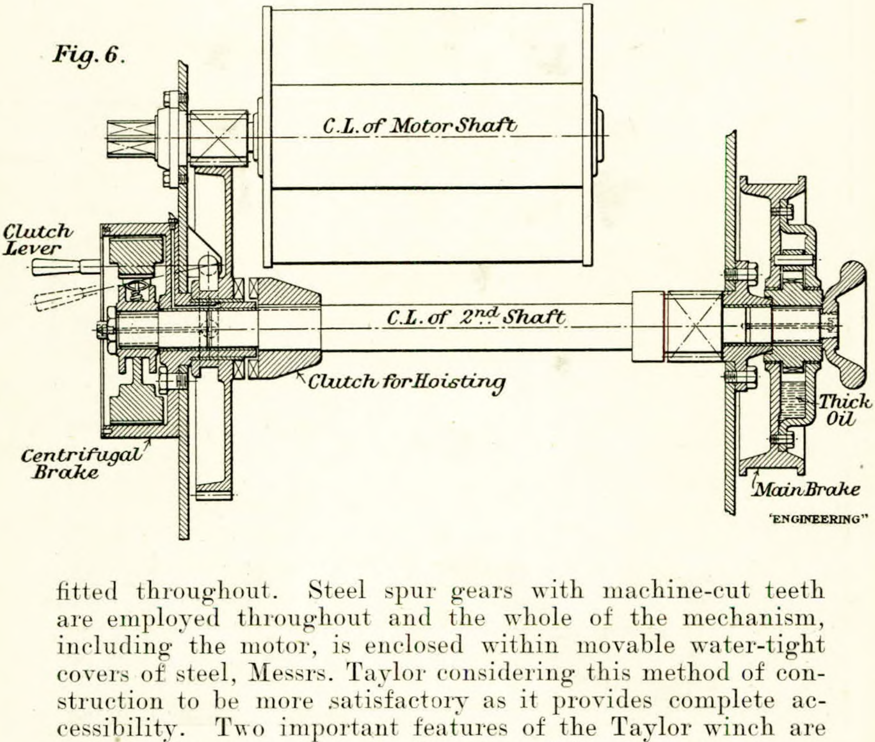
The central disposition of the rope pulleys relative to the track eliminates any tendency to twisting during either launching or hoisting inboard. There are, of course, two tracks per boat and these may be made independent of the ship's structure; that is, they are not an integral part of it, and can, therefore, be added or removed as desired. The separation of the carriage and luffing arm from the track is effected by removing the bottom pair of rollers from the carriage and the pair from the arm. This permits all the moving parts to be lifted off the tracks. It should be noted that the rollers of the carriage are on through axles and are not overhung. Lubrication is carried out by the use of a grease gun, which is coupled to the various points concerned by a nipple so designed that there is only a minimum of projection. The rope pulleys on the luffing arms and those at the top of the carriage, which are likely to be neglected on account of their position, are fitted with roller bearings, the others on the carriage and those of the tracks are fitted with self-lubricating bearings, a system of a reservoir with felt pads being used.

Fig. 3.



The proper working of a gravity davit depends largely upon the employment of a suitable winch. In the examples illustrated in Figs. 1 and 3 this is placed below the boat. The tracks are supported at their inner ends by a deck house, but when a clear passage way is required under the tracks, the winch is situated on the top of the deck house. This is the arrangement generally preferred, but there are cases in which no deck houses are available. Where this is so, the method shown in Fig. 7 is adopted, the tracks being supported by carrying their inner ends on vertical columns connected by a cross girder. The winch may be either hand operated or electrically operated. The frame is made of steel plates, the bearing shells, which are lined with phosphor bronze, being bolted to them as shown in Fig. 6. In the latest type of winch, however, ball bearings mounted in steel housings are

Fig. 6.



fitted throughout. Steel spur gears with machine-cut teeth are employed throughout and the whole of the mechanism, including the motor, is enclosed within movable water-tight covers of steel, Messrs. Taylor considering this method of construction to be more satisfactory as it provides complete accessibility. Two important features of the Taylor winch are a device for controlling the lowering of the boat at any predetermined speed, and an arrangement by which the two drum shafts can be safely rotated independently when adjusting the length of ropes either when they are new or have stretched unequally.

The first-mentioned device is particularly valuable in the case of an emergency, as the speed of the descent is determined by an automatic controlling brake, and is thus not liable to become excessive if the gear is carelessly handled.

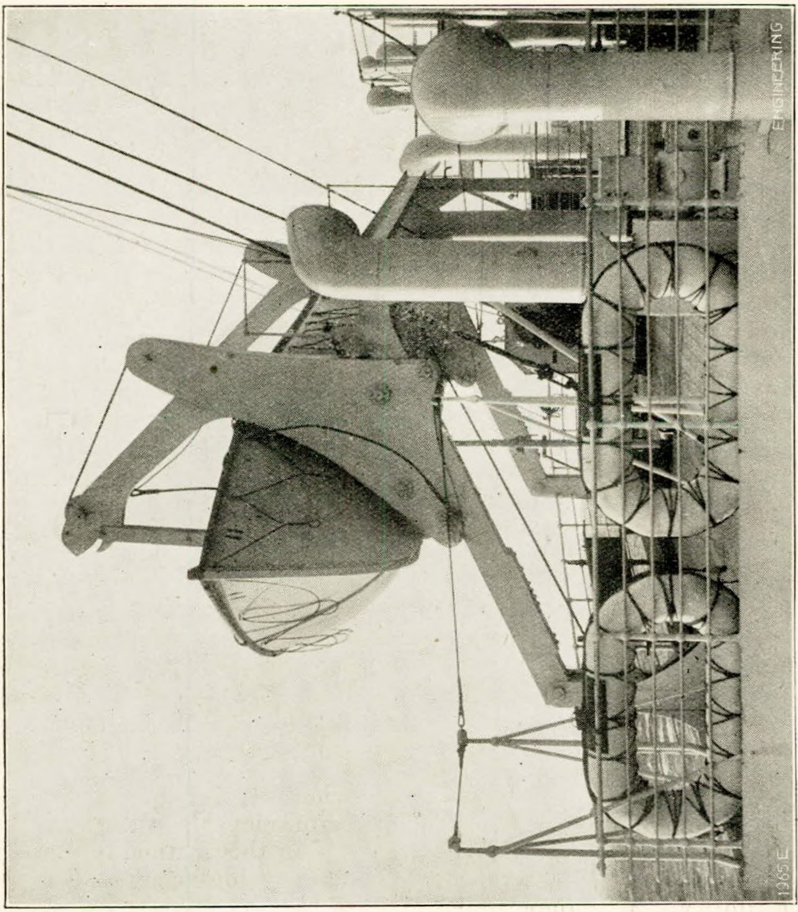


Fig. 7. Installation on M.S. "Llangibby Castle"

The brake, which is of the centrifugal type, is mounted on the second shaft and is wholly enclosed. It can be seen at the left hand of Fig. 6. The main brake is shown at the right hand of the figure. It is of the band type, the load being applied by a weighted lever. The Board of Trade regulations lay down that in a boat-lowering winch the main brake shall be such that it must always return to its " on " position immediately it ceases to be held by hand in the " off " position. With a brake of the ordinary type constructed to meet this requirement, it is necessary to hold the brake off while the load is being hoisted. This is not always easily effected, particularly in those cases where, in an electrically-operated winch, the controller is placed on a lower deck than the winch. Messrs. Taylor have surmounted the difficulty by the ingenious connection of the brake drum to the second shaft through a ratchet and pawl mechanism. This is seen on the right-hand of Fig. 6, and works in an oil bath. When the boat is being lowered, the brake can be used in a normal manner by relieving the band of the pressure due to the weight to any extent desired, though excessive speed is prevented by the automatic brake previously referred to. It is unnecessary to release the brake when the boat is being hoisted.

The second of the two special features previously mentioned consists of provision for sliding the pinion on the third shaft out of gear with the spur wheels on the rope drum. This shaft is between the two drums, and, by disconnecting it from them, each can be adjusted independently of the other to correct any differences in the lengths of the two ropes. The operation of sliding the shaft along is no more than is met with in gear-changing in many machines, but it is necessary to prevent the possibility of the pinion being left out of gear, in which case the boat would fall without any sort of check upon it immediately the gripes were slipped. The third shaft has, accordingly, been made with a collar which bears hard up on the bearing shell on the side frame remote from the pinion when the pinion is in gear. To slide the shaft along then, together with the attached pinion, it is necessary to remove the bearing completely, and as it must be replaced when reassembling the machine, the shaft must be pushed back into the correct position, and the danger of leaving the pinion out of gear is eliminated.

CHAPTERS IN NAVAL AND MARINE ENGINEERING HISTORY.

Extract from article by Eng. Capt. Edgar C. Smith, O.B.E., R.N., describing pioneer steamships of 1838-1840.

" Engineering," 30th May, 1930.

For the sake of conciseness, two tables have been drawn up giving the principal dimensions of the six vessels which ran to

New York and also of the *Britannia*, the first of the Cunard ships which ran to Halifax. These are followed by another table giving the dates of the maiden voyages, as well as of the *Acadia* and *Caledonia*, sister ships of the *Britannia*, and the numbers of voyages made by each vessel up till the end of 1840. The ships were all of wood, while the engines were of the side lever type.

From these tables it will be seen that the *Sirius* and the *Royal William*—the latter not to be confused with the *Royal William* which crossed from Canada in 1833—were much smaller than the others. Neither of them was in fact intended for the Atlantic passage. At the beginning of 1838, however, as the *Great Western* was nearing completion, while the *British Queen* was far from ready, the London company chartered the *Sirius* from the St. George's Steam Packet Company, and despatched her from Cork four days before the much larger *Great Western* was due to leave Bristol, and the precious honours thus fell to the *Sirius*. Her first voyage out was not accomplished without considerable difficulty, there was little coal in her bunkers when she reached New York, and though, after returning home in May, she made another passage out and home, she proved uneconomical and was returned to her original owners. Abstracts from the log of the *Sirius* were published at the time, and among the remarks are such entries as "Pressure on boilers 5¾ lb." "Mixed resin with the picked ashes;" "one ton of coals burned one hour and fifteen minutes, without ashes or resin" and "Fresh water in the boilers all the way, with Hall's condensers." It was not a little remarkable that the *Sirius* and also the *British Queen* were both fitted with surface condensers, a great novelty at that time.

PARTICULARS OF SHIPS.

Ship.	Length.	Breadth.	Tonnage.	Builder.
	Ft.	Ft.	Tons.	
Sirius	178	25½	703	Menzies.
Great Western ...	236	35¼	1,320	Patterson.
Royal William ...	175	27	617	Wilson.
Liverpool	223	30⅚	1,150	Humble and Milcrest.
British Queen ...	245	40½	1,863	Curling and Young.
Britannia	207	34¼	1,154	Duncan.
President	243	41	2,366	Curling and Young.

PARTICULARS OF ENGINES.

Ship.	Diameter of Cylinder.	Stroke.	Horse-Power.	Maker.
Sirius	60	6 0	320	Wingate.
Great Western ...	73½	7 0	400-750	Maudslay.
Royal William ...	—	—	270	Fawcett and Preston.
Liverpool	75	7 0	468	Forrester.
British Queen ...	77½	7 0	500	R. Napier.
Britannia	72½	6 10	440-740	R. Napier.
President	80	7 6	540	Fawcett and Preston.

VOYAGES, 1838-40.

Ship.	Port.	Date of Departure.	Port.	Date of Arrival.	No. of Voyages 1838-40.
Sirius	Cork ...	4.4.38	New York	23.4.38	2
Great Western ...	Bristol ...	8.4.38	,,	23.4.38	17
Royal William ...	Liverpool ...	5.7.38	,,	24.7.38	3
Liverpool	,,	22.10.38	,,	23.11.38	5
British Queen ...	Portsmouth	12.7.39	,,	27.7.39	8
Britannia	Liverpool ...	4.7.40	Boston	18.7.40	3
President	,,	1.8.40	New York	17.8.40	2
Acadia	,,	4.8.40	Boston	—	2
Caledonia	,,	1.9.40	,,	—	2 out 1 home

THE NEW NORTH SEA ENTRANCE LOCK AT YMUIDEN.

"The Engineer," 2nd May, 1930.

On Tuesday, April 29th, the new lock at Ymuiden at the entrance to the canal which connects Amsterdam with the North Sea was formally opened by the Queen of the Netherlands, in the presence of the Royal Family, members of the Dutch Cabinet, and representatives of engineering and industrial interests in Holland. The construction of the lock has occupied ten years, and the cost of the untertaking amounts to about one and a-half million pounds. The new entrance lock has a length of 1312 ft., with a width of 164 ft., and it has a depth of 49 ft. over the sill. The canal, which at present has a depth of 41 ft., is to be deepened to 49 ft., in conformation with the depth of the new entrance lock. In order to construct the lock, no less than 21,800,000 cubic yards of material had to be removed, and close upon 300,000 cubic yards of ferro-concrete were employed. There are three lock gates of the rolling type, each of which measures 175 ft. 6 in. by 67 ft. 4 in., with a thickness of 23 ft. 6 in. The gates each weigh about 1,200 metric tons, and contain an air space of 16,470 cubic feet, which enables them to be floated for examination or for repair. The canal is big enough to admit the world's largest steamers, and it is spanned by two electrically operated revolving railway bridges, which, when open, give a clear passage of 164 ft. The new entrance lock in the largest in the world, and the railway bridges are the largest of their type erected in Europe. At the opening of the lock the Royal Party and the other guests travelled on the Royal Dutch Steamship Company's new motor liner *Johann van Oldenbarnefelt*, which, after passing through the lock, proceeded on a short trial cruise in the North Sea.

THE PORT OF COCHIN.

"The Engineer," 9th May, 1930.

At the port and harbour of Cochin, which is situated on the West Coast of India in latitude 9° 58′ N., longitude 76° 14′ E. and is the only safe and sheltered harbour in British territory between Bombay and Cape Comorin, developments are taking place with the object of making the port into a first-class harbour. A dredged channel leads into the harbour and is practicable at all seasons of the year for vessels drawing 28ft. Inside the harbour vessels lie at swinging buoys. Vessels up to 475 ft. in length can at present be accommodated at three of the buoys and a vessel of 400 ft. of a maximum draught of 20 ft. can also be accommodated at a buoy. It is expected that five berths for large steamers and two berths for steamers up to 400 ft. in length will be available shortly. The port is connected with the hinterland by rail and water transport. The railway facilities are to be greatly increased in the near future, which circumstance will further enhance the importance of the port to the planting and producing districts from South India. There is an engineering firm which can undertake repairs. The total number of vessels which called at the port during 1927-28 was 1,174, of 1,005,354 registered tons.

THE LATEST ELLERMAN LINER.

"The Engineer," 16th May, 1930.

The new Ellerman liner the *City of Barcelona*, which has been built by Barclay, Curle and Co., Ltd., on the Clyde for the London service of the Ellerman Hall Line, is an interesting cargo ship on account of her special propelling machinery and the arrangements made for the lifting of heavy cargo. The new steamer has a length of 425 ft., a beam of 58 ft., a depth of 29 ft. 9 in., a measurement of 5,600 tons, and a deadweight carrying capacity of 9,500 tons. She is propelled by a four-cylinder, triple-expansion steam engine, which is fitted with valve gear of the Beardmore-Caprotti type. The cylinders have diameters of 23½ in., 40½ in., 50 in., and 50 in., with a common stroke of 48 ft., and steam is supplied at a pressure of 265 lb. per square inch with 180 deg. of superheat. The exhaust steam from the main engine passes to an exhaust turbo-generator plant of Metropolitan-Vickers design, which supplies direct current to a 990 B.H.P. auxiliary propelling motor mounted in the thrust block recess at the other end of the engine-room. The deck auxiliaries include gear for lifting 108 tons, enabling cargoes of locomotives and heavy rolling stock to be conveniently handled. No particulars have been given us with regard to the trial results, which, it is understood, were very successful, but no doubt opportunity will be taken to compare the performance of this new type of propelling machinery with that of other modern steamers and motor vessels which are being operated by the Ellerman Lines. It may be recalled that in February last Mr. Wm. Hinchcliffe, the superintendent engineer of the Ellerman Lines, gave an interesting paper before the Liverpool Engineering Society, in which he contrasted the performance of the geared turbine steamer the *City of Roubaix* and the motor ship the *City of Lille.**

THE GIBRALTAR TUNNEL.

"The Engineer," 23rd May, 1930.

A statement made by the King of Spain to a French Press representative at the Railway Congress at Madrid to the effect that the Gibraltar tunnel will be constructed before the Channel Tunnel, has awakened the French to an appreciation of the importance to them of the Gibraltar undertaking. So long as the execution of the project appeared more or less problematical, there was no serious thought of the tunnel serving a useful purpose in facilitating communication between France and her African Colonies. Now that the King of Spain has given a positive assurance that the Gibraltar tunnel will be constructed as soon as the necessary funds are available, its value is beginning to be realised. There will be direct railway service to Casablanca. Most people travelling between France and

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* See May Transactions—p. 251.

Algeria will prefer to go by rail rather than make what is often a very disagreeable crossing of the Mediterranean. Moreover, the Gibraltar tunnel will obviously increase the value of the proposed Trans-Saharan Railway. It may therefore minimise the commercial value of the sea route between Marseilles and the North African ports, which are being developed at great expense to provide for future traffic, but the strategical importance of the sea route will remain so long as the Mediterranean problem is unsolved.

PULVERISED COAL.

"The Engineer," 23rd May, 1930.

The efficiency of pulverised coal at sea was recently demonstrated in the voyage of the cargo steamer *West Alsek* from Ireland to Boston, during which the vessel encountered in the North Atlantic the most severe weather of recent years. The pulverising plant operated smoothly, even while the vessel was rolling 45 deg., and the results were highly satisfactory, in spite of the fact that wet coal of about 12,000 B.Th.U. was being used. The *West Alsek* is equipped with the "Todd" unit system of pulverised fuel burning, and has been in regular service for the past ten months, during which time the installation has performed satisfactorily on both American and British bituminous coal of the cheaper grades. The equipment has shown a 20 per cent. increase in horse-power and a 10 per cent. increase in speed, with an increase of only 3 per cent. in coal consumption. As a hand-fired installation the *West Alsek* burned 464 lb. of coal per mile with a speed of 8·78 knots and 1790 I.H.P. As a pulverised coal burner, however, only 449 lb. of coal per mile were used, with a speed of 9·58 knots and 2250 I.H.P. output. With the pulverising equipment it also has been possible to use a much cheaper grade of coal, besides which a 20 per cent. saving has been made in the boiler-room staff.

THE NEW UNION-CASTLE MOTOR LINER "DUNBAR CASTLE."

"The Engineer," 30th May, 1930.

The new Union-Castle motor liner *Dunbar Castle* has been built at the Govan yard of Harland and Wolff, Ltd., and engined by the firm's Finnieston works for the Intermediate South and East African Service of the Union-Castle Mail Steamship Company, Ltd. On Wednesday morning, May 21st, the ship with about one hundred guests of the company left the Tail of the Bank at Greenock for London, arriving at Tilbury at mid-day

Friday, May 23rd. The voyage was a very smooth one and the absence of vibration was freely commented upon.

The following are the principal dimensions and particulars of this new liner:—

Hull Particulars.

Length between perpendiculars ...	470 ft.
Breadth moulded	61 ft.
Depth moulded	35 ft. 3 in.
Gross tonnage	10,002
Service speed	14½ knots
Maximum speed	About 15 knots.

Passenger Accommodation.

First-class passengers	200
Second-class passengers	260
Open-berth passenger space (as required)	100

Propelling Machinery.

Type: Twin-screw, single-acting, four-stroke, Harland-B. & W. pressure-charged oil engines.

Designed maximum output at 105 r.p.m.	6300 S.H.P.
Service output at 98 r.p.m.	5200 S.H.P.
Number of cylinders each engine ...	Six
Diameter of cylinders	740 mm.
Stroke	1500 mm.

Auxiliary Machinery.

Auxiliary generator sets, three oil-electric.
Two Brown-Boveri exhaust turbine-driven blowers.
Two Clarkson thimble-tube silencer boilers.
Electrically-driven deck and engine-room auxiliaries and refrigerating plant.

The vessel has been designed in accordance with the latest requirements of the Board of Trade with regard to her sub-division, safety and navigational equipment. The hull is divided into nine water-tight compartments, and the double bottom, which extends the whole length of the ship, is designed to carry water ballast, fuel oil and fresh water.

A submarine signalling installation and also echo-sounding gear are fitted, and the lifeboats are carried in gravity davits of the Taylor design.

PROPELLING MACHINERY.

The principal particulars of the main and auxiliary propelling machinery are given in the above table.

The main engines are of the builder's standard design, and they are arranged for pressure-charging on the Büchi patented system. In addition, they are provided with fuel-valve lift control gear, as an aid to economical operation.

The hot gases from the exhaust manifolds are led direct to the two Brown-Boveri exhaust turbine-driven blowers. These units have been designed to deal with the gases at a maximum temperature of 980 deg. Fah., and at gauge pressures up to 8·7 lb. per square inch. The two blowers are each rated at an output of 11,000 cubic feet of air per minute, delivered at a gauge pressure of 4·27 lb. at the inlet manifold of the main engines. The speed of the blower units is about 4000 to 4500 r.p.m. During official tests the blowers were shown to have an efficiency of 53½ per cent. when operating with exhaust gases at 3·5 lb. per square inch before the turbine and 460 deg. Cent. and when running at a speed of 3700 r.p.m. Even when the engine output was increased to 50 per cent. above the normal output when working at atmospheric pressure, the blower plant continued to run with every satisfaction. After leaving the exhaust turbines the exhaust gases pass to two silencer boilers of the Clarkson thimble-tube type, one for each main engine. Each of these boilers has a heating surface of 270 square feet and is 5 ft. in diameter with a height of 8 ft. 6 in., the combustion chamber being 6 ft. 8 in. high. Each boiler has a designed duty of about 2000 lb. of steam per hour at 100 lb. working pressure. They are equipped with the Clyde oil fuel burning system for port use and under oil-fired conditions the output of each boiler is about 2500 lb. per hour at the same working pressure.

The refrigerating plant is of interest, since the ship has been specially designed for the fruit trade. The plant was supplied and fitted on board by J. and E. Hall, Ltd., of Dartford, and it comprises insulated space in Nos. 1, 2, 4 and 5 'tween decks, having a total capacity of about 100,000 cubic feet. All these spaces are maintained at suitable temperatures for the carriage of citrous and deciduous fruit by means of cold air circulation. For each compartment there is a specially designed battery of brine pipes, with an electrically driven fan. No. 2 space is specially equipped for carrying meat at low freezing temperatures, and there are also insulated chambers of about 8000 cubic feet capacity for ship's use, in addition to brine connections to pantries, etc. The refrigerating machinery is placed in a special compartment forward of the main engine-room, and it comprises three twin-cylinder CO_2 machines of the vertical type, each driven by a variable speed motor of 70 B.H.P. at a maximum speed of 350 r.p.m. The machines, which are totally enclosed, are provided with forced lubrication, and they run very quietly. There are three CO_2 condensers and three evaporators. The circulating water for the condensers is provided by a single large vertical centrifugal pump, while standby supplies can be obtained from other engine-room pumps. There are four vertical centrifugal pumps for brine circulation, and special arrangements are made for supplying brine at different temperatures, and also warm brine for thawing. Most of the other auxiliary machinery is of the electrically-driven type, current being supplied from the three auxiliary lighting and power sets already referred to in the table.

THE NEW CUNARD LINER.

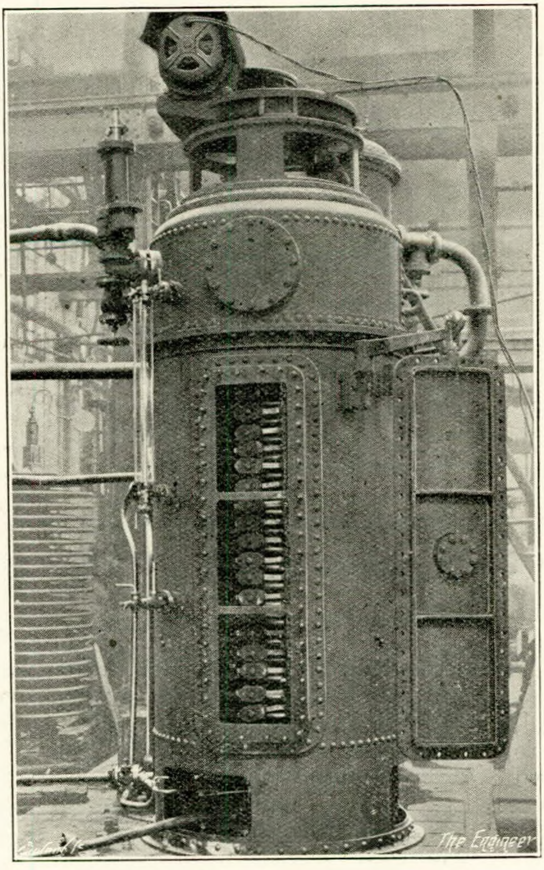
"The Engineer," 30th May, 1930.

Considerable satisfaction is felt in the Clyde and Sheffield district in the selection by the Cunard Steamship Company, Ltd., of John Brown and Co., Ltd., of Clydebank and Sheffield, as the builders of the new express liner for the Cunard service between the Channel ports and New York. Naturally, some weeks must elapse before certain vital questions now under consideration can be finally decided, thereby enabling a contract to be signed and the necessary materials ordered. The construction of the new liner, it is expected, will occupy about three years. No official announcements have yet been made concerning the dimensions of the new liner or the type of her propelling machinery. From unofficial forecasts, however, we gather that a ship of about 75,000 tons displacement with a designed speed of about 30 knots is being considered. There will be accommodation, it is suggested, for about 4000 passengers, with about 800 officers and crew. The cost of the new liner has been mentioned as probably between five and six million pounds. No official information is available concerning the propelling machinery, but it seems likely that geared turbines with high-pressure water-tube boilers will be favourably considered. It may be recalled that John Brown and Co., Ltd., recently received an assurance from the Clyde Navigation Trust that in the event of the order for the new liner being placed at Clydebank the necessary dredging operations at the mouth of the river Cart, opposite the yard, would be undertaken in order to allow the required depth for launching a ship over 1000 ft. in length. John Brown and Co., Ltd., have constructed many noteworthy liners for the Cunard service, including the *Lusitania*, the *Aquitania*, and the *Franconia*.

A NEW TYPE OF MARINE EVAPORATOR.

"The Engineer," 6th June, 1930.

In the accompanying engraving we show a new type of marine evaporator with revolving disc-shaped elements, which is manu-



Englisch-Clarke Chapman Evaporator.

factured under the Englisch-Clarke, Chapman patents by Clarke, Chapman and Co., Ltd., of Gateshead-on-Tyne. In the ordinary type of tube evaporator for salt water, a common fault is the separating out of the salt from the sea water, which adheres to the outer surfaces of the tubes and interferes with the heat transmission. This defect is claimed to be entirely overcome in the new type of evaporator we are describing, as the salt is deposited in a relatively loose encrustation, which is easily removed from the revolving disc-shaped elements by stationary scrapers. The salt deposit finds its way to the bottom of the evaporator and is removed at regular intervals by running off a portion of the contents of the evaporator. The scrapers, which will be seen inside the open inspection door in the centre of the evaporator, are self-adjusting and they are easily removed. To the left of our illustration are seen the heating elements. They are mounted on a shaft, which is carried on a thrust bearing at the top of the evaporator and the drive is of the worm and spur gear type running in an oil bath. The driving motor is coupled through a two-part flexible coupling and for the larger sizes of evaporator the motor has an output of 6 to 7 brake horse-power.

The heating elements and the shaft which serves to admit steam to the discs, are made in sea-water resisting bronze. Water-separating baffles are fitted and there is a specially large water separator external to the evaporator which is filled with "Raschig" rings. This arrangement ensures completely dry vapour. The type of evaporator illustrated is claimed to maintain a constant evaporation, and it does not require special attention to keep the evaporator surfaces clean.

THE DEVELOPMENT OF THE INTERNAL COMBUSTION ENGINE.

"The Engineer," 6th June, 1930.

In the eighteenth Wilbur Wright memorial lecture, delivered before the Royal Aeronautical Society, Mr. H. R. Ricardo characterised the rapid progress of the internal combustion engine as one of the most remarkable developments of mechanical engineering during the past fifty years. Of that progress it is fair to say that the most outstanding phases have been the latest—those associated with the development of the engine for aeronautical purposes. Fifty years ago the internal combustion engine weighed about 500 lb. per horse-power and its use was naturally confined to stationary purposes. Ten years later its weight dropped to 75 lb. and engineers began to study the possibility of employing it for road transport. With the passage of another decade, its weight had fallen to 10 lb. and the revolution of road transport had begun. In 1903, the Wright brothers found it possible to build an engine weighing 7 lb or 8 lb. per horse-power—there is some doubt about the actual figure—and with it they achieved for the first time power-driven flight. Twenty years ago engines weighing 3 lb. per horse-power were available and flight had become generally practised. Since then the weight has fallen to about 1½ lb. as a good average, and for racing purposes engines weighing no more than ⅞ lb. per horse-power have been produced. The remarkable trend of the curve of specific weight revealed by these figures has been accompanied by no loss of efficiency or trustworthiness. On the contrary, these two essential characteristics have been steadily improved simultaneously with the reduction of weight. Mr. Ricardo, in fact, claims that "the modern aero-engine is not only about the most efficient prime mover in existence, but it is also one of the most reliable." What advance, we may well ask, yet remains to be made?

TRIAL TRIP WIRELESS!

"The Engineer," 6th June, 1930.

A novel feature of the trial trip on the Clyde of the new White Star liner *Britannic*, which took place recently, was the use of Marconi telephone sets fitted on board and in the builders' offices at Belfast to enable the engineers and technical experts at sea and ashore to keep in constant touch. This is the first time that the wireless telephone has been used in connection with a ship's trials, and the installation proved of particular value in exchanging reports of the performance of the new ship. The distance apart of the Clyde and the Belfast shipyards is 150 miles, and on several occasions a few minutes' talk by telephone saved much time and trouble. The wireless telephone sets fitted on the liner and in the offices of Messrs. Harland and Wolff were of the Marconi standard type Y.C.4, which have a power of 500 watts.

A PROPOSED ARCTIC AIR ROUTE.

"The Engineer," 6th June, 1930.

For a long time many people have been attracted by the idea of establishing a Transatlantic air service following a route from the north of Scotland by way of the Faroe Islands and Iceland to Greenland, and thence across Baffin Land and over Hudson's Bay to Winnipeg or other Canadian centre. This route provides natural emergency landing grounds over the greater part of its length, and at no point does it involve the crossing of a length of sea exceeding 300 miles. It is announced that on July 3rd a British expedition will leave this country to explore the route. The party, numbering fourteen, is being equipped by certain members of the Royal Geographical Society and a few other benefactors. It will be led by Mr. H. G. Watkins, and will include an air pilot lent by the Air Ministry, a wireless officer lent by the War Office, and, it is hoped, a naval surgeon lent by the Admiralty. The expedition will sail for Greenland in Commander Shackleton's vessel *The Quest*, which has been chartered from her Norwegian owners. One of its principal tasks will be to study the meteorological conditions over Greenland, for which purpose it will establish a central base on the south-eastern coast of that territory. For carrying out an experimental flight next year over the whole route, Vickers (Aviation), Ltd., has offered the loan of a " Vellore " freight-carrying machine. This scheme, it would appear, is not the same as that referred to by Lord Thomson in the House of Lords. The Canadian Government is, however, interested in it, as it is in the Atlantic Airways scheme, and it is hoped will undertake the survey work required in the Hudson's Bay and Baffin Land portion of the route.

FARADAY CENTENARY CELEBRATIONS, 1931.

" The Engineer," 6th June, 1930.

Date of the Centenary.

In 1831 Michael Faraday, following up the work of Volta, Oersted and Ampère, began, or rather resumed, in his laboratory at the Royal Institution, experiments on the induction of electric currents, and on August 29th, 1831, made the discovery in which lies the origin of the dynamo and starting point of the utilisation of electric power for the purposes of man. On that day, as his Diary shows, he wound two coils of wire on to opposite sides of a soft iron ring, connected one coil to a battery and the other to a galvanometer, and at "make" and "break" of the battery circuit observed deflections of the galvanometer connected in the other circuit. From this simple experiment, and the variations of it made by Faraday in succeeding trials, have grown, in the past hundred years, the science of electrical engineering and the great electrical industry in all its phases as we know it to-day. No other experiment in physical science has been more fruitful for mankind. August 29th, 1931, is then the centenary of one of the great events in the history of the world, and the greatest event in the history of electrical engineering.

SPECIAL MATERIALS AND THE DIESEL ENGINE.

"The Marine Engineer," July, 1930.

In no branch of science has there been a greater advance in recent years than in metallurgy. Light alloys have reached a stage of perfection such that they may be used for many purposes for which earlier alloys were quite unsuitable. Non-corrosive materials have been developed to meet the requirements of the engineer for services where the metals previously used had proved unsatisfactory under modern conditions. There have also been advances in our knowledge of cast iron and of the foundry methods which will give the most reliable and consistent material, an advance which the Diesel engine has largely been responsible for.

It is perhaps doubtful whether all engineers, particularly those in the heavy engineering industry, have fully realised the greater scope that is possible in the design of their machinery by the wider use of what are generally termed special materials. Members of the older school of designers, who have been used to thinking of cast iron, mild steel and brass as the staple materials for design work, are often liable to think that these newer alloys, costing as they do more than the older materials, are excluded from practical use on that score. Cost per pound weight is, of course, little real guide to the value of a metal. For example, there are in every branch of engineering work many parts which have little or no actual stress to carry; such parts, if made of cast iron, must be fairly thick on account of the difficulty of casting, whereas, if aluminium alloys are used, the metals can be much thinner, so that the finished casting weighs about one-sixth of the weight of the corresponding cast iron part, and probably costs considerably less. Furthermore, fewer castings will prove faulty, and if a suitable alloy is used, machining will be easier.

Turbine designers have perhaps been more ready to accept the benefits that metallurgists have offered than have certain other " heavy " engineers. Generally speaking, Diesel engine designers, who have perhaps more to gain by improved materials, have been rather tardy in making general use of the alloys that are now available, although the wider introduction of the commercial high-speed engine is changing the position. Even for the slower running oil engine, or at least the relatively slow speeds, there is much to be gained by the use of light alloys.

We may instance one design of stationary Diesel engine in which aluminium alloy pistons are used in conjunction with a hard alloy steel liner and a rather special and very excellent design of two-piece steel cylinder cover. As a result of this break-away from conventional practice higher piston speeds can be used and at the same time it may be remarked that the engine in question uses a higher mean indicated pressure than any other unsupercharged engine in regular service. The advantages more than counterbalance the extra cost, if any, of the special alloy pistons and other parts, and there seems no reason why similar advanced design should not be applied in marine work where weight reduction is much more important than in a stationary plant. The reciprocating parts generally in the majority of marine propelling and auxiliary Diesel engines might with advantage be reduced in weight by the use of higher grade materials. The resultant reduction in wear and tear and the increased piston speed that could be allowed would almost invariably repay the extra cost per ton weight, while the cost per B.H.P., which is what matters to the shipowner, would be reduced.

FIFTY YEARS AGO.

Extracts from " The Marine Engineer," July 1st, 1880.

THE SCREW STEAMER " ANTHRACITE."—It is now many years since Mr. Jacob Perkins demonstrated the practicability of using steam at a very high pressure for the purpose of discharging bullets from a gun, by means of his steam gun, at the old Adelaide Gallery. Although the capability of steam for taking the place of gunpowder in this respect was then proved, the former has not yet superseded the latter in practice. Working still upon the high-pressure theory of Mr. Perkins, his descendants have followed up the principle in another and more promising direction—namely, in connection with the steam engine. It has been left to the grandson of that gentleman, Mr. Loftus Perkins, to develop the theory to such a high degree of perfection as to bring it satisfactorily within the domain of practice. For several years past the Perkins' system of using high-pressure steam has been in use both on land and in steam vessels with every success. The later instances, however, being more fully developed than the earlier, are naturally more perfect. The most recent example occurs in connection with a small vessel, the *Anthracite*, which is the smallest steamer that has ever undertaken a voyage to America on her own unaided resources. The Perkins' system consists of a tubulous boiler in which steam is generated at a very high pressure, and a special system of engine in which the steam is used and re-used over and over again. The boilers are charged with fresh distilled water, a small quantity only being required, and this, after being converted into steam and used in the engine, is condensed and re-used. The advantages of the system are—a very small consumption of fuel, immunity from explosion by reason of the sub-division of the boiler into numerous parts, each part having a high resisting power, and durability of the boiler, which is equal to that of the engines and ship. The boiler is constructed of horizontal tubes, welded up at each end, and connected by small vertical tubes, and is proved to 2,500 lbs. per square inch. The engine has three cylinders of different diameters, the smallest cylinder being placed over that of medium size, and being worked, from the same piston rod. Steam is used at pressures ranging from 300 lbs. to 500 lbs. to the square inch, 350 lbs. being the ordinary working pressure. The *Anthracite* was built by Messrs. Schlesinger, Davis and Co., of Wallsend, and was engined by Messrs. Hawks, Crawshay and Sons, of Gateshead-on-Tyne. She is 84 ft. long and 16 ft. beam, and 10 ft. deep, her engine and boiler room being 22 ft. 6 ins. long. Her gross tonnage is 70.26 tons, and her registered tonnage 27.91 tons. Her engines have three cylinders of 8 ins., 16 ins., and 23 ins. diameter respectively, with 15 ins. stroke. They are of 20 horse-power nominal, and 168 horse-power indicated. The high-pressure and medium cylinders are single-acting, the low-pressure cylinder being double-acting.

ROYAL ALBERT DOCK.—The Victoria Docks have been a scene of great excitement during the past week. The new extension was formally opened on the 24th ult., by the Duke and Duchess of Connaught, accompanied by a large and illustrious circle of friends. The extension is to be called the Royal Albert Dock, whilst the old dock still rejoices in the name of the Victoria Dock. There is no doubt that the opening of this new extension will add very largely to the accommodation of the enormous liners that are now becoming all the fashion. Several very dangerous reaches of the river will have been avoided by the use of the new entrance, and the quay space will be much more ample than in the crowded Victoria Dock, so as to facilitate prompt loading and unloading. The water is now fully admitted to the new docks, so that the two together form a magnificent area of 175 acres of water in a string of docks nearly $2\frac{3}{4}$ miles long. Already all the north side, and from a quarter to half the space on the south side has been let, so this new extension promises to be one of the most busy of the docks. The total cost of this extension has been about a million and a quarter. It is to be hoped that this magnificent addition to our dock accommodation will materially aid in developing our London shipping traffic, to be equal to that of Liverpool. Messrs. Lucas and Aird were the contractors for this great work, and right well they seem to have accomplished it. They were present at the opening, with an immense number of invited friends, making a concourse of some 4,000 people.

SIR HENRY SEGRAVE.

"Shipbuilding and Shipping Record," June 19th, 1930.

Although the name of the late Sir Henry Segrave was more closely associated with the automobile and the aeroplane than it was with the speed-boat, a brief survey of the design and equipment of *Miss England II*, the vessel on which he so unfortunately lost his life, is sufficient to show the enormous value of the work which he did and to silence those who would suggest that lives such as his are spent in useless endeavour. A considerable amount of research work has been directed towards the production of a suitable form for the hull of very high-speed craft, and this should not be without effect upon the design of vessels intended for more prosaic purposes. Again, his work on the production of a suitable propeller running at a speed of about 12,500 r.p.m. and absorbing a power estimated at not far short of 4,000 B.H.P., and thereby to give to a vessel a speed of 100 miles per hour, should be of value as indicating a means whereby small high-speed engines can be employed for the propulsion of commercial vessels. In the design of the engine also wonderful work has been done in developing an engine of very high power-weight ratio, and it has been stated of the Rolls-Royce engines fitted in *Miss England II* that they were originally designed to give 875 B.H.P. each, but that by modification of the design, the adoption of supercharging, and the use of a new aluminium alloy, the power of each engine was increased to nearly 2,000 B.H.P. with a power-weight ratio of appreciably less than 1 lb. per B.H.P. It is not suggested that engines of this type could find a place on any type of merchant vessel, at any rate not for practical purposes, for some time to come, but they serve to point the way in which saving of weight can be effected. With these and other accomplishments brought about largely on account of the demand for a vessel of extraordinarily high speed, it cannot be said that such work is of no practical value.

DOUBLE-ACTING AUXILIARY DIESEL ENGINES.

"Shipbuilding and Shipping Record," June 19th, 1930.

The employment of the double-acting principle in a Diesel engine with its attendant drawbacks of higher cylinder temperature and additional complication is generally regarded as being justified only when the demand for power is considerable, as on large passenger motorships. It will be recognised, however, that the double-acting Diesel engine, particularly if it is operated on the two-stroke cycle, possesses a very even turning moment which makes it an attractive proposition where relatively high speeds of rotation are required as, for example, when driving electrical generators. Moreover, such an engine, if properly designed, should be capable of running with a freedom of vibration which is not always obtained with units operated on the single-acting principle. It is of interest to note that the Richardson-Westgarth double-acting principle has been successfully embodied in a three-cylinder unit of 1,500 B.H.P., having a speed of rotation of 300 r.p.m., which it is claimed is the highest speed which has ever been employed on a double-acting Diesel engine. The cylinder diameter is only 15 ins., with a piston stroke of 18¼ ins., and the engine can thus be supplied with a short stiff bedplate which, taken in conjunction with the generator of 1,000 kW. to which it is directly connected, yields a unit of very moderate overall dimensions. The engine is entirely self-contained, being provided with its own scavenge pump, no air compressor being required since airless injection is employed. The weight of the engine as well as the cost is relatively low and while from the size of the generator it will be recognised that the unit is intended for use on land, it should make an attractive proposition as an auxiliary generator set on board ship, and such a unit is now available.

BOILER EXPLOSION REPORTS.

REPORT No. 3067. Steam Trawler *Port Jackson*.

The explosion occurred at about 8.30 a.m. on the 11th September, 1929, whilst the vessel was proceeding from Fleetwood to the fishing grounds. No person was injured.

The boiler was of the cylindrical multitubular marine type, 12ft. in internal diameter and 10ft. in length. It was designed for a working pressure of 180 lbs. per square inch and fitted with two non-withdrawable plain furnaces 41½ins. in diameter and ¾in. thick. The usual mountings were fitted, including safety valves adjusted to lift at 180 lbs. per square inch.

There is no record of repairs to the boiler prior to 1927. On 12th August in that year, eight combustion chamber stays were renewed, the tubes were re-expanded and the manhole door spigots reinforced by welding. On 31st October, 1928, a crack in the flange of the front end plate to which the starboard furnace is attached was cut out and built up by electric welding, and on 17th December, 1928, several combustion chamber rivets were renewed.

The upper portion of the flange on the front end plate of the boiler, to which the port furnace was attached, cracked through circumferentially for a length of about 8ins., and allowed some of the contents of the boiler to escape.

The explosion was caused by fracture of the material of the flange in the front end plate for the attachment of the port furnace, due to expansion and contraction stresses.

The *Port Jackson* is a steam trawler engaged in fishing from Fleetwood and is fitted with one single-ended boiler, using coal as fuel and supplying steam to a set of triple expansion engines.

The vessel left Fleetwood at 6 a.m. on the morning of the explosion, and at 8.30 a.m., whilst the engine man was attending to the machinery, the fireman came to the engine room and reported that he could not fire the port furnace on account of water running out. On going into the stokehold, the engine man found water running down the end plate of the boiler, but could not determine the cause on account of the defect being hidden by the furnace front. He then informed the skipper, who decided, as the vessel was only about 20 miles from Fleetwood, to put back to port.

During the next hour's steaming it was found that the leak was getting worse, and at about 9.30 a.m., as all water had disappeared from the gauge glass, the fires were drawn and the vessel hove to. On removing the furnace front it was discovered that the end plate, where flanged for the port furnace, had cracked in the manner described above. The vessel was then towed back to Fleetwood by the steam trawler *Florence Brierley*. On arrival, the crack was cut out for a length of 36ins. and electrically welded.

When the defect was examined by me the repair had been completed and the condition of the plate in the vicinity of the crack could not be ascertained, but it is stated by the Insurance Society's Surveyor that he had examined the boiler annually for the past five years and no grooving had been detected. A similar defect was found in the starboard side in October, 1928, but the crack was not so extensive. It was noticed during boiler cleaning, and repaired in the same way as the crack in the port flange which caused the explosion.

It is the usual practice with steam trawlers for steam to be raised in the boilers by a shore staff, the enginemen not coming on board until the vessel is ready for sea. It is stated that 12 hours is the usual time occupied for raising steam from cold water to 180 lbs. per square inch, no circulating valves or other device being fitted to equalise the temperatures in the boiler during the process. Neither is it the practice to blow out a part of the colder water from below the furnaces and allow hot water to fill this part of the boiler. The natural convection currents, which are unlikely to disturb the water in this vicinity, are relied on entirely to produce circulation.

Fresh make up feed was not employed, and the heating surfaces were therefore probably not free from scale. This would increase the temperature to which the material of the furnace would be raised, and increase the difference in the length between the hot and cold conditions, thus intensifying the stresses imposed on the end plate. As is usual in the boilers of steam trawlers, plain furnaces were fitted; the strains due to the stresses imposed by expansion and contraction of the furnace were thus concentrated at the section which failed.

I am informed that when the repairs were completed the boiler was subjected to a satisfactory hydraulic test.

Observations of the Engineer Surveyor-in-Chief.

Where the end plate of a cylindrical marine boiler is flanged to take the furnaces and the flange is formed with a small radius, grooving at the radius very often results and if in addition plain furnaces are fitted, this defect can usually be expected to develop.

In this boiler both flanges in the front end plate for the attachment of the furnaces have now been repaired where considerable grooving had taken place, and as the same conditions as regards the radius of the flange and stiffness of the furnace, etc., will exist as before the failure, it will be necessary to keep the parts under careful observation in future so that repairs can be undertaken before the condition of the plate becomes dangerous.

REPORT No. 3089. Steam Drifter *Trustful*.

The explosion occurred on the 21st January, 1930, when the vessel was at the northerly entrance to the Caledonian Canal. No person was injured.

The boiler was 23 years old, and of the single-ended, return tube, marine type, 10ft. diameter and 9ft. long, having two plain furnaces each 3ft. in diameter. The mountings included a water gauge of the hollow column type, the steam end of which was connected to the boiler by means of a pipe and screw down valve, and the water end by a pipe and cock. On the side of the hollow column were two test cocks. A new front end plate was fitted in 1926 and at the same time the boiler was retubed.

The upper part of the tube plate of the starboard combustion chamber was buckled about $\frac{3}{4}$in. into the chamber, the plate being forced over the ends of the tubes. The contents of the boiler were thus allowed to escape through the tube holes. The combustion chamber crown and back plates were buckled generally $\frac{5}{8}$ to $\frac{7}{8}$ inch between the stays, the crown in addition being forced down bodily $\frac{5}{8}$in. The explosion was due to shortage of water.

The *Trustful* was a steam fishing drifter, having one boiler, which was worked at a pressure of 130 lbs. per square inch. Her owner, Mr. William More, acted as skipper, with William Robertson as engine driver. The latter had had several years experience of the work, but did not hold an engineer's certificate.

The vessel had been lying for six weeks at Buckie, when Robertson, on the 16th January, 1930, received instructions to prepare the boiler and engines for sea. On the 18th January she sailed to Burghead under her own steam, everything working satisfactorily. She left Burghead on the 20th January, the intention being to proceed to the Irish fishing grounds via the Caledonian Canal. Trouble was indicated when entering the canal soon after 9 a.m., 21st January, by a fizzing noise at the back end of the starboard furnace. The vessel, however, continued her way for the full length of Loch Ness with about 80 lbs. steam pressure and engines moving slowly, but when near Fort Augustus at about 1.30 p.m. Robertson reported to the skipper that he could not get steam, and the vessel was with difficulty taken to the quay. For more than three hours preceding this the extra feed cock on the condenser had been kept open and steam was seen escaping from the funnel. Robertson states that he did not know how much water was in the boiler because sometimes he could see it in the glass and at other times it was out of sight above the top of the glass. At the time, thinking he had too much water, he opened the blow-off valve and blew some out. He frequently opened and closed the steam, water and drain cocks at the gauge glass, but could come to no decision regarding the height of the water in the boiler. He did not attempt to use the valve at the top, or the cock at the bottom of the water gauge pipes. His answers to questions during the course of this inquiry showed that he had not sufficient knowledge to enable him to test properly the water gauge. After the accident he accompanied the surveyor for the insurance company to the top of the boiler and it was found that the steam valve for the water gauge was shut, it being only possible to turn in the closing direction the 4½in. diameter wheel handle a distance of about ⅜in. measured on the periphery of the wheel. Robertson, in his evidence, explained that he always regulated this valve because, if kept full open, the water in the glass moved up and down too freely. He stated that he generally kept it two turns open. The valve was examined and found to be very slack in the screw and stuffing box. There is little doubt that the vibration of the engines and ship had caused it gradually to close, thus making the water gauge quite useless. Had the water gauge been tested in a proper manner the defect would have been ascertained and remedied in a few minutes. The owner has agreed to replace this valve before again using the boiler by a cock clearly marked to show whether opened or closed. The cost to make good the damage is estimated at close on £300.

Observations of the Engineer Surveyor-in-Chief.

The engine driver had had several years experience in the management of steam boilers, but it is evident that he did not really understand the working and testing of water gauges.

The steam valve to the gauge had been improperly used to check the motion of the water in the glass and the slackness of the spindle indicates that it had been so used frequently.

As the engine driver admitted that he was in doubt as to the height of the water in the boiler, it would have been prudent for him to have either drawn his fires, or at least to have closed the damper and so slowed down the rate of evaporation until he had ascertained what the position really was.

There is no doubt that the explosion was due to shortage of water, and it would not have taken place if the instructions regarding water gauges contained in the publication " Hints to boiler attendants on board fishing and other vessels," issued by the Board, had been followed.

The owner has agreed to replace the valve by a cock, which will be more reliable if properly used.

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 7th June, 1930:—

NAME.	GRADE.	PORT OF EXAMINATION.
Barr, Alexander G.	1.C.	Glasgow
Cameron, Archibald	1.C.	,,
Lee, Robert	1.C.	,,
Lowry, Henry	1.C.	,,
Mackinnon, Kenneth	1.C.	,,
Nicol, Stanley	1.C.	,,
Scott, Thomas	1.C.	,,
Brown, Frederick C. B.	2.C.	,,
McFarlane, William	2.C.	,,
Mackenzie, Malcolm	2.C.	,,
Hunter, John	2.C.M.	,,
Calder, William A.	1.C.M.E.	,,
Hooker, Frederic H.	1.C.M.E.	,,
Gray, James	1.C.M.E.	,,
Hanson, Arthur W.	1.C.M.E.	Hull
Boorman, Cyril E.	2.C.	,,
Epps, George L.	2.C.	,,
Whincop, George F.	2.C.	,,

For week ended 7th June, 1992—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Turner, Geoffrey G.	2.C.	London
Atkins, John A.	2.C.M.	,,
Moir, Ronald J.	1.C.	,,
Hamilton, Herbert N.	1.C.	,,
Canning, Kenneth C.	1.C.	,,
Braithwaite, Edward A. V.	1.C.	,,
Tomlinson, Wilfred	1.C.M.E.	,,
Jones, Hubert S.	1.C.	Liverpool
Jones, Sydney	1.C.	,,
Miller, Thomas H.	1.C.	,,
Boothroyd, Percy	2.C.	,,
Forbes, Hume C.	2.C.	,,
McGowan, Leslie C.	2.C.	,,
Wright, William	2.C.M.	,,
Christian, Charles H.	1.C.M.	,,
Heaton, John P.	1.C.M.	,,
Gibbins, Robert O.	1.C.	Sunderland
Hendry, John	1.C.	,,
Morgan, James	1.C.M.E.	,,
Blakey, Richard L.	2.C.	,,
Handford, Robert P.	2.C.	,,
Hurst, Cyril G.	2.C.	,,
Rutter, John W.	2.C.	,,
Willcox, Harry T.	2.C.	,,
Johnson, Charles A.	1.C.	Newcastle
Sharpe, Douglas E.	2.C.	,,
Willey, Lawrence A.	2.C.	,,

For week ended 14th June, 1930:—

NAME.	GRADE.	PORT OF EXAMINATION.
Johnston, William	1.C.	Liverpool
Smith, Arthur I.	1.C.	,,
Wright, Edward	1.C.	,,
Dempsey, Herbert	1.C.M.	,,
Dart, Frederick C.	2.C.M.E.	,,
Powell, Hugh	1.C.M.E.	,,
Campbell, Allan K. M.	1.C.	London
Ford, Henry A.	1.C.	,,
McMullan, George	2.C.	,,
Buckwell, Victor W.	1.C.M.E.	,,
Thomas, Wilfred	2.C.M.	Newcastle
Davison, William O.	1.C.M.E.	,,
Scaife, Thomas L.	1.C.M.E.	,,
Hayward, Edwin A.	1.C.	Cardiff
Moon, John I.	1.C.	,,
Thomas, Edgar R.	1.C.	,,
James, Norman C.	2.C.M.	,,
Walker, Ronald	2.C.M.	,,
Thomas, David W.	1.C.M.E.	,,
Calderhead, William M.	1.C.	Glasgow
McGee, Archibald	1.C.	,,
Stanger, Charles E.	1.C.	,,
Vogt, Edward T.	1.C.	,,
Watson, George C.	1.C.	,,
Fleming, John	2.C.	,,
Stark, James	2.C.	,,
Forsyth, George	2.C.M.E.	,,
McDonald, Colin	1.C.	Leith
Baillie, James C.	2.C.	,,
Aitken, Alexander W. S.	1.C.M	,,
Henry, Alexander	1.C.M.E.	,,

For week ended 21st June, 1930:—

NAME.	GRADE.	PORT OF EXAMINATION.
Stewart, James	1.C.	Glasgow
Chapman, Colin P.	1.C.	,,
Gray, George C.	1.C.	,,
Dunbar, John	1.C.	,,
Stevenson, Robert A.	1.C.	,,
Whyte, William G. B.	1.C.	,,
Girdwood, John R.	2.C.	,,
McAlpine, James	2.C.	,,
Scully, Robert W.	2.C.	,,
Burmingham, George W.	2.C.M.	,,
Sims, Henry	1.C.	Liverpool
Dickson, Robert J.	1.C.	,,
Bolger, James F.	1.C.	,,
Bathgate, John S.	1.C.	,,
Shave, Ralph S.	1.C.	,,
Wallace, William K.	2.C.	,,
Kirk, Arthur L.	2.C.	,,
Jones, William C.	2.C.	,,
Jones, John I.	2.C.	,,
Ashfield, Arthur G. W.	1.C.	London
Roberts, Arthur L.	1.C.	,,
Cartwright, Edward	2.C.	,,
Bennett, Alfred H.	1.C.M.E.	,,
Ritchie, Samuel	1.C.M.E	,,
Pallon, William S.	1.C.	Newcastle
Sharp, George M.	1.C.	,,
Stout, Oliver	2.C.	,,
Butterworth, Arthur	1.C.	Sunderland
Lamb, William H.	1.C.	,,
Waddle, William	1.C.	,,
Lacon, Edwin	2.C.	,,
Raine, Norman	2.C.	,,
Walker, Thomas	2.C.	,,
Tighe, Jack	2.C.	,,
Aitchison, Ralph D.	1.C.M.	,,
Hunter, Robert	1.C.M.	,,
Haswell, Herbert W.	2.C.M.	,,
Robertson, George S. K.	2.C.M.	,,
Tate, John T. R.	2.C.M.	,,
Bertram, William	1.C M.E.	,,

For week ended 28th June, 1930 :—

NAME.	GRADE.	PORT OF EXAMINATION.
Cumine, Alan	1 C.M.E.	London
Burge, Charles	1.C.M.E.	,,
McMullan, Thomas J.	1.C.	Southampton
Wilson, Reginald A.	2.C.	,,
Siggers, Herbert B.	1.C.	,,
McCuaig, Duncan A.	1.C.	Belfast
Donnelly, Alexander L.	2.C.	,,
McKinney, Robert J.	2.C.M.	,,
Jones, Keith E.	1.C.	Cardiff
Gilbert, Oliver N.	1.C.	,,
Connor, John F.	2.C.	,,
MacPherson, Angus A. S.	2.C.	,,
Bowman, William	1.C.M.	Glasgow
Williamson, William O.	1.C.	,,
McLennan, Kenneth	1.C.M.E	,,
Welsh, William B. R.	2.C.	,,
Innes, Herbert C.	2.C.	,,
Benson, John E.	2.C.	Newcastle
Burnett, Jacob E.	2.C	,,
Butchart, Maurice W.	2.C.	,,
Redpath, Edward H.	2.C.	,,
Bjorck, Carl E.	1.C.M.E.	,,

For week ended 28th June, 1930—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Macdonald, Ronald A.	1.C.	London
Ledger, Stanley W.	2.C.	,,
McComiskey, Arthur R. G.	2.C.	,,
Ross, George S.	2.C.	,,
Winter, George	2.C.	,,
Edwards, Walter N.	2.C.M.	,,
Westwater, Alexander	1.C.	Leith
Davidson, William R.	2.C.	,,
Linklater, John	2.C.	,,
McKay, James	2.C.	,,
Wilson, James	2.C.	,,
McIntosh, Robert W.	2.C.M.	,,
MacBean, Lewis D.	1.C.M.E.	,,
Guy, Joseph I.	2.C.	Liverpool
Healey, Thomas	1.C.	,,
Reevell, Walter H.	1.C.	,,
Hope, John E. P.	2.C.	,,
Hodson, Henry W.	1.C.M.	,,
Dodsworth, Harold	1.C.M.E.	,,
Gale, William J.	1.C.M.E.	,,
Heron, John A. H.	1.C.M.E.	,,
Jones, David	1.C.M.E.	,,
Jones, Sydney	1.C.M.E.	,,
Heaton, John P.	1.C.E.	,,
Henderson, James R.	Ex.1.C.	Newcastle
Cumine, Alan	Ex.1.C.	London
Byars, Robert F.	Ex.1.C.	,,
Batt, Cecil F. I.	Ex.1.C.	,,

For week ended 5th July, 1930 :—

Ferris, Clarence B.	Ex.1.C.	Belfast
Armstrong, Robert	2.C.	Glasgow
Black, James	2.C.	,,
Champness, Gerald T.	2.C.	,,
Harkness, Donald M.	2.C.	,,
Patrick, James	2.C.	,,
Tait, David	2.C.	,,
McMillan, William	1.C.M.	,,
Douthwaite, Charles	1.C.	Liverpool
Salt, Joseph H.	1.C.	,,
Solly, Henry W.	1.C.	,,
Brandwood, William	2.C.	,,
Heath, Alec	2.C.	,,
Moir, Reginald H.	2.C.	,,
Hesketh, Richard A.	1.C.M	,,
Gates, Alexander H. F.	1.C.M.E.	,,
Clayton, Harold R.	Ex.1.C.	,,
Ingamells, Bernard P.	Ex.1.C.	,,
Millar, James G.	Ex.1.C.	,,
Golightly, George T.	1.C.	London
Winder, Harold G.	1.C.	,,
Coleman, Edgar H.	2.C.	,,
Denton, Arthur B.	2.C	,,
Rapley, Keith U.	2.C.	,,
Tabbitt, Cyril O.	2.C.	,,
Way, Charles T.	2.C.	,,
Park, Edward T.	1.C.M.	,,
Rogers, Benjamin	1.C.E.	,,
Cairns, John H. A.	1.C.M.E.	,,
Macfarlane, Roderick M.	1.C.M.E.	,,
Maddock, Richard	2.C.	Newcastle
Matthews, William N.	2.C.M.	,,
Frazer, Douglas	2.C.M.E.	,,

INSTITUTE NOTES.

LLOYD'S REGISTER SCHOLARSHIPS.

The examination for this year's Scholarship was held on May 12th and 13th, seventeen candidates being examined at various centres as follows:—

Newcastle, 6; Liverpool, 4; Glasgow, 2; Edinburgh, 2; Cardiff, 2; Belfast, 1.

The Scholarship was gained by Wilfred Thompson, of Tynemouth, an apprentice engineer with the North-Eastern Marine Engineering Co., Ltd., Wallsend-on-Tyne. He will take up a degree course at Armstrong College, Newcastle-on-Tyne at the beginning of next term.

George A. Westlake (Graduate), who won the Lloyd's Register Scholarship last year, and is studying at Armstrong College, has passed the Second Honours Examination for the Degree of B.Sc. in Marine Engineering, and has also won a half-share of the Charles Mather Scholarship, value £40, which is awarded on the results of the examination.

ROYAL SOCIETY OF ARTS. THOMAS GRAY MEMORIAL TRUST PRIZE AWARD.

Under the Thomas Gray Memorial Trust, the objects of which are "The Advancement of the Science of Navigation and the Scientific and Educational Interests of the British Mercantile Marine," the Council of the Royal Society of Arts in 1929 offered a Prize of £50 for an essay on the following subject:—

"You are overtaken by a revolving storm. Discuss the handling of a low-powered steamer from the time of the first indication of the approach of the storm until the storm has passed, supposing the ship to be in (*a*) the safe semicircle, (*b*) the dangerous semicircle, and (*c*) the direct path of the storm's centre."

Sixty-nine essays were submitted for this Prize. On the unanimous recommendation of the Judges, the Council awarded the Prize of £50 to

J. S. Commander,
Master, S.S. *British Ensign*,
The British Tanker Co., Ltd.

Capt. Commander was elected a Companion of the Institute of Marine Engineers in February, 1928.

Presented by the Author: —

"Between Two Oceans." By M. T. Zarotschenzeff. Published for the Author by the Cold Storage and Produce Review, Empire House, St. Martin's-le-Grand, E.C.1. Price 5/-.

This book gives a general survey of the scientific and technical principles, methods and operation, of the rapid chilling and freezing systems which are in use in Newfoundland, Canada and the United States, for the preservation of fish and meat. Definite information is at last available for those interested in the process of freezing fish, fruit and meat in small portions, and ensuring their preservation in good condition for some considerable time. There is, incidentally, proof that this business is past the experimental stage. Methods of sharp freezing, quick freezing and rapid freezing are mentioned, the latter giving the smallest size of crystals in the article. The following systems are described: Ottesen, Birdseye, Bloom, Kolbe, Cooke, Petersen, Huntsman and Leim, "Nordic." There are over one hundred illustrations which greatly enhance the value of the book and help to make every detail clear. Several examples are quoted giving data of plant required, power costs, brine temperatures necessary and times required, also the method and cost of packaging. There is a chapter on the advantages of adopting rapid freezing in the United Kingdom.

The Author is a prominent refrigerating engineer of high repute, who is well known in the Baltic, France and Italy; he has lately been demonstrating in this country an improved patent process of his own described as "fog freezing," which gives better results than the ordinary immersion process. As he wished the book to be free of any advertisement of his own work it is not mentioned, but particulars of his process are available in current trade periodicals.

J.T.

Presented by J. A. Masson (Associate): —

"Marine Oil Engines: their Construction, Management and Maintenance." By W. D. Martin. Published by Jas. Munro and Co., Ltd., Glasgow. Second edition, 1919. Price 7/6.

Purchased: —

Instructions as to the Survey of Passenger Steamships. Volume I.—Text. Supplement No. 1 to 1928 edition. Issued the Society's thanks to the Junior Section Committee for their co-operation on this occasion.

"TITANIC" ENGINEERING STAFF MEMORIAL BENEVOLENT FUND.—The Council gratefully acknowledge a donation of 8/6 from A. G. Raitt (Member, Shanghai), also 17/- from H. McLean (Member, Valparaiso).

ELECTION OF MEMBERS.

The following were elected at the Council Meeting held on Monday, July 14th, 1930:—

Members.

James Duncan Black, 135, Folkestone Road, Dover, Kent.
James Harold George Chappell, 126, Herbert Road, Plumstead, S.E.18.
Horace Edgar Cropley, Box 44, Warragul, Victoria, Australia.
Alistair Ferguson, 7, Quarry Point, Quarry Bay, Hongkong.
Charles John Maynard Flood, B.Sc., Wh.Ex., 5, Ruvigny Mansions, Putney, S.W.15.
George Hayes Garner, 211, Coulsdon Road, Upper Caterham, Surrey.
Duncan Godfrey Hardy, 1, Goodmayes Avenue, Goodmayes, Essex.
David Alan James, 100, North Side, Clapham Common, S.W.
Wilfred Herbert Jones, Bank Cottage, Vale Road, Whitby, Wirral, Cheshire.
David Latto, 101, Kingsland Road, Plaistow, E.13.
Thomas Gilbert McClung, 39, Bemersyde Road, Durban, South Africa.
Colin McDonald, 62, Dalry Road, Edinburgh.
John Reginald Phillips, 67, Plymouth Road, Penarth, Glam.
Reginald Frank Potter, 25, Westridge Road, Portswood, Southampton.
William John Press, 38, Sandhill Gardens, Neill's Hill, Belfast.
William Lamond Steven, Insurance Engineers, Ltd., 45, Frederick Street, Edinburgh.
Garret Wellesley Walker, 3, Mayville Terrace, Dalkey, Co. Dublin.

Charles Richard Oxborrow, 207, Victoria Road, Woolston, Southampton.

Associate Members.

Charles Albert Bedford, 4th Engineer, *c/o* Mackinnon, Mackenzie and Co., P.O. Box 163, Calcutta, India.
Arthur Vernon Jarratt, Atlas Diesel Co., Ltd., New Oxford House, W.C.1.
Halfdan Sommerfeldt Jespersen, 1, Shakespeare Road, Hanwell, W.7.
James Shaw, S.S. *Canara, c/o* British India Engineers' Club, 2, Royal Exchange Place, Calcutta.
Walter Robert Wells, *c/o* Municipal Office, Penang, S.S.

Student Graduates.

Edwin John Moyse, 82, St. Edwards Road, Gosport, Hants.
James Lawrence Oliver, St. Anthony's Vicarage, Newcastle-on-Tyne.

Graduate.

Wilfred Thompson, 63, Percy Street, Tynemouth, Northumberland.

Transferred from Associate-Member to Member.

Leonard Henry Davis, Winamac, Marshall Road, Rainham, Kent.
Richard Alistair Harvey, Strageath, Allandale Road, St. John's, Newfoundland.

Transferred from Associate to Member.

William Ernest Hoes, 29, Farnaby Road, Bromley, Kent.

Transferred from Graduate to Associate-Member.

Matthew Caldwell Houston, 10, Belgrave Road, Ilford, Essex.

OBITUARY.

FREDERICK JOHN BLAKE.

It is with great regret that we have to record the sudden death at Southampton on July 25th, 1930, of Mr. F. J. Blake, R.D., Chief Engineer R.N.R., who for many years was the Superintendent Engineer to the White Star Line at that port. Mr. Blake was born at Coalbrookdale, in Staffordshire, on November 21st, 1866, and received his technical education at Crewe and Liverpool. He served an apprenticeship with James Jack & Co. and David Rollo & Sons, at Liverpool. After three years at sea he obtained his Chief Engineer's certificate, and in 1893 joined the White Star Line as assistant fourth engineer on the *Majestic*. He soon became a chief engineer in the company, and served in that capacity on several White Star Liners. In 1904 he was appointed assistant superintendent engineer to Ismay, Imrie & Co., of Liverpool, and three years later, when the White Star Line mail steamers were transferred to Southampton, was appointed Superintendent Engineer at that port, a position which he held with honour until his death.

Mr. Blake was closely identified with several interesting salvage operations, including those of the *Suevic*, *Olympic*, *St. Paul* and *St. Louis*. For several years he had charge of the American Line mail steamers calling at Southampton. During the war he spent most of his time in the United States supervising the repairing and putting into service of ships, and in 1917 he superintended the construction of twelve steamers at San Francisco, which, originally ordered by the Ministry of Shipping, were subsequently commandeered by the United States Shipping Board. In New York he acted as Superintendent Engineer to the International Mercantile Marine Company, and also had charge of a large number of American-owned ships. Since the putting into service of the *Majestic* he took a personal pride in the upkeep and operation of the machinery of that ship.

Mr. Blake took an early interest in the work of the Royal Naval Reserve, and received his R.D. decoration in 1908. He had been a member of the Institute for the past twenty years. In 1920 he was elected Vice-President for Southampton, and in this capacity he rendered valuable assistance in the work of the Institute in that area.

glass, opaque to all points save their own pet grievances. Thinking over this matter once again, the author imagines it may be of some value if this Institute could be induced to consider the matter afresh and seek the origin of the misunderstandings, resulting possibly—who can tell—in achieving a real step onwards to the ideal.

In these periodical outbreaks of criticism the author does not recall any instances in which the legal and medical professions figure; is he correct, or do they make their strictures without the noise of big drums, trumpets, etc.? This is an interesting point and worth more than a passing thought. What is meant by the word "education"? It is not easy to answer this question shortly. Perhaps one may say that "education" means a system or process of training designed to draw out, or call forth the latent powers of an individual to do things as perfectly as is possible for that individual. It is intended also to help the person to achieve this standard of perfection at the earliest possible moment. This statement it should be noticed is unlimited, and obviously includes both manual and mental fields of activity. There is no need to take exception to this comprehensiveness, but its recognition leads at once to a simplification of the discussion in hand. Too many approach the subject of education by tacitly assuming that it has nothing to do with any effort other than mental. Of course the musician spends hours in the training of hands and feet, or in the development of the voice. The dentist and surgeon are also examples of prominent professions in which the careful development of manual dexterity is required, but these are cases which many look upon as intellectual professions, and frequently overlook the practical or manual training required as part of their educational scheme.

The engineering profession, it is submitted, differs somewhat from those above-named, in that it includes at one end individuals who require practically little or no manual dexterity, and at the other end those in whom manual dexterity is comparatively all important. This adds at once to the difficulty of grasping the subject in all its details with the proper perspective and so doubtless leads to much of the confusion in the views expressed by individual critics. The great weakness in the situation is that generally the leaders in engineering are not the leaders in education. It will be a great gain when closer co-operation between the engineering employers and the education officers exists. There must be co-operation, for the professional man cannot be (save in rare instances) all sufficient in teaching, as well as in practising. The meaning of this is self-evident, and only requires stating to be appreciated.

EARLY EDUCATION.

Another preliminary point to be stressed is that the beginnings or foundations are all important. How frequently one finds that parents and guardians will take comparatively great pains and trouble about the education of their child of 13 or 14 years of age and upwards, but cannot find time to give any serious attention to the education of the child of six or seven; and yet it is suggested that the younger child's case is by far the more important. It has been the author's experience when this point has been mentioned to hear that it is only important that the child should begin to learn, and that it cannot go far wrong in the early stages; anybody can teach it letters and so on. The fruits of this error can be seen in later years and the individual has to pay the price of the neglect of his parents or guardians.

The nursery is the first stage in a child's education, and it cannot be denied that the character of the child's after life is more or less determined during this stage. At this stage of its existence the child is imitative, and copies the doings and sayings of its elders, regarding its parents in particular as beings that can do no wrong. Thus in the home the moral character (in particular) is formed almost altogether, and it is to be regretted that many parents do not realise the immense power of their influence and example for good or evil over the future citizens.

The next stage in the child's education must take him out of the home for a part of his time, and outside influences will play a gradually increasing part in forming and modifying the character, hence the necessity for enquiry into the character of the inmates of the school, as well as of the teachers. This is a counsel of perfection, but possible of realisation in some measure, and certainly desirable. The character of the staff is of far greater importance at this stage than that they have won high academic honours, or that the school can produce a long list of successful students who have won scholarships.

The growing child will now be in the Primary School, and before him is the vista of the Secondary School, Technical

School, and the University. No special mention of public schools is made, for their work is naturally the same in character and scope.

TOO MANY SUBJECTS.

Some attention must now be given to the subjects suitable for each of these stages. First the subjects dealt with in the Primary Schools must of necessity be those classed as reading, writing and elementary arithmetic. No additions to these subjects should be permitted at this stage; also it is suggested that no advancement to the Upper or Secondary Schools should be allowed until proficiency is attained. Because a child is nine or ten, or any other arbitrary age is no convincing argument for giving him additional subjects which will most likely confuse, bewilder and discourage him. Smaller classes and more individual tuition is necessary with the juniors than is usually given. Each child has his own peculiar difficulties, and the teacher's efforts must be to learn these peculiarities, and so know how to ease the road onwards. Lecturing to children in groups of 20 or more, for 20 or more minutes, is a very poor method of teaching and is the source of immense trouble later on. This method of teaching is associated with that bugbear "home work." Home work usually takes the form of giving—at chance—so many examples from some text-book, in two or three subjects, to be dealt with at home. This work is frequently "rushed," for it is by chance if the work done is adequately examined by the teacher, and there is no time available in which the child can have his own troubles cleared away. Take a class of 25 children with an average of two subjects on which questions are set for his home work each night. Each day these 50 exercise books require examining and correcting, involving say four minutes each or three hours work out of school for each member of the staff daily! Add to this another hour at least for the personal help to each child (2 min. 24 sec. only) necessary to clear away its own peculiar difficulties, and it becomes at once apparent how little chance most children have of coping successfully with the present overloaded curriculum in force in the majority of elementary and secondary schools. Everyone who has had to deal with the victims of the present system can bear witness to the very low average ability shown when they have to take the initiative in applying their knowledge (or want of it?) to professional work. The reason is clearly the lack of time to grasp the principles underlying the matter and having to rely upon their memories to get them through the examination tests applied.

The remedies are obvious (1) provide smaller classes, especially in the case of the juniors; (2) avoid lectures and give individual tuition; and (3) reduce the subjects dealt with by some 50 per cent. or more in the junior classes. The slogan should be "a little done thoroughly," in lieu of "a smattering of many subjects." A pint pot must not be looked upon as having the capacity of a gallon measure.

Another matter that requires consideration is physical exercises and games; are they receiving too much emphasis at the present time? A good game is worth much, but the way games are specialised to-day makes it almost a crime for an individual to lose a point. Is that the highest ideal to aim at? Will an excellent wicket-keeper make the better and more accurate draughtsman? The author inclines to the view that if the present attention given to sports were turned to the encouragement of those qualities that go to make good citizens, the country would gain much by such a transfer of effort.

The same difficulties confront the student when he reaches the upper school. It is suggested that the present system which controls the selection of the management committees of schools is wrong. A very large proportion of those committees should be formed equally of employers and teachers who possess considerable experience, with a minority of those self-styled educationists, too often faddists.

CHOICE OF TEACHERS.

When the syllabus of subjects is being settled the " employer " section of the committee would have first-hand knowledge of what is required from the staff in the conduct of business, and the teaching element would know how far it was practicable to deal thoroughly in the time available with the subjects proposed. In this way it would be easier to avoid the errors of over-loading " The Mighty Atom " as a consequence of educational faddists. The educationists can often make a great case for the inclusion of their pet subjects in the child's educational course but these faddists too often overlook that the child's brain has to grow in strength, and does not at once attain its full possible powers. The educationist must not forget that the list of subjects must be arranged to suit the often slow growth of the child's intelligence, and that the average individual must set the pace and thus limit the range of work possible for the masses.

So far, no special mention has been made of manual training, other than that relating to games. This subject is, however, an all important one, and one that is becoming increasingly difficult. The ever-increasing use of machinery to do all the usual operations formerly assigned to the craftsman makes it almost impossible to find craftsmen capable of teaching, and the market open to real craftsmen is getting very small. For this reason the teaching of manual work in technical schools is not an easy matter. The author remembers his difficulties when dealing with the training of munition workers due to the absence of skilled mechanics. The teachers supplied were quite unable to cut screws having an odd number of threads per inch. They could not use a chisel, and the amount of tool-steel ground away in sharpening tools was almost as pathetic as the finish of the work produced. For these and other reasons the teaching of craftsmanship in schools is surrounded with quite as many difficulties as any other field of school work.

VALUE OF TIME.

Possibly the main reason why school training in practical work does not appeal to many engineers is the usual total lack of appreciation of the value of the time taken in completing a given task, as well as of the financial side of business. It is quite usual to throw a spoiled piece of work away and start afresh; the second specimen, if approved, will then score as much credit as if no failure has occurred. This in a workshop would be impossible, for the particular piece would be late, and so the original failure would be detected, a result impossible in ordinary school work. Of course mistakes are made in shops, but in every such case the offender realises at once that so much time has been wasted, and its cost has been registered against him. For this and other similar reasons the school work can only serve as an introduction to the shop training, which may possibly lead to a reduction of the time spent in this latter stage.

The boy having attained the age of 14 to 16 years, his future will have to be carefully considered in the light of his present state of development, in which consideration it is submitted that the school successes form only one factor. The school life will have demonstrated what proportion of his character is perseverance in well-doing; for genius is still the faculty of doing little things well always, and the best man is the one that can do lots of hard work against difficulties and so achieve his purpose. Therefore in determining his future it is submitted that his school life should be scrutinised for evidence of (1) the ability to work and persevere against apparent odds, (2) not easily being discouraged when failure occurs; (3) what it is that interests him mostly; (4) whether the use of his mind, or of his fingers has the greater interest for him; and (5) the line of thought that excites the greatest curiosity. Perhaps the certificates or school distinctions won may be of value in confirming one's conclusions, but otherwise they may be more or less ignored in deciding how to help the boy to choose his life's work. One must know all the conditions under which certificates have been awarded before they can carry weight.

ENGINEERING TRAINING.

Assume engineering to be the life's work. Remembering that positions are most numerous at the bottom of the ladder and that the density decreases rapidly as the Presidential chair at the summit is approached, it will be seen that the answer to point (4) above mentioned will now have great weight. If manual dexterity is the leading answer, and money is none too plentiful with the parents or guardians the obvious course is apprenticeship, with if possible a supplemental course in the evenings at some technical school. In this way the individual with the average skill will be able to earn his living. If his early promise of manual skill is made good he will soon be able to command the leading positions at the bench. If his mental work prospers, then a foremanship and managerial posts will be open to him.

In the event of his capacity for mental training proving good, there are scholarships available which will enable him to get advanced training at some college, which may pave the way for an entrance into a drawing office, and so on to design work when he will be able to take any ordinary post open in his particular field of work.

Next take the case of a boy who has shown great mental ability in his school work; it then becomes most necessary to examine closely into his work. This leads one to think carefully about the true value of certificates, diplomas, etc., which may have been won during school life.

EXAMINATION FALLACIES.

These trophies are usually obtained by means of examinations, and whilst much may be said (and justly said) against examination methods, they must be admitted to be the only means open at the moment to test the attainments of students; but just as teaching is an art not easily acquired, so good examiners are also very scarce. Anyone who has had to deal with examination work will readily allow that it is not an easy task to write questions that are fair and just both to the student and the examiner. When reading the questions set by an examiner, it is frequently very difficult for an expert to guess the sort of answer that is expected. The candidate faces the ordeal of answering say ten questions in three hours; that is to say, 18 minutes is the average time available per question! In this time the candidate has to realise all that the question demands, and how best to deal with it! Is this fact always appreciated by the examiner? The author feels that examiners who write such questions as—" How many methods are there of propelling a vessel, and what in your opinion is the most economical, say, for an 8,000 ton cargo vessel?"—cannot realise that they are demanding very much from a junior student of engineering science—too much even from an advanced student, when only 18 minutes are allowed for his effort! The latter part of this question is not an easy one even for experts; the relative advantage and disadvantage of steam and oil, the various methods of application, together with the modifying influences of the equipment of the ports of call, the possibilities of refuelling, etc., need only to be mentioned to remind one of the problem—" what is the student expected to write?" In the preface to a book on Surveying, the author stated that the great question he was faced with in its production was that something had to be left out, and what was it to be? So all good students, when faced with a general question such as the above, feel quite unable to do themselves justice, because they know not what to leave out. From another point the question is open to criticism, for it is addressed to candidates who are still serving as apprentices, and how can they be expected adequately to discuss the relative merits of things of which they have no first-hand experience or knowledge? It is obvious (or should be) to all those who examine junior students that the problems set should be designed so as to test the soundness of the candidates' knowledge of mechanical principles and their application to simple problems; beyond this, one cannot advance until the candidates have had the time and opportunity to acquire by experience and study knowledge of a more advanced standard. Questions asking for the candidates' opinions should be very carefully scrutinised before acceptance, to see that the problem proposed is a simple one, and well within the powers of a junior student.

RESEARCH METHODS.

Perhaps this point may be made clearer by the analogous one presented in the laboratory. Anyone having experience in the management of a laboratory must have noticed that the beginner's first lesson in research work must always be to reduce all the possible variables in the problem being attacked to one, and one only; otherwise the results obtained cannot be assigned quantitatively to their cause. This is the rock upon which many experiments otherwise carefully carried out come to grief and lose all their value. So it is very easy for an examination question to fail because there are too many points presented for the students' consideration. Every examiner should frame his questions to be so direct as to be incapable of having more than one meaning assigned to them. Then the candidate having a competent knowledge of his subject cannot be in doubt as to what it is that the examiner expects to find in his reply.

Another very real trouble is the candidate's lack of ability to state exactly and logically what he actually knows about the problem proposed. This is often an heirloom from the primary school, and one of the penalities paid because thoroughness is so usually sacrificed at the altar of quantity.

These are some of the reasons that have led to the previous suggestion that school certificates, etc., may be ignored save where they confirm the conclusions otherwise drawn from the character of the boy as known to his parents or guardians and teachers. All these parties must, in order that the best may be done for the boy, take their full share and responsibility in watching, assisting and guiding the development of his latent powers. Each has his own peculiar opportunities; and no one can justly leave to the others his share in this onerous trust.

THE SANDWICH SYSTEM.

The absolute necessity that the practical knowledge and training must be acquired under actual shop or field conditions has already been pointed out, and need not be further emphasised, but the workshops and the laboratories of a technical school or college can very properly be called upon to explain and demonstrate many points that the shop staff frequently cannot deal with for want of time. In a number of instances large firms recognising this want have established schools into which all apprentices are sent for varying periods. These schools appear to duplicate the technical schools, and the reason for this is in a great measure due to the lack of competent instructors. The author has already called attention to this defect in his proposal concerning the constitution of the managing committees of schools, who too frequently at present fail from want of actual knowledge, and cannot discriminate between the candidates for the position of instructor otherwise than by the certificates of competency(?) they are able to present; whereas in the commercial school everyone concerned in its management is fully alive to the sort of instruction that must be given.

Here perhaps the so-called sandwich system may be conveniently noticed. Some of the reasons which led to its introduction have already been mentioned, and need not be repeated.

From the academic point of view, it is unquestionably an advantage to take up the advanced instruction at once, as then the youth does not have time to become "rusty," and so time is saved; further, if the instruction offered is in the hands of competent instructors, it will help much in a ready appreciation of the reasons for much that is done in the shops, and so again save time both for the youth and his mentors; but this course is still frequently opposed by works managers and others on the score that the man holding a diploma showing that he has passed through a recognised course of instruction has no practical knowledge of shop processes! It is as though a grocer refused to supply a customer with raisins because the would-be purchaser did not possess any raisins!

To meet this absurd position, it is now the custom in many places to arrange for six months to be spent in the technical school and the works alternately. Many speak well of this arrangement. The success of this method depends naturally upon the co-operation between the works authorities and the technical schools concerned. Some reasonable elasticity is required, so that the period spent in the school shall coincide with the length of the school course, which cannot always be exactly six months. The author has in mind one case where some apprentices were allowed to take up a two years' course at a college, free of all expense—a very generous arrangement. But there was one real trouble, as the college course commenced early in October and terminated at the end of June, the examinations taking place during the first 14 days in July at the end of the second year. These students, however, had to return to the shops at the beginning of May, the Christmas vacation being spent in the shops. The college course could not be modified to meet the necessities of the few, and so the last few weeks of the college course was lost by these students. Remembering that the boys had some five years to serve in the shops it appeared that in this case the firms were badly advised to insist upon the return. It seemed to be a real case of red tape in a tangle, spoiling an otherwise excellent gift to young men.

UNIVERSITY WORK.

In these discussions much confusion frequently arises over University work, which is and must always remain distinct from technical school work. When a man has the means, time and ability to pursue the study of some subject as fully as it is possible to do, then it is the work of some University to first instruct him in all that is known at the moment about the matter, next to give him the opportunity of working under the direction of and in many cases with a leading authority, so that his work may assist in augmenting the total knowledge possessed. The University must in a sense remain a training ground for the pursuit of human knowledge for its own sake, and cannot conceivably be a place where mass production and other cognate subjects are studied, or where results are measured in terms of sterling.

Many critics of to-day would do well to think of the work of men like Prof. Clerk Maxwell at Cambridge in electrical phenomena, or that of the immortal Faraday, and note the immense amount of work that had to be done before broadcasting became an accomplished fact.

There are two classes of work that must be done by the Universities and similar institutions: firstly, the discovery of new phenomena, such as, for example, the discoveries of Faraday concerning the effects upon each other of electrical currents flowing in insulated circuits; secondly, the work of Clerk Maxwell in establishing mathematically the laws demonstrated by Faraday, and the deductions that may be drawn from the equations resulting from his work, followed eventually by the work of Forbes, Hertz, Lodge, Hopkinson and others to show that the equations of Maxwell have a real physical reality, as well as a mathematical significance. Electrical engineering owes its existence entirely to the results of pure research, but the fruits come always years afterwards and almost always the material rewards are reaped by others, who too frequently fail to realise that they have only developed the work of some obscure worker.

CONCLUSION.

This monograph has been written under the disadvantages that the field is so large and that so many factors which cannot be ignored, contribute to the general result. Hence it is very difficult to determine exactly the cause of our educational failure. The paper is an honest attempt to draw attention in plain language to some of the defects of our educational system, and to challenge thoughtful engineers to think out the educational problem afresh. The author is conscious that for lack of space and time he has stated the matter incompletely, and only superficially, yet he hopes that enough has been written to form the basis of a discussion which may help to carry a stage forward a subject the importance of which cannot be over-rated.

For convenience some of the principal suggestions for the amendment of some of the difficulties are here summarised:—

1. The early stages of education need much greater care and thought by parents and the school authorities.
2. The number of subjects dealt with simultaneously at all stages should be reduced.
3. The maximum numbers in all classes should be reduced, so that generally individual tuition could be substituted for lecturing.
4. The grand principle of all educational systems should be thoroughness, and classes should be graded not by age, but by attainments and ability.

5. Elementary schools should deal strictly and solely with the elements; secondary schools with work of a more advanced character; technical schools and the so-called colleges, with work up to the Matriculation (London University or equivalent) standard; finally leaving all the higher academic work to be carried on by the Universities, who should alone grant degrees.

6. The technical colleges and schools should cater for the technical education required for commercial purposes, and leave to the Universities the pursuit of research and other work for the advancement of knowledge uninfluenced by considerations of immediate pecuniary gain. The works laboratories and technical schools should be fully occupied with enquiries into problems arising from day to day in the perfecting of manufacturing processes.

Safety Valve Blow-off Pressure and Possible Fresh-Water Losses.

The following letter from Mr. Donald MacNicoll (Member) will be appreciated by those who noticed the extract to which he refers:—

Cockburns Ltd.,
Clydesdale Engineering Works,
Cardonald, Glasgow.

7th July, 1930.

The Secretary,
Institute of Marine Engineers, London.

I have perused with interest the extract from the "Shipbuilding and Shipping Record," 3rd April, 1930, in connection with Safety Valve Blow-off Pressure, published on page 374 of the Transactions for June, 1930, volume XLII.

I think the statement made therein about valves being set 25 lbs. above the working pressure requires a little amplification.

It is best to refer to the blow-off point of safety valves in terms of percentage of the working pressure to convey correct impressions; thus 25 lbs. is practically only 6% on a working pressure of 400 lbs., but it is 25% on 100 lbs.

In the past surveyors have been very reluctant to give any extra pressure on the safety valves over the working pressure.

Now the safety valve is a most delicate piece of mechanism. At the point of blow-off it is in a state of more or less perfect balance. There is then no opening effort and no closing effort, consequently the slightest distortion in the seatings shows up in leakage or feathering. It is essential that at the working pressure there should be a few pounds of load to ensure contact of the faces all round otherwise leakage will occur. Apart from the question of distortion, at the point of blow-off the slightest vibration causes the valves to dance and consequently leak. This was a troublesome feature during trials of the old reciprocating destroyers, particularly with the old Admiralty type safety valves with their long elastic springs.

The Board of Trade in the past determined that during the accumulation trial of safety valves on board a passenger ship the pressure must not exceed 10% of the working pressure. Now in the case of spring-loaded safety valves introduced after the experiments and trials conducted by a committee of the Institution of Engineers and Shipbuilders in Scotland in 1915, in connection with safety valves, they generally required this allowance of 10%, so that, to prevent an excess accumulation pressure above 10% the valves of necessity had to be set to blow-off practically at the working pressure.

To-day the advocates of steam amongst other things will have to consider carefully about having thoroughly economical safety valves. Internal combustion engine advocates, who state that within a few years not a steam vessel will be plying the seas are pure faddists and are doing a great disservice to the country. In time of war, which it is hoped will never occur again, every ounce of oil will be required for our Navy and motor transport by land and air, and the bulk of the merchant fleet must perforce use coal. Apart from this it is obvious that if everyone went in for oil it could command any price. Therefore there must be an economic balance between the fuels and the best way to obtain this is to perfect the steam engine, both reciprocating and turbine, as far as possible. If in time of stress no oil is available the motor ship is useless. On the other hand an oil-fired steamship can always be converted to be coal-fired.

To return to the subject of leakage through safety valves, the bulk of the British Merchant Service are now fitted with our improved high lift safety valve, which, being approved by the Board of Trade, Lloyd's, British Corporation, etc., at half the area of the ordinary lift safety valve, initially halves the possibility of leakage from distortion. Originally the *Majestic* had $4\frac{1}{4}$in. triple safety valves, which allowed leakage as described, namely, two tons per twenty-four hours, but these were altered to 3in. double improved high lift, and now no appreciable leakage occurs.

Further, I think the Survey Associations already referred to will agree that rarely is an accumulation of from 3 to 4% exceeded on these valves, so that if they were set 5% above the working pressure they would still pass the accumulation trial within the required 10% of the *working pressure*. I think that owners, superintending engineers, marine engine builders, and all those who are anxious that an economic balance should be maintained between different forms of fuel will have to insist that the blow-off pressure of safety valves should be 5% above the working pressure.* Otherwise an initial and by no means the least of the sources of efficiency loss in steam installations will be neglected, particularly for higher pressures. Thus at 400 lbs. absolute pressure the loss is double that at 200 lbs. absolute. At the same time it must be fully appreciated that the red line on the steam gauge must be carefully worked to; but at the worst, even allowing that careless firemen worked up to the blow-off pressure, the infringement on the factor of safety is infinitesimal. Normally, however, this would seldom occur or the objective would be defeated.

I trust this communication will be considered of general interest to the members.

Yours faithfully,

(Signed) DONALD MACNICOLL.

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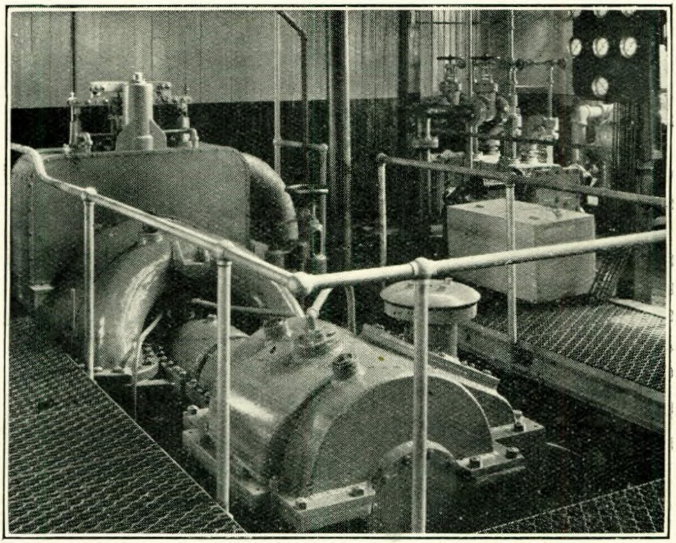
*Manufacturers might construct their boilers to withstand a working pressure 5% in excess of the legend W.P. without appreciable increase of scantlings and weight. The safety valves could then be set to blow off at the higher pressure, and thus meet Mr. MacNicoll's objections whilst still adhering to B. of T. rules.—ED. Trans.

FIRST ALL-WELDED STEEL GEARCASE.

"The Marine Engineer," July, 1930.

The application of welding to shipbuilding and marine engineering has received a considerable amount of attention of recent years, particularly in Germany and America. One of the most interesting applications we have had brought to our notice relates to a 1,400 S.H.P. geared turbine installation in which what is claimed to be the first all-welded steel gearcase has been used. This has been installed on the American Dredging Company's dredger *New Jersey* by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., and is illustrated below. Because the all-welded construction provides a lighter and stronger gearcase, it has now become this company's standard practice for dredger installations. It will be observed that the gearcase presents a neat appearance, and in view of the weight-saving achieved it is to be hoped that the system will next be applied to, say, a destroyer or cross-channel steamer installation.



The Welded Gearcase is neat in appearance.

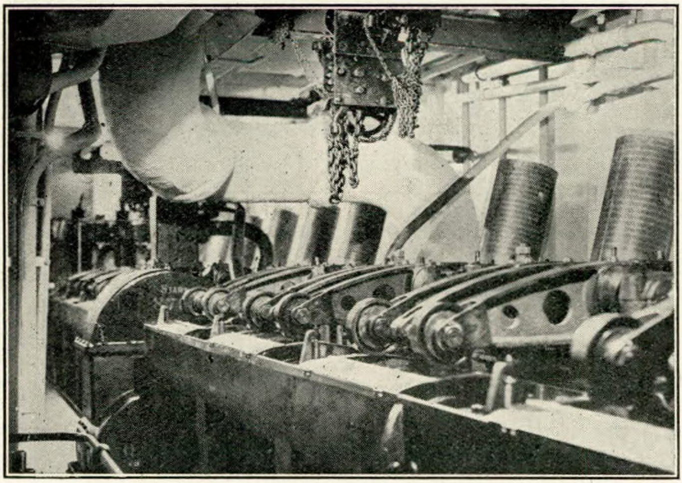
PASSENGER AND CARGO CROSS-CHANNEL MOTORSHIP "INNISFALLEN."

"The Marine Engineer," July, 1930.

The first motorship to be registered in the Irish Free State went on service on June 16th, when the twin-screw vessel *Innisfallen* sailed on her maiden voyage between Cork and Fishguard. She has been built by Harland and Wolff, Ltd., for the direct Fishguard-Cork night service of the City of Cork Steam Packet Co., Ltd., and was launched from the South Yard, Belfast, on March 4th of this year. Her principal particulars are as follow:—

Length between perpendiculars	... 320 ft.
Breadth, moulded	... 45ft. 6in.
Depth, moulded	... 19ft.
Gross tonnage	... 3,250 tons.
Service speed	... 18 knots.
First-class passengers...	... 200
Third-class ,, ...	... 40

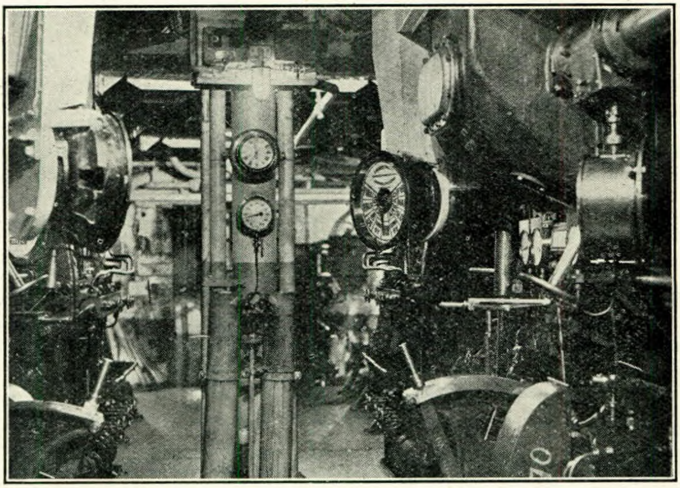
In addition to the 40 third-class passengers who are provided with berths in two, four and six-berth cabins, approximately 400 passengers can be carried aft without sleeping accommodation. About 750 head of cattle can be carried in well-ventilated holds.



Cylinder Tops of a Main Engine showing Special Cam Rollers.

The *Innisfallen* is equipped with electric deck auxiliaries, Laurence Scott winches being provided. The electric capstan and windlass are of Clarke Chapman make, while the Harland and Wolff electric-hydraulic steering is provided with two Laurence Scott motors.

The propelling machinery consists of two ten-cylinder four-stroke cycle, trunk-piston, airless-injection Harland-B. & W. engines, the aggregate power being about 7,500-8,000 I.H.P. An interesting feature of the design is the utilisation of roller-bearing cam rollers. The engines have fresh water cooling of jackets and covers and oil-cooled pistons. Michell thrust blocks are provided. The main engine's exhaust is directed through a Spencer-Bonecourt waste-heat boiler, which is arranged with oil firing on the Clyde system for use in port.



Controls of the Two Airless-injection Harland-B. & W. Engines.

The majority of the engine-room pumps are of Drysdale make, while the centrifugal purifiers are of the Sharples type. Three six-cylinder airless-injection Harland-B. & W. auxiliary engines are provided for driving the electric generators.

We recently had an opportunity of inspecting the *Innisfallen*, and were very favourably impressed by the design of the vessel, particularly the cattle-carrying arrangements. Main and auxiliary machinery functioned excellently, the manœuvring being most rapid.

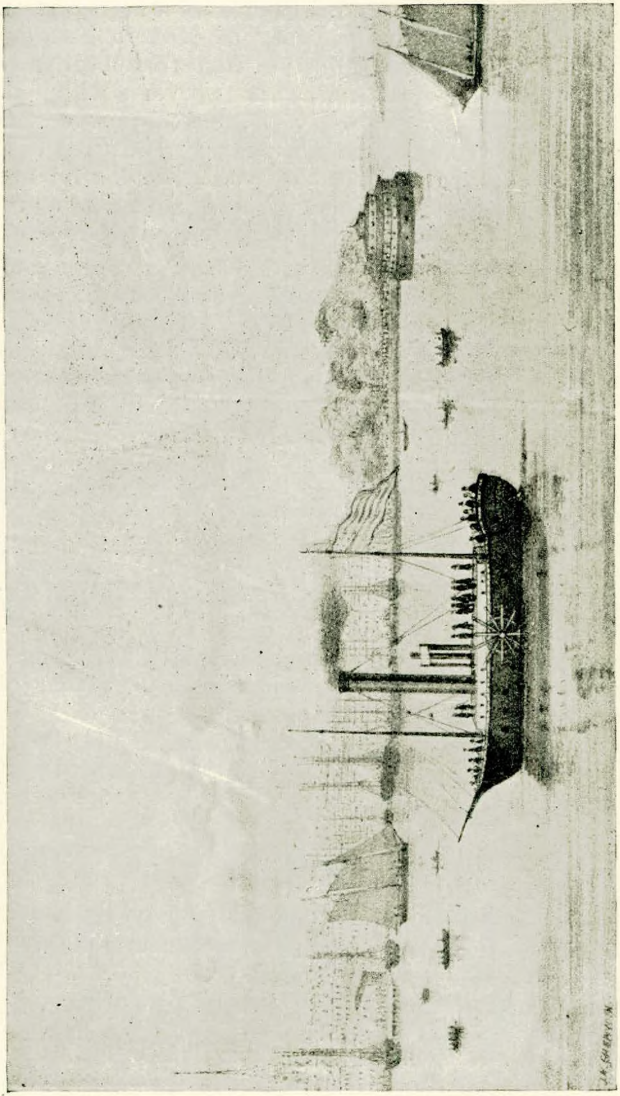
MACHINERY INSTALLATIONS OF BYGONE DAYS. THE "CLERMONT": FULTON'S PIONEER STEAMER.

"The Marine Engineer," July, 1930.

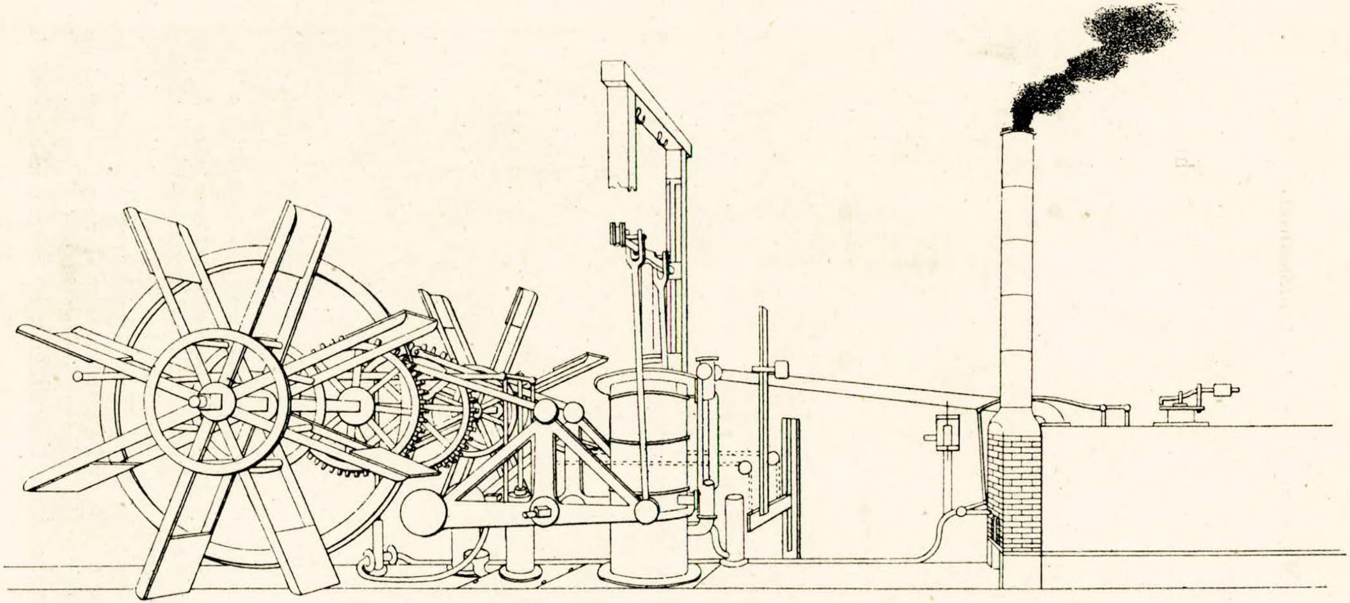
Fulton's pioneer steamer *Clermont* was built in accordance with an Act passed by the State of New York in 1803, which gave a monopoly of running steamships on waters within the States for a term of twenty years to Robert Fulton and Chancellor Livingstone on condition that they built a vessel of at least twenty tons burthen within two years which should be capable of steaming against a four-miles-an-hour current on the Hudson River. When the two years had expired the boat had not yet been built and the time was extended for another two years, the *Clermont* being launched a matter of a very few weeks before the extended time limit expired.

There has been a good deal of discussion as to Fulton's precise claim to the credit of pioneer. Until the *Clermont*, he had not been particularly successful, for although he had built a steamer on the Seine some years previously, she was admittedly taken from Symington's *Charlotte Dundas*, which Fulton had watched working, but her construction was so faulty that the engine fell through her. He also borrowed the plans and specification of John Fitch, the American steamship pioneer of 1791, who had committed suicide, an embittered and disappointed man. Some years afterwards a committee of the New York Legislature found that Fulton's steamers were in substance Fitch's patent of 1791. Be that as it may, the *Clermont* was the first steamer to run for any period with practical success and profit to her owners. She was an ugly flat-bottomed wooden paddler, 130ft. long (later lengthened to 140ft.), by 16½ft. wide, with a burthen of 160 tons. She was given two masts and a tall funnel and leeway was checked by two leeboards. In general model she resembled a Long Island skiff, and owing to the weight of her machinery she had very little buoyancy, only just sufficient for river work.

The machinery of the *Clermont* was built by Boulton and Watt, Soho, near Birmingham, and a number of their skilled workmen went across to the United States to assist in its erection and fitting. It was a steeple engine with a cylinder 24in. in diameter by 48in. stroke, having the bell-crank motion working a cast iron main shaft. It is reported that on her earliest trips men used to stop up holes in the engine with molten lead. The cylinder and the parts of the engine which had been built in England cost £548, but even then they were nearly lost, for they lay on the wharf at New York for many months, held by the agent of the ship which brought them



The Pioneer Steamer "Clermont" on the Hudson.
(*Reproduced from "The Sea—its History and Romance," by Frank C. Bowen.*)



Perspective View of the Propelling Machinery of the "Clermont."

(*Blocks kindly lent by "The Marine Engineer."*)

over because of non-payment of the freight. The condenser was of the size and type then habitually used for land engines and, as in land practice, it stood in a large cistern of cold water. The large capacity of this cistern, in addition to the heavy weight of the engine and boiler fittings, had a lot to do with diminishing the buoyancy of the ship to a dangerous point and making her almost unmanageable until new steering gear was fitted. The engine worked the two paddle by means of bell-cranks, flywheel and spur gearing, which had been designed and executed by Fulton himself. The paddles were 15ft. in diameter, each wheel having eight floats 4ft. long with a dip of 2ft. To begin with, these paddles were uncovered and drenched the passengers when they worked, but later, boxes were fitted over them and this particular discomfort was overcome. At the same time it was still necessary to disconnect one paddle when it was desired to take a sixteen point turn.

The engine was supplied with steam by a low-pressure copper boiler, 20ft. long and 7ft. high by 8ft. wide, which was made by Cave and Sons, and weighed 4,399 lb., in addition to the masonry in which it was set. When the *Clermont* was reconstructed this was replaced by a sheet iron boiler, which unfortunately burst in service. The funnel rose 30ft. above the deck and was nearly as tall as the masts, owing to their having to use wood fuel in her early days.

Such was the early history of the ship which was designed for the day passenger trade between New York and Albany, being named *Clermont* after Chancellor Livingstone's residence, renamed *Katherine of Cleremont* after his wife, for a short time, and finally called *North River*. After a preliminary spin she was given a trial from New York to Albany in August, 1807, but owing to the floats dipping too deeply into the water she only contrived a little less than five miles an hour. After a trip or two this was rectified, boxes were put over the paddles and a covering over the boiler. These changes effected some slight improvement, particularly in comfort, and she was put on to the passenger service for the rest of the year, during which she suffered innumerable collisions, which were not unconnected with the jealousy of the river skippers. This caused the New York legislature to pass a special Act providing a fine and imprisonment for any attempt to damage her. During the winter season she was lengthened 10ft. and considerably strengthened, a poop was added, and her speed appreciably increased, so that in 1808 she was crowded with passengers on the regular New York-Albany run, being joined by Fulton's *Car of Neptune* and *Paragon* at the end of the year. She ran on this service until 1814, by which time there was quite a fleet of ships on the river, when she was laid aside and after some years scrapped.

NUMBER OF SCREWS IN LARGE LINERS.

"Shipbuilding and Shipping Record," July 3rd, 1930.

The possibility of introducing five screws for the propulsion of large liners was mentioned by General de Vito in his interesting paper relating thereto. He suggested that in view of the continuous running at full power it would be advisable to limit the power per screw to 40,000 S.H.P. Although in Italy the Ansaldo Shipyard is building three cruisers having 48,000 S.H.P. (designed) on each screw, this was considered by the distinguished author to be higher than should be adopted in merchant practice. Of course these remarks have reference only to the largest and fastest liners. For power ranging from 90,000 to 120,000 S.H.P., three screws might be adopted; from 120,000 to 160,000 S.H.P., four screws are desirable; beyond 160,000 S.H.P., five propellers may have advantages. Such were General de Vito's suggestions. From the point of view of limiting the power per shaft so that the stresses may be kept within reasonable limits five would have advantages over four. It is very doubtful whether there would be any further advantage, but rather the reverse. Such complications would arise through attempting to accommodate five sets of machinery that the problem might baffle solution. Further, the screws would overlap in projection to an extent which would induce grave interference. The suggestion to adopt triple screws in vessels having from 90,000 to 120,000 S.H.P. does not commend itself. Triple-screw vessels are seldom very efficiently propelled.

BURGERHOUT TO BUILD WERKSPOOR ENGINES.

"Shipbuilding and Shipping Record," July 3rd, 1930.

N. V. Burgerhout's Shipbuilding and Engineering Works, Rotterdam, have arranged a licence agreement with the Werkspoor Works, Amsterdam, for the construction of four-stroke cycle Diesel engines of Werkspoor type. Burgerhout's already build the two-stroke cycle Nobel Diesel Engine. They have recently booked an order for a 11,500 ton motor tanker with two Burgerhout-Werkspoor engines of 2,000 B.H.P. each, and two similar engines for vessels to be built by other shipbuilders. It is understood that this tanker and these engines are under construction for the Anglo-Saxon Petroleum Co. Ltd., London.

NO EXCUSE FOR THE USE OF STEAM IN SHIPS NOW UNDER CONSTRUCTION.

American "Motorship," June, 1930.

There seems to be a widespread misconception, particularly in this country, concerning the limitations of the Diesel engine for ship propulsion. The thought has been expressed by men seemingly well versed in other general subjects pertaining to marine engineering, that all of the ships under construction and contracted for in American yards, with the possible exception of a few tankers, are beyond the power range of the Diesel—that is to say, they are too large and too powerful to be propelled with such machinery.

Opinions of this kind are not based upon sound reasoning or careful observation of what is going on in the world about us. Thus far we have not started to build, nor have we contracted for the construction of any ships appreciably larger and more powerful than the big foreign motorships. As a matter of fact this country has not committed itself to the construction of more than two ships which might be classed as out of the power range of a direct drive Diesel installation, and as yet there is no commercial ship in the world, the construction of which is started or under consideration, which could not be successfully powered with Diesels if electric or gear transmission were employed.

If there is any limit to the practical application of Diesel engines to ship propulsion, the size of the ship, her power and speed are of less moment than the route upon which she will operate.

A modern steam-power installation is somewhat lighter and less costly to begin with than a Diesel installation of similar power. Eventually the difference in weight will be equalised by employing Diesels of higher speed, and the difference in first cost will not be great when methods of machinery installation are improved. High cost in this country of the latter is largely due to lack of experience in our shipyards in making

Diesel engine installations. This fact cannot be convincingly disputed now that foreign yards frequently install the machinery in motorships without additional cost over that of installing steam machinery, and only a few of them demand as much as ten per cent. additional for the Diesel work. With the differences in first cost, weight, and fuel consumption well established, there remains only two major factors to be taken into consideration in order to reach a definite conclusion as to whether steam or Diesel power should be employed in a ship. These are the length of the run and the difference in price of fuel for the two kinds of machinery—not the power of the machinery. Other items such as the size of the crew carried, the amount of wages paid and the percentage of time the ship is in port or at sea are of secondary importance.

By comparing the highest known rate of fuel consumption for the motorship with the lowest rate for the steamship, the difference in favour of the former is found to be about two to one. Therefore if the machinery in a steamship weighs 100 tons less than the machinery in a motorship of similar power, that difference in weight will be compensated for on any route requiring the motorship to carry 100 tons of fuel—thereafter weight conditions favour the latter. To equalise, in terms of cost, the difference in rate of fuel consumption between steam and Diesel power, it is necessary to operate on a route where the price of Diesel fuel is at least twice as much as for steamer fuel. It is difficult to find trade routes fulfilling these two requirements essential to the economical application of steam to ship propulsion. And so far as ships under construction in American yards are concerned, none of them are being built to operate on such routes. Some of them look big to us because until recently we have not been building ships. We grant, however, that as motorships some of them would be big—a few would compare favourably with the passenger motor-liners owned by France, Germany, England, Sweden, Italy, Holland and Japan, to mention the countries which come most readily to mind.

UPWARD TREND OF OIL PRODUCTION.

"The Motor Ship," July, 1930.

There is apparently some fear in America among oil-producing companies that the oil situation may again tend to get out of hand. During the past two months production has shown an upward turn, although it is still below last year's figure, and it may be remembered that in August, 1929, there was an unprecedented rise in output, until a record figure of nearly three million barrels per day was reached.

There is, according to the American technical journals, an urgent need for further curtailment of production in the United States, and evidently we are as far as ever from any shortage of oil.

SERVICE RESULTS WITH MOTOR SHIPS.

"The Motor Ship," July, 1930.

Some remarkable figures have become available relating to the results obtained with six sister ships owned by the Runciman Moor Line, all 8,100 ton Doxford-engined vessels, two of which were built in 1924 and four in 1928. They are the *Vinemoor*, *Westmoor*, *Glenmoor*, *Innesmoor*, *Jedmoor* and *Northmoor*. All have a trial trip speed of 10½ knots.

The total period of combined service for all the ships is about 10½ years, and the average consumption for the whole of this time, taking the mean of the six vessels, works out at 0·323 lb. per i.h.p. hour, or 0·36 lb. per s.h.p. hour for the main engine alone. The average engine power is 1,615 i.h.p., and the average speed for the whole time is 9·65 knots. The daily consumption for the engine alone averaged 5·6 tons per 24 hours. The lubricating oil consumption works out at a mean of 9½ gallons a day for all six ships over the period in question.

The particulars available for two of the ships, each for more than three years' service, showing the total main and auxiliary machinery repairs, indicated an expenditure of well under £200 per annum for each ship. The vessels were at sea the normal time annually, namely, about 240 days.

The available details seem to show a good case for the installation of Diesel-electric auxiliary plant, since the amount of boiler oil consumed was approximately 25% of that required for the propelling engines.

ENTERPRISE IN JAPAN

"The Motor Ship," July, 1930.

We referred in the June issue of "The Motor Ship" to the construction in Japan of a 12,000 ton motor tanker, the designed service speed of which is 14 knots, which is greatly in excess of that in any existing tanker. Information is recorded this month of another oil-carrying ship of approximately the same characteristics but equipped with single-screw machinery of 7,200 B.H.P. It is evident that Japanese owners have the courage of their convictions in their belief of the future for high-speed tankers, and in many other directions the Japanese are showing considerable enterprise in the development of Diesel engines and motor ships.

An example is to be found in the arrangements which are made for training engineers. The Imperial Government established about a month ago a special institution for training students of 11 local navigation schools for a period of one year on actual sea service. For this purpose two large training ships with auxiliary Diesel propulsion, the *Kaiwo Maru* and the *Nihon Maru*, have just been completed, these being 2,400 ton vessels with 1,200 B.H.P. Diesel machinery. A fishery training craft, the *Hakuyo Maru*, has also been built for the Government Fisheries College, whilst a special Diesel tug 60ft. in length has been placed in service lately, built for the Tokyo Higher Navigation College. It has been constructed to enable students to become accustomed to handling Diesel engines.

When it is considered that during the course of this year Japan will turn out eight large motor passenger liners—a bigger number and tonnage than any other country—it will be realised that Japanese shipbuilding is making great strides, even though at the present time the outlook is shadowed by the prospects of depression.

STRENGTHENING ST. PAUL'S.

"The Engineer," 13th June, 1930.

Sheffield continues to do its share in the great work of making St. Paul's Cathedral safe for future generations. Last week Brown Bayley's Steel Works, Ltd., began the delivery of the second great chain of stainless steel which it has made for the purpose of binding the dome together to check the expansion of the piers. There are thirty-two links, each measuring 16ft. 3in., and the whole chain weighs about 30 tons. It will be embedded in concrete, and will line the outside of the bastions supporting the dome. As previously reported, other Sheffield firms have also made valuable contributions to the work, steel for the piers having been supplied by Hadfields, Ltd., and Thos. Firth and Sons, Ltd.

THE NEW CANADIAN PACIFIC LINER "EMPRESS OF BRITAIN."

"The Engineer," 13th June, 1930.

The new 42,500 ton passenger liner, the *Empress of Britain*, which was successfully launched at 1.6 p.m. on Wednesday last by the Prince of Wales from the yard of John Brown and Co., Ltd., at Clydebank, will, when completed, be the largest vessel of the Canadian Pacific fleet and the largest ship to ply between any two ports of the British Empire. She has been specially designed to meet the requirements of her owner's Atlantic service between Southampton, Cherbourg, and Quebec, and her designed sea speed is to be about 24 knots. The overall length of the new liner is 758ft., with a breadth moulded of 97ft. 6in., and a depth to "B" deck of 60ft. 9in., while the loaded draught is 32ft., with a measurement of 42,500 tons. With her straight forward raked stem and cruiser stern, and her stream-lined funnel of pear-shaped section, she is a handsome ship. The new liner is designed to carry up to 452 first-class passengers, 260 tourist third, and 470 third-class passengers, and the accommodation in all classes is of the highest Atlantic type. The decks include a continuous shelter deck over the upper deck, and a bridge deck over the shelter deck, which extends the full length of the ship. Other upper decks include a promenade deck, which extends over three-quarters of the length of the ship, a boat deck over half the length of the ship, and a sun deck above. The dining saloon is the largest unpillared space yet embodied in a ship of her class. The safety and navigational equipment is of the very latest type. The new liner will be propelled by a quadruple-screw, single-reduction, geared turbine installation, working in conjunction with high-pressure water-tube boilers. This machinery installation is the largest and most important of its type yet built. The working pressure of the turbines is 375 lb. per square inch, with a maximum boiler pressure of 425 lb. per square inch, and 700 deg. Fah. total superheated temperature.

BOILER EXPLOSION INQUIRIES. FRACTURE OF THE LOW-PRESSURE SLIDE VALVE CHEST OF S.S. "KELVINIA."

"Engineering," 4th July, 1930.

The accident to the engines of the S.S. *Kelvinia* was of a very unusual character, and it was shown to have been caused by the accumulation of steam under considerable pressure in the low-pressure slide valve chest while the engines were stopped at sea. The engines were of the ordinary triple-expansion type and were supplied with steam at 190 lb. pressure. While on voyage from Balboa to San Pedro, on January 11th, 1929, the centrifugal circulating-pump engine developed a bad knock. As the knocking increased it was decided to stop the pump for readjustment, and circulate water through the main condenser by means of the ballast pump. The change over does not appear to have been carried out in a very efficient manner, and a series of minor troubles arose owing to the main injection valve being left open and the water from the ballast pump not finding its way to the condenser. The vacuum in the condenser was lost, the pressure in the auxiliary exhaust system rose, the dynamo stopped, and finally the main engines brought up with the low-pressure slide valve covering top and bottom ports. Owing to the pressure of a connection from the auxiliary system to the low-pressure slide valve chest, steam then accumulated in the chest which finally burst. There was a relief valve on the auxiliary exhaust system, but that had been rendered inoperative, there were relief valves on the low-pressure cylinder, but, under the circumstances, the excess steam could not find its way into the cylinder. There was, however, no relief valve in the chest itself. The slide chest was a separate casting about 7ft. square and 2ft. deep with walls 1¼in. thick, and naturally the accident was a bad one. After the occurrence the engine was arranged to work compound, the ship returned to Balboa where a new slide chest was made, and to this were fitted two 3½in. relief valves to lift at about 25lb. pressure. The relief valve on the auxiliary exhaust system was also altered so that it could not be rendered inoperative by screwing down. The engines were made by the Sun Shipbuilding Company, Chester, Pennsylvania, United States of America, in 1918, and the ship belonged to the Glasgow Steamship Co., Ltd., Glasgow.

MARINE WATER-TUBE BOILER

"The Engineer," 20th June, 1930.

An interesting boiler embodying the latest developments in high-pressure boilers for service afloat is shown below. This is one of a batch nearing completion by John I. Thornycroft and Co., Ltd., Southampton.

Each boiler has a total surface of 8,880 square feet designed for 500 lb. working pressure and a superheat of about 280 deg. Fah., the air being preheated before reaching the burner openings.

These boilers were designed by John I. Thornycroft and Co., in collaboration with the Admiralty, and several novel features have been embodied in the design.

The barrels, which were made by John Brown and Co., Sheffield, are of forged steel with ends closed in, and machined all over internally and externally. The top barrels are $2\frac{3}{4}$in. thick in way of the tube plates, and the lower barrels 1 11/16th inch, and the shell is made flange thickness in way of mountings to enable pads to be dispensed with. The generating tubes are of seamless solid drawn steel, the two fire rows being $1\frac{3}{4}$in., the next four before superheaters $1\frac{1}{2}$in., and the remainder $1\frac{1}{8}$in. external diameter.

The superheaters are of the hairpin type, with solid forged cylindrical headers. The ends of the headers are solid with the barrels and thickened portions are left in way of mountings to avoid pads. Plate baffles are fitted in the headers to give double flow.

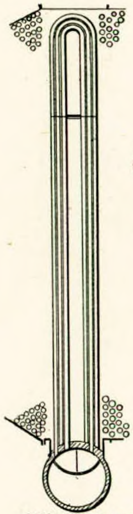
The tubes, which are $1\frac{1}{8}$in. external diameter, and of low carbon steel, lie horizontally in the nest of generating tubes, the headers being parallel to the fronts of the boilers. Suitable supports of " Era " steel are fitted in the boilers to carry the superheaters. This type of superheater has proved very successful and was fitted to H.M.S. *Meteor* and *Mastiff* as far back as 1914.

The space in the vessel allocated to these boilers being very restricted and lightness an essential feature, the air heating arrangements consequently had to be kept small and compact. The bulk of the heating surface of the air heaters is made up of tubular heaters, but a variation from the usual type with cylindrical tubes has been made by stream-lining the tubes to reduce the space occupied and the air pressure across the heaters as much as possible. The casings also have been utilised to preheat the air, which, after leaving the heater tubes, is led across them.

Before finally deciding on the type of heater to be fitted, experiments were carried out, space available, etc., being taken into consideration, and it was decided that the stream-lined tube type best met the case.

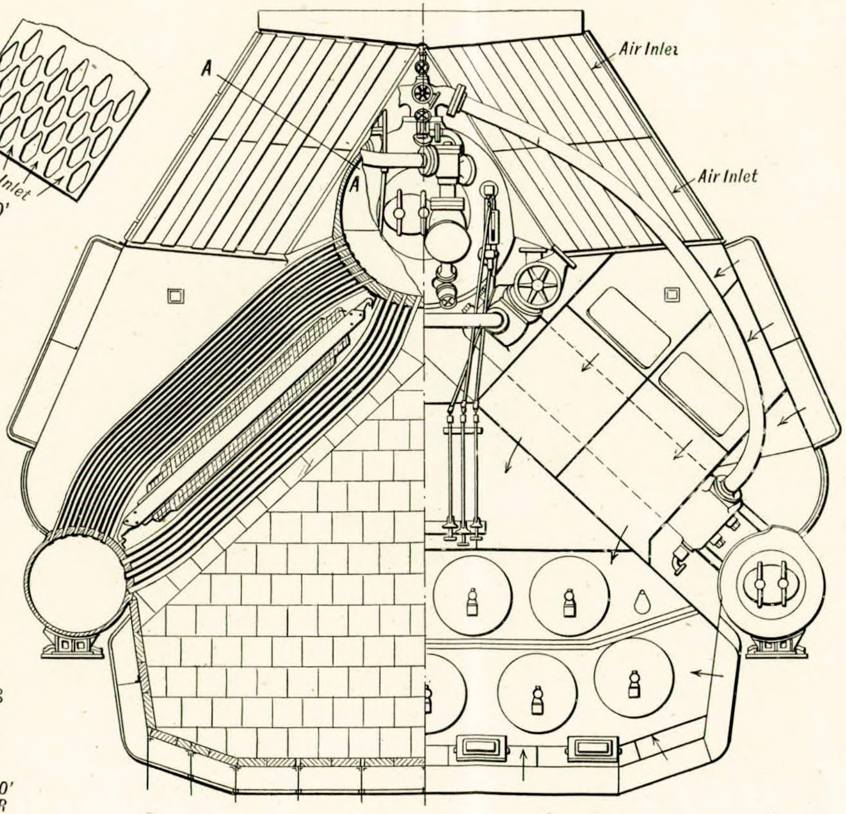
To offset, as far as possible, the increase in air pressure necessitated by air heaters, in addition to stream-lining the heater tubes, as previously mentioned, the combustion tubes were specially designed, and it is estimated that the total drop

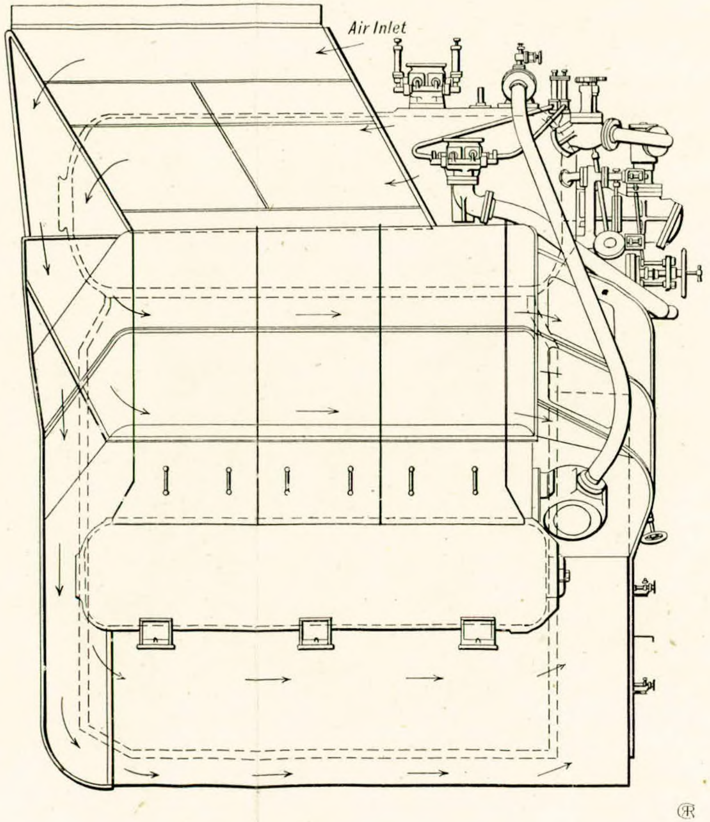
SECTION THRO' AIR HEATER AT A.A.



SECTION THRO' SUPERHEATER

"THE ENGINEER"





of air pressure from stokehold to funnel will be in the region of $4\frac{1}{2}$in. to 5in. at full power, *i.e.*, burning over 1 lb. of oil per square foot of heating surface per hour. This figure compares with $5\frac{1}{2}$in. to 6in. with the old type of combustion tubes without air heaters.

Cockburns' safety valves of the full bore type are fitted for saturated and superheated steam, the latter being set to lift at a slightly lower pressure than the saturated valves, to ensure a flow of steam through the superheater tubes. The water gauge fittings are of Dewrance and Wall type, screw-down valves being fitted. The feed regulator is of the Contraflo type supplied by Weirs.

These boilers are being built by John I. Thornycroft and Co., Ltd., to the order of the Parsons Marine Steam Turbine Co., Ltd., and are to supply steam to turbines being built by the latter company.

MR. SPERRY AND THE GYROSCOPE.

"The Engineer," 20th June, 1930.

In several obituary notices of Mr. Sperry, he is described as the inventor of the gyroscopic compass. We are not aware that he ever claimed that distinction in unqualified terms. Mr. Sperry's first gyroscopic compass was installed in the United States battleship *Delaware* in 1911, but in 1910 the Anschütz brothers were producing a well-developed, if imperfect, form of the device. Mr. Sperry undoubtedly deserves the honour of having devised an original type of gyroscopic compass and of having added to it equipment for recording the ship's course, for steering her automatically and so forth. If, however, anyone is to be credited with " the " invention of the gyroscopic compass, it should be Foucault, who in 1855 demonstrated or sought to demonstrate the rotation of the earth by means of a gyroscope. Mr. Sperry brilliantly applied gyroscopic principles, not only in compasses, but for the stabilisation of ships and aeroplanes. It may with justice be said to be the only system of gyroscopic stabilisation for ships which so far has been developed beyond the experimental stage. Among recent gyroscopic applications introduced by Mr. Sperry's Company we may mention the Sperry gyro direction indicator for aeroplanes and the Sperry artificial horizon. The second-named device consists of a gyroscopically mounted wheel driven by a small Venturi tube, and is combined with an indicator which shows the pilot of an aeroplane, whether he is diving or climbing, and whether he is flying level or with one of his wings low. The instrument has already proved its value, both to pupil fliers and to skilled pilots flying through clouds or in other conditions in which the natural horizon is obscured.

THE WORLD POWER CONFERENCE AT BERLIN. POWER SUPPLY ON SHIPS.

"The Engineer," 27th June, 1930.

In this section, as might be expected, British authors predominated, Great Britain having to be credited with four out of the seven papers which were presented. The chair at the meeting was appropriately taken by Sir Charles Parsons. Three of the papers dealt with oil engines, the other four being concerned with steam turbines, boilers, systems of boiler firing, electrical propulsion and the design and performance of auxiliary machinery. Special attention was paid to the use of high-pressure steam at sea, this subject forming the basis of a paper presented by Sir Charles Parsons, Mr. R. J. Walker, and Mr. Stanley S. Cook. These authors emphasised the advantages which were to be derived from the use of higher steam pressures and temperatures. The greater the pressure the higher the average temperature at which the heat enters the working fluid, so that the theoretical conditions for efficiency are improved by increasing the pressure. The theoretical aspect was discussed at some length, and it was shown that high-pressure steam up to and even beyond 1,000 lb. per square inch undoubtedly presented possibilities of increased working efficiency. Although a working pressure of 1,000 lb. per square inch was used by Loftus Perkins as early as 1824, it was not until quite recently that working pressures higher than 200 lb. per square inch were used in British mercantile ships and 275 lb. per square inch in water-tube boilers for naval service. The adoption of higher working pressures in land installations in Britain, America, and in Europe had influenced marine practice. The first modern high-pressure steam installation aboard a ship was that of the Clyde turbine steamer *King George V.*, the turbines of which were built for a working pressure of 500 lb. per square inch and a steam temperature of 750 deg. Fah. The success of the *King George V.* had influenced the building of larger high-pressure steam installations for liners of the Canadian Pacific *Duchess* and

Empress classes. In these ships a series of three turbines grouped around a common gear wheel transmitting power to the propeller shaft, was used. That type of drive enabled turbines of an efficient and robust type to be employed. The excellent results of the *Duchess of Bedford*, with her 0·57 lb. of oil per S.H.P. hour for the main and auxiliary engines, including the steering gear, were referred to, and a layout of a quadruple-screw turbine installation with 160,000 S.H.P. output, operating at a steam pressure of 600 lb. per square inch and 750 deg. Fah. total temperature, was given; with it an overall oil fuel consumption of 0·54 lb. per S.H.P. hour would be obtained. The authors foresaw an oil consumption even less than 0·5 lb. for an installation which would embody in it all the latest improvements in auxiliary plant and stage feed heating. With such a fuel consumption the high-pressure steam plant was considered by the authors to provide the cheapest form of marine propulsion.

SIXTY YEARS AGO.

"The Engineer," 4th July, 1930.

Sixty years ago the Pacific Railway had just been completed and opened to traffic. To the traveller across the Western States of America it afforded for the first time a means of journeying alternative to the pony express, the covered wagon, or the voyageur's canoe. Adventure did not, however, disappear with its construction. It had been built in the face not only of great natural difficulties and the rivalry of conflicting interests, but of active hostility on the part of some of the native tribes. The Indians frequently raided the working encampments and isolated stations, and when the line was completed were, on occasion, bold enough to attempt the holding up of a passing train. An accident of the kind was reported in our issue of July 8th, 1870. A telegram from Salt Lake stated that on June 15th the driver of a train approaching the Platte River discovered a band of three hundred Indians crossing the line. As the train came near them they emitted loud yells. The driver, believing that they were about to attack the train, put on full steam and dashed through the band at high speed. Thirteen of them were killed. No information was given in our note as to the identity of the Indians. If they were Blackfeet or Crows, as they might well have been from the locality of the incident, the driver was probably right in his interpretation of their intentions, for these tribes, particularly the Blackfeet, were daring warriors as well as thieves.

If, however, they were Shoshonies or Nez Percés Indians, or members of several other possible tribes, their intentions were probably peaceable, their clamour at the approach of the train being characteristic of an Indian welcome. Readers of Washington Irving's "Astoria" and "The Adventures of Captain Bourneville," will recall that the early explorers and trappers in the Western States were repeatedly guilty of attacking natives whom they thought to be hostile, but who in reality were quite peacefully disposed. In 1832, for instance, a party from Captain Bourneville's expedition found a large band of Snake Indians assembled at a river crossing. The trappers and hunters were convinced that the natives meant mischief, and without waiting to parley fired a volley into their midst. Many were killed and the rest fled. The Snakes were a poor-spirited nation, downtrodden by other tribes and anxious to have the white man's friendship and protection. Events of this nature generated a bitter spirit of revenge on the part of the natives and were frequently the origin of apparently unprovoked outbreaks of bloodthirstiness. That the Indians of 1870 still retained the revengeful characteristics of their fathers may be inferred from the fact that the incident on the Pacific Railway was regarded as likely to endanger peace on the border and to react on the safety of the line.

TURBO-ELECTRIC PROPULSION.

"The Engineer," 4th July, 1930.

The *Platano,* the turbo-electric cargo and passenger steamer, built by Cammell Laird and Co., Ltd., for Elders and Fyffes, Ltd., has returned to the Mersey after carrying out successful official speed and consumption trials. The speed was considerably in excess of contract requirements. The *Platano* is 415ft. long, with a breadth of 56ft., and a depth of 34ft., having a displacement of about 10,500 tons. The main electric propulsion equipment, supplied by the British Thomson-Houston Company, consists of one 5,500 kw. turbo-alternator, which supplies current to a three-phase synchronous motor. The vessel's cargo spaces are specially insulated for the carriage of fruit.

ENGINEER OFFICERS IN THE MERCHANT MARINE REQUIRE TECHNICAL AND PRACTICAL TRAINING.

American "Motorship," July, 1930.

There has been some talk and not very much action in an attempt to improve upon our time honoured method of recruiting ship's officers and engineers from the rank and file of unlicensed seafarers. So far as the deck officer problem is concerned, it has no bearing on the motorship which does not also apply to the steamship. This is less true of the licensed personnel in the engineroom. Yet no effort has been made by the school ships to differentiate between the training of motorship engineers and steamship engineers. That is perhaps just as well, for the motorship and her machinery which will not be called upon to employ the graduates of these nautical institutions of learning, dealing as they do in the technology of obsolete steam power alone.

We have two classes of institutions of learning which combined are capable of solving any future problem of manning our ships; one is the college, and the other is that division of the school of hard knocks which is represented by the sea. If we must forego the advantages of one, we can best dispense with the former. Practical training aboard ship is indispensable to a successful career as a ship's officer or engineer. It is an inescapable fact, however, that ships would be better off if officered by college men, and many graduates of our colleges would be better off if they were capable ship officers.

The difficulty is of a psychological nature, due primarily to the fact that it is almost impossible to find a hardworking-gentleman type of individual. Our schools find a means of inducing boys to endure strenuous physical effort in the form of sport, but it is one of the ironical facts of life, that just as soon as the boy is paid to exercise his brawn he finds it as revolting as it was intriguing when he paid a handsome sum for the privilege of doing it.

Seafaring college men may become a matter of fact and not of fancy when the mass production methods of education swamp the market ashore with educated labour. It is indeed unfortunate that so few of the graduates of technical colleges look upon a career at sea as being worth striving to attain. Our shipowners are somewhat responsible for this condition. When a boy just out of school applies to them for employment he is offered a clerkship in the office or nothing at all. He may be led to believe that a wonderfully successful career lies in store for him in the shipping business; but once he is placed on a routine job, he finds advancement very slow, and the pay is barely enough to feed and clothe him. Were he induced to go aboard ship he would find the living problem automatically solved, advancement inevitable and the increases in pay very attractive, if he were striving to become an officer.

The school ship which is not a college accepts grammar school graduates and offers an interesting and enjoyable two years of outing to its scholars who seldom follow the sea once they have graduated. It is worthy of note that, insofar as the engineroom is concerned, a chief engineer would entrust a watch to a competent oiler in preference to a recently graduated schoolship engineer.

While it is desirable ultimately to obtain men of good education and a high degree of intelligence for the licensed berths aboard ship, this is no more true of the motorship than of the steamer. At present we have more licensed engineers for both steam and motorships than our merchant marine requires. Unquestionably, this surplus is due to the ease with which licences may be obtained, a condition responsible for the licensing of many incompetent men.

If the Diesel engine were incapable of being operated by seafaring engineers of average ability, our motorships would have suffered very severely because the rules which govern the licensing of engineers emphasise the importance of a knowledge of steam. Our steamboat inspectors and examining boards are steamship engineers, and it has been remarked that they remain inordinately committed to the propounding of questions pertaining to steam machinery while examining motorship engineers for license.

THE COURSE OF MOTOR SHIPBUILDING.

"The Motor Ship," August, 1930.

Motor ships under construction now represent 63½ per cent. of the total world's tonnage being built. In this country the figure is 60 per cent.; abroad it is 66 per cent. These proportions are, in each case, higher than have previously been noted at any time, and they are impressive even if allowance be made for the fact that more than one-third of the tonnage being built is for oil carrying, and that tankers are almost exclusively propelled by Diesel machinery.

In 1920, steamers represented 90 per cent. of tonnage under construction. In 1925 motor ship and steamer tonnages in course of production became practically equal, and this condition, with slight variations, remained for the following four years. Twelve months ago the oil-engined vessel began to forge ahead, and at the present moment ships of this class under construction represent a tonnage 72 per cent. greater than that of steamers, a position quite undreamed of a decade ago.

In the last quarter more motor ships were ordered, commenced, launched and completed than steamers, the completions totalling 51, of 334,000 tons. A year ago, British steamers then building exceeded motor ships by about 45 per cent. Now the motor ship tonnage under construction is 50 per cent. greater than that of steamers, and it cannot be too strongly emphasized that it is not motor shipbuilding but steam shipbuilding which is depressed. In this country the tonnage of motor ships on the stocks is 40 per cent. more than a year ago, and abroad the figure is 30 per cent.

These general facts are sufficient to indicate the growing strength of the shipbuilidng situation under the shadow of severe depression which is feared, unless shipowners, and particularly British owners, come to the conclusion that the corner in world depression has been, or is about to be turned. For shipowners, more than those engaged in any other trade, must lay their plans at the first signs of revival, or preferably even before such signs definitely appear.

It is possible, however, that too pessimistic a view has latterly been taken and that there must be courage and vision if this country is to hold its position in shipping. As Mr. Lawrence Holt remarked last month, to maintain anything less than the largest share in the world's ocean tonnage would be not only a dereliction of duty but also a national disaster.

Judging from building statistics at the present time, we are far from maintaining this standard. In this country, 45 per cent. of the world's tonnage is being built, but if we analyse the figures the situation is more disturbing than this proportion would indicate. Omitting tankers, the cargo and passenger vessels now being constructed in the United Kingdom total 754,382 tons gross, against 1,173,687 tons gross in the rest of the world, so that we are responsible for only 39 per cent. of the world's cargo and passenger tonnage, against 52 per cent. a year ago.

In other words, whilst foreign shipowners are now building a cargo and passenger tonnage approximately equal to that of a year ago, we are only constructing somewhat under 60 per cent. of last year's total. The position appears even more serious when it is recalled that the cargo and passenger vessels being built for foreign owners are, for the most part, motor ships of the most economical type. These figures lead to no other conclusion than that, at any rate for the time being, we are losing hold on the shipping situation, and are not maintaining our predominant position by new construction.

It may be that foreign shipowners are unjustified in continuing to build relatively large tonnages of cargo and passenger ships. But their policy seems to indicate a greater confidence in the future than is felt in this country. Whether it be right or wrong, however, the effect is the same. The proportion of modern and efficient British cargo tonnage is declining, and that is a serious thought. That there is too large a tonnage afloat for present requirements is admitted, but whether there is, even now, too large an efficient tonnage, or will be in a year's time, when vessels now ordered will come into service, is another matter.

All experienced owners are well aware of the rapidly changing conditions in sea transport, and it will not be satisfactory if, when the turn of the tide comes, British shipowners are less able to take advantage of it than their Continental competitors. There has scarcely been an order for a cargo ship since the beginning of the year, and nothing is being done to make up for the replacement of obsolescent ships; hence, with the least indication of the lifting of the gloom which surrounds world trade at the present moment, orders for new cargo tonnage must be placed. And, in so far as the shipbuilding situation is concerned, the contracting for new cargo ships should be taken in relation to orders for tankers; for the tendency in some quarters of considering tanker construction as quite incidental or accidental appears to be incorrect.

Viewing all circumstances in which shipping and shipbuilding are now involved, it seems that too much emphasis has been laid on the side of pessimism. Experience shows that after a prolonged cessation of orders such as we have noted during the past eight months, contracts, when again they begin to be placed come rapidly, and prices tend to rise. It will not, therefore, be surprising if in the next few months a change comes over the situation, and in the meantime many shipbuilders and a large proportion of engine manufacturers who have laid themselves out for Diesel construction have no immediate cause for complaint. Admittedly, the world situation is not too hopeful but one can err on the side of pessimism.

THE BLUE FUNNEL FLEET.—"Engineering," 18th July, 1930

Some interesting particulars extracted from a paper read before the Institution of Naval Architects by the Hon. L. H. Cripps, C.B.E., on July 15th, 1930.

General Particulars.							TABLE I. Efficiencies and Relative Cost to Carry 7,000 tons Cargo 100 Miles.					TABLE II. Relative Cost of Ship Upkeep and Ship Stores in Percentages.		TABLE III. Relative Cost of Engine Upkeep and Engine Stores in Percentages.		
							Average.			Relative Fuel Cost to Carry 7,000 Tons Cargo 100 Miles.		Relative Cost.			Relative Cost.	
Ship.*	Class of Machinery.†	Fuel.	Designed Speed. Knots.	Displacement in Tons.	Number of Ships in Class.	Average Age. Years.	S.H.P.	Fuel Efficiency. Actual Coefficient / Theoretical Coefficient	Speed. Knots.	At Average Speed.	Reduced to Common Basis of 13½ Knots.	Ship Upkeep.	Ship Stores.	Designed S.H.P.	Engine Upkeep.	Engine Stores.
								Per cent.			Per cent.	Per cent.	Per cent.		Per cent.	Per cent.
Atreus	S.S. reciprocating, Sat.	Coal	13	13,500	5	19	3,343	92·57	12·62	86·0	100·0	100	100	4,000	100	100
Keemun ..	T.S. reciprocating, Sat.	Coal	12	18,300	3	28	3,269	85·03	11·68	77·5	105·3	143	112	5,500	105	110
Lycaon.. ..	S.S. reciprocating, Sup.	Coal	13½	15,000	8	15	4,091	96·18	13·08	77·4	82·3	80	100·1	4,400	105	112
Antilochus ..	T.S. reciprocating, Sat.	Coal	12½	18,900	5	24	3,429	93·28	11·98	66·6	86·6	147	130	4,500	122	116
Æneas (P.) ..	T.S. reciprocating, Sup.	Coal	13¼	19,400	3	20	4,669	86·8	13·40	98·0	98·8	178	88	5,000	197	165
Nestor (P.) ..	T.S. reciprocating, Sup.	Coal	13½	26,800	2	17	5,928	93·25	13·46	94·1	94·8	198	88	6,000	234	171
Adrastus ..	S.S. turbines, Sup. ..	Coal	14½	15,200	8	8	4,895	94·07	13·97	86·3	80·7	75	97	6,000	96	112
Phemius ..	S.S. turbines, Sup. ..	Oil	14½	15,200	1	8	4,683	88·25	13·93	109·0	102·2	79	99	6,000	64	107
Polydorus ..	S.S. turbines, Sup. ..	Oil	13	12,600	2	5	3,813	97·8	13·38	94·3	95·8	53	90	3,700	61	95
Calchas (I.P.) ..	T.S. turbines, Sup., old engines	Coal	14	20,800	4	7	5,776	81·9	13·66	97·2	96·6	108	125	6,500	193	147
Calchas (I.P.) ..	T.S. turbines, Sup., new engines	Coal					5,556	100·8	13·83	77·6	76·1					
Menelaus (I.P.)	T.S. turbines, Sup. ..	Coal	—	—	—	—	5,547	98·3	13·41	77·8	79·2	—	—	—	—	—
Sarpedon (P.)	T.S. turbines, Sup. ..	Coal	15	19,400	2	7	7,369	93·52	15·08	118·8	95·2	162	132	7,500	183	202
Antenor (P.) ..	T.S. turbines, Sup. ..	Oil	15	19,400	2	5	7,424	93·9	14·97	131·0	106·8	161	123	7,500	134	167
Peisander ..	T.S. Diesel	Oil	13	12,600	5	4	3,787	98·42	13·03	42·2	45·3	56	84	3,700	65	161
Orestes ..	T.S. Diesel	Oil	14½	15,300	4	3	5,160	97·6	13·77	48·9	47·1	68	92	6,600	87	197
Agamemnon ..	T.S. Diesel	Oil	—	—	—	—	5,190	102·6	13·83	49·8	47·3	—	—	—	—	—
Dolius .. .	T.S. Diesel	Oil	11	11,400	2	6	2,071	89·29	10·70	27·35	43·5	49	92	2,200	88	162
Medon	S.S. Diesel															

* P = Passenger. I.P. = Intermediate Passenger.
† S.S. = Single screw. T.S. = Twin screw. Sat. = Saturated. Sup. = Superheated.

THE PROPULSION OF THE MERCANTILE MARINE.

"The Marine Engineer," August, 1930.

The publication of a new edition of Lloyd's Register Book is always a noteworthy event, for, apart from the great value of this indispensable reference work, the statistical tables, drawn up with great care and clarity, afford to the shipping community the only real guide to the changes taking place each year in the mercantile fleets of the world. The 1930-31 edition which has just been issued includes a full record of about 33,000 steamers, motorships and, that fast-waning class of freighter, sailing ships.

These tables show that there has been a net increase of the world total of 1,533,332 gross tons, a higher rate than the preceding twelve months, when 1,119,653 tons were added. These additions represent greater accumulations of steam and motorship tonnage since the decline of the sailing ship—the reduction has been 2,360,000 tons since June, 1914—continues its uninterrupted course, and to-day the proportion of sailing ship tonnage is under 2·3 per cent. The total under this head is now 1,583,840 tons, a figure which is reduced to 825,000 tons by excluding barges and odd craft usually towed. That is the price the sailing-ship owner has paid for the development of mechanical propulsion. Consequently for general comparative purposes this small proportion may be ignored. The total tonnage is set out in the following table:—

	Great Britain and Ireland.	World Total.
1930.		
Steamers and motorships ...	20,321,920	68,023,804
Sailing ships	116,524	1,583,840
Total	20,438,444	69,607,644
1929.		
Steamers and motorships ...	20,046,270	66,407,393
Sailing ships	120,061	1,666,919
Total	20,166,331	68,074,312

Steam and motorship tonnage to-day totals 68,024,000 gross tons compared with 45,404,000 tons at June, 1914, and 19,511,000 tons at June, 1898. By excluding such vessels as tankers, trawlers, river and estuary craft, vessels on the Great

Lakes and generally those less than 5,000 tons gross and over 25 years old, an estimate has been made that the total ocean-going tonnage is 27,136,200 tons, and of this the British proportion is as high as 38·47 per cent., which is more reassuring than the 29·9 per cent. shown in the next table.

The principal maritime countries to-day are given in the following table, with their relative positions at June, 1914. It will be noted that Germany has not yet regained her pre-war status, being still 936,000 tons below her 1914 figure of 5,135,000 tons.

Percentage Tonnage of Steamships and Motorships Owned by the Principal Maritime Countries.

	1930	1914
Great Britian and Ireland	29·9	41·6
United States (sea going)	15·7	4·5
Japan	6·3	3·8
Germany	6·2	11·3
Norway	5·4	4·3
France	5·1	4·2
Italy	4·8	3·1
Holland	4·5	3·2

As we have already indicated, the figures show the great development which has taken place in the use of steam turbine engines and of internal-combustion engines. There are now 1,464 steamers of 10,413,000 tons fitted with turbine engines or a combination of steam turbines and reciprocating engines, and 3,696 vessels (including auxiliary vessels) of 8,096,337 tons fitted with internal-combustion engines, as compared with 730,000 tons and 220,000 tons respectively in 1914. It is also interesting to note that while, during the last 12 months, there has been an increase of 1,468,000 tons in the tonnage of motorships, and of 368,000 tons in the tonnage of vessels fitted with steam turbines, the tonnage of steamers fitted solely with reciprocating steam engines has actually decreased by 220,000 tons. The increase in the motorship tonnage at June, 1930, as compared with June, 1925, amounts to 5,382, 000 tons.

An interesting feature is the comparatively large proportion of motor tonnage included in the merchant navies of some countries. While the total motor tonnage amounts only to 11·6 per cent. of the total tonnage owned in the world (in Great Britain and Ireland 11·1 per cent.), such percentage is much higher in the Scandinavian countries, *viz.*, Norway 35·2, Denmark 32·5, and Sweden 29·4. Among the principal maritime countries, France and the United States have the smallest proportions of motor tonnage, *viz.*, 4·1 and 4·7 per cent. respectively.

An analysis of the type of machinery now employed also shows that there are recorded in Lloyd's Register Book, 150 vessels, with the total tonnage of 1,265,929 tons (included in the above-mentioned totals for turbine vessels), which are fitted with a combination of steam turbines and reciprocating engines. Another interesting particular is that there are 67 vessels with a tonnage of 308,281 tons which are electrically propelled. Of these vessels, 53 of 235,947 tons are owned in the United States including three vessels of over 20,000 tons each. Of the 29,996 steamers and motorships of 100 tons gross and upwards recorded in Lloyd's Register Book, 3,695 are twin-screw vessels, and 128 have triple or quadruple screws.

There are 3,904 steamers of 19,857,788 tons fitted for burning oil fuel, of which 858 of 5,519,291 tons are registered in Great Britain and Ireland, and 1,698 of 8,448,805 tons are registered in the United States of America, the following table showing the respective employment of coal and oil fuel at the present time as compared with 1914:—

	1914. Percentage of Total Gross Tonnage.	1930. Percentage of Total Gross Tonnage.
Sailing vessels and sea-going barges ...	8·06	2·27
Oil, etc., in internal-combustion engines	0·45	11·63
Oil fuel for boilers	2·65	28·53
Coal	88·84	57·57
	100·00	100·00

These figures, read in conjunction with Lloyd's Register shipbuilding statistics for the June quarter indicate that, owing to the large number of tankers under construction, 131 of the 148 being motorships, the proportion of motorships to steamships will be higher at the end of this year. It is interesting to observe that at the end of June, at which date the statistics quoted above are drawn up, the tonnage of motorships now under construction in Great Britian and Ireland exceeded that of steamers building, the figures being 831,159 tons and 556,804 tons respectively. The motorship tonnage being constructed abroad (1,089,346 tons), is more than 94 per cent. greater than the tonnage of steamers, and there are now being built in the world 91 motorships each of 8,000 tons and upwards, and only 30 steamers of such size under construction. These figures include 10 motorships and 11 steamers each of 15,000 tons and upwards.

MACHINERY INSTALLATIONS OF BYGONE DAYS. THE FAMOUS OLD WHITE STAR LINER "BRITANNIC" OF 1874.

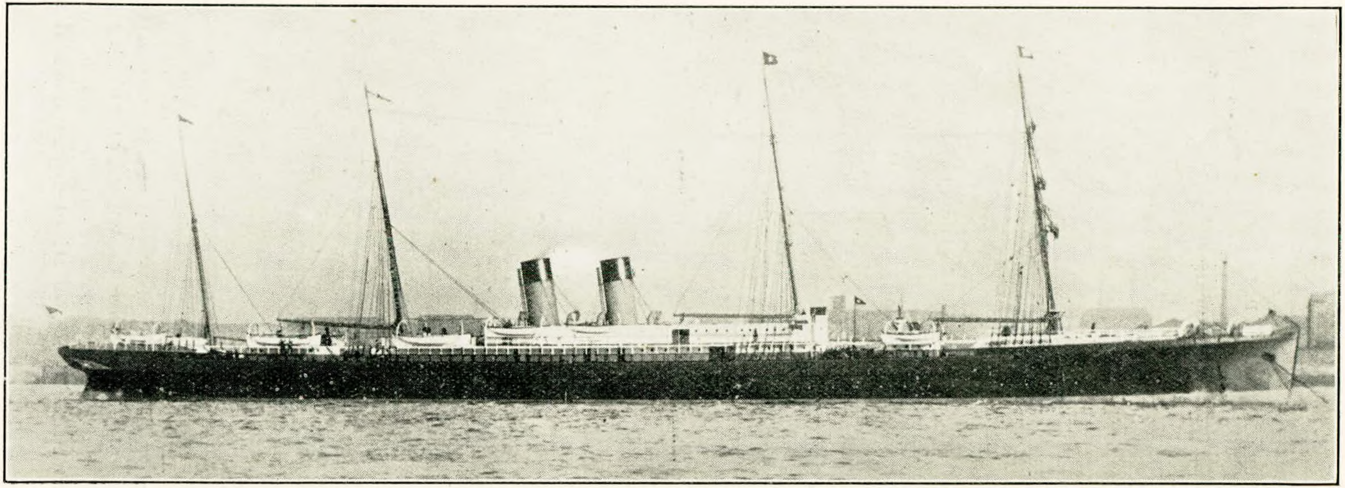
"The Marine Engineer," August, 1930.

The new White Star cabin liner *Britannic* has attracted so much attention, not only because she is the first large British motor liner for Atlantic service, but also because of her own qualities, that her first predecessor of the name is particularly interesting at the moment. So was the second *Britannic* for that matter, but her interest lay principally in her size, and she was so tragically short-lived that there is a tendency to overlook her.

The first ship of the name, built in 1874, was the White Star Company's first attempt to make a really radical improvement on the design of the pioneer *Oceanic* of 1871, whose advent had caused such a stir on the North Atlantic. The second type built for the company had shown certain improvements, but they were surprisingly small; the *Britannic* and her sister, the *Germanic*, were the first real improvements, increasing the tonnage of the *Oceanic* from 3,700 to 5,000 and the speed from 14 to 16 knots. That development, as is only natural considering the time that had elapsed, was very small compared with the changes between the old *Britannic* and the new, whose general details are as follows:

	Britannic of 1930.	*Britannic of* 1874.
Gross tonnage	26,943	5,004
Net tonnage	16,445	3,174
Displacement	36,440	9,100
Length	680ft.	455ft.
Beam	82ft.	45ft. 2in.
Depth	43ft. 9in.	33ft. 9in.
Engines	Diesel	4-cyl. comp.
H.P.	20.000 (brake)	4.900 (indicated)
Speed	17 knots	16 knots
Consumption per day ...	95 tons	110
Screws	2	1
Passengers	1,550	1,300
Cargo	14,070*	3,200†

* Deadweight. † Net Cargo.



White Star Liner "Britannic," built by Harland & Woolf, Ltd., in 1874.

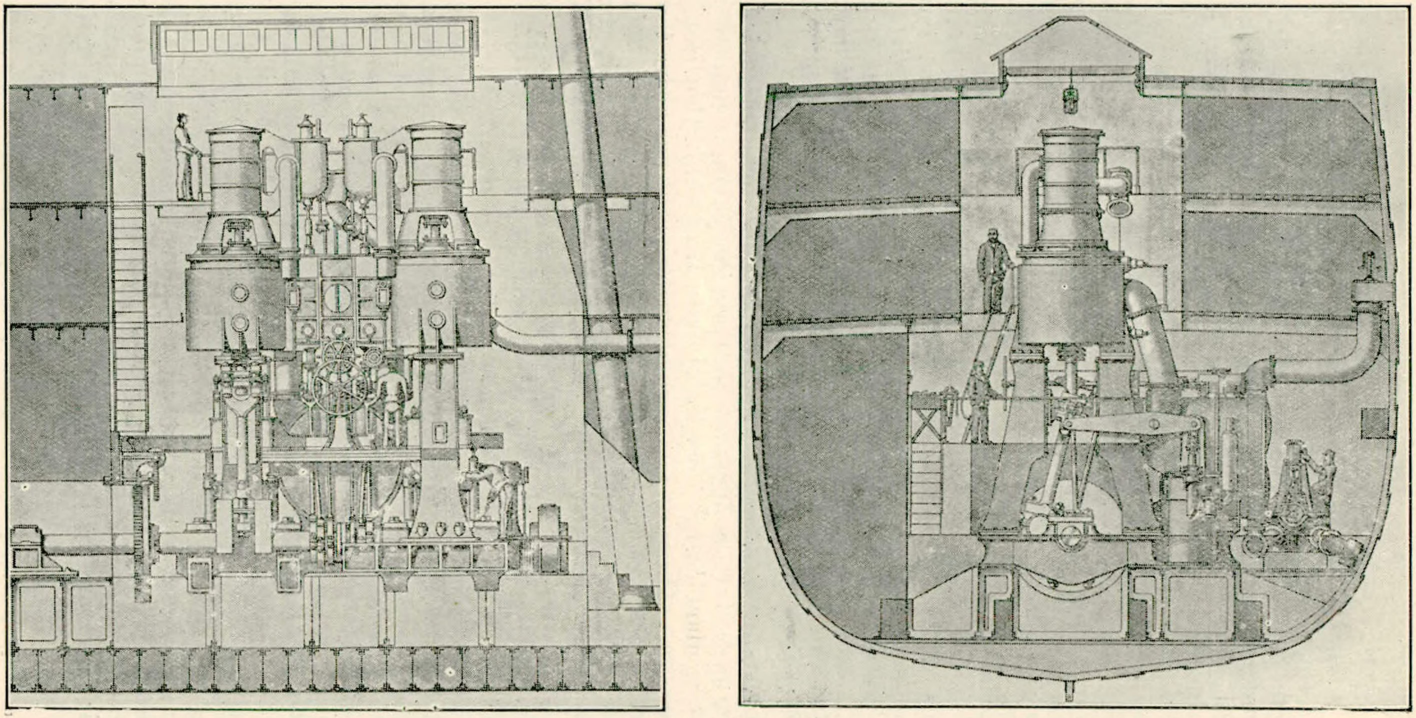
Both in hull and machinery the *Britannic* was regarded as a wonder ship in the seventies. Harland had greatly improved the lines of steamers in the passenger liners that he had turned out since the 'sixties, and the principles that he had laid down were accentuated in the *Britannic*, which had a very fine entrance, with the usual Harland and Wolff absence of fore foot, a long and full midship section and a beautiful run aft. The clearance lines aft were shorter than usual, but this certainly did not interfere with her speed as had been foretold when they were first seen.

Harland and Wolff's engineering department, which can now tackle such colossal Diesel and steam jobs, was then in a very elementary condition and, like her predecessors, the *Britannic* drew her engines from Maudslay, Sons and Field, of London, the design being that of Mr. Charles Sells, of that firm, who was one of the most brilliant engineers of that day, and who had worked for Maudslays ever since he had entered the firm as an apprentice in 1837.

The engines were of the double-compound inverted direct-acting type, the two low-pressure cylinders having a diameter of 83in. and the high pressure a diameter of 48in., the stroke being 60in. The cylinders were placed in pairs, one above the other, in the tandem system that was then popular. The crankshaft, which was the first one of any considerable size to be built up, was 19$\frac{5}{8}$in. in diameter, while the propeller shaft was 18in. The machinery was designed to give 4,900 I.H.P. at 52 r.p.m., but they could be worked up to 5,400 I.H.P. without trouble.

Except for this power, at that time greater than any that had been put afloat, there were not many really noteworthy features about the actual engines of the *Britannic*, but they were a fine working set which gave very satisfactory results. Far more interesting when she first came out was the arrangement for lifting and lowering the propeller, an idea which had been experimented with by Harland and Wolff in 1871 in a small steamer, and whose main idea was to permit the screw to be immersed as deeply as possible, permitting it to work in solid water and avoiding racing in bad weather.

By means of a large universal joint the aftermost two lengths of shafting could be drawn right up, so that the boss of the propeller was out of the water, when any ordinary repair jobs could be done on it, or lowered until it was on a



Machinery Arrangement of the Old "Britannic," which had Double Compound Engines.

level with the keel line and fully immersed, no matter how badly the ship was pitching. A steam engine was fitted aft which lifted the shaft through the whole arc in two minutes, with auxiliary hand gear and the after-capstan as a last resource. Excellent in theory, this idea involved setting the cylinders with a very distinct rake, and the result was such terrible vibration that after a few voyages she had to be taken in hand by Harland and Wolff, Ltd., and at very considerable expense altered back to the more normal practice, when she was a complete success and vibrated no more than any other fast single-screw ship of her size.

Steam was supplied by eight double-ended boilers, each 20ft. long by 8ft. 10in. in diameter, having 32 furnaces 6ft. 6in. long by 3ft. 3in. in diameter, and working to a pressure of 70 lb. per sq. in. The heating surface was 19,500 sq. ft., and when the ship was steaming at her full speed of 16 knots the coal consumption was 110 tons per day, or 1·8 lb. per I.H.P. per hour. The bunker capacity was 1,100 tons.

Like all Harland and Wolff-built ships, the *Britannic* had a very excellent installation of auxiliary machinery, in this particular, being considerably in advance of her contemporaries. On trial her engines developed 5,400 I.H.P. without difficulty, although the speed was not recorded, as was the custom with Harland and Wolff ships built for the White Star Line.

The *Britannic* left Liverpool for New York, and arrived in 8 days 1 hr. 58 min., an average of 14,469 knots. She soon improved on that, but it was not until the latter part of 1876 that she lowered the *City of Berlin's* westward record, her time being 7 days 11 hr. 37 min., against 7 days 13 hr. 11 min. of the Inman ships. Immediately afterwards she lowered the eastward record which her sister, the *Germanic*, had taken from the *City of Berlin*. After that her speed tended to improve steadily, and it was a ding-dong fight between the *Britannic* and the *Germanic* as to who should hold the record.

It is difficult to say which of the two sisters was really the best, but the *Germanic's* machinery wore out more quickly, and in 1895, when she received new engines and boilers, the *Britannic* was still going strong, and continued to do so both on the Western Ocean and on the Transvaal War trooping service. She was the ship chosen to take out to Australia the British guard of honour which represented the United Kingdom and the other colonies at the inauguration of the Commonwealth.

When, in 1903, the *Britannic* was sent to Belfast to be re-engined in the same way that her sister had been eight years previously, the standard on the North Atlantic had gone up very considerably, and when the cost of installing modern twin-screw machinery was examined, it was decided that it was too great, and she was sold to German scrappers for £11,500.

THE WHITE STAR MOTOR LINER "BRITANNIC."

"Engineering," 18th July, 1930.

A remarkable example of ship-model construction has been placed on view in the library of the Institute of Marine Engineers, The Minories, London. The model represents the White Star motor liner *Britannic* to a scale of 64 ft. to an inch, and has been constructed by Mr. Charles Hampshire, M.I.Mar.E., a number of whose other ship models have been at the Institute of Marine Engineers for some time. This latest model, which is a very beautiful piece of work, has been built from drawings supplied by Messrs. Harland and Wolff. The boat is represented travelling at full speed, the sea being made from a plastic material, with correctly shaped waves, which were formed after the study of aerial photographs of ships travelling at different speeds. All boats, deck-fittings, etc., are made to the correct scale, while human hair is employed for light standing rigging, flag and signal halliards, wireless aerial and handrails; for funnel guys, stays and derrick tackle, fine horsehair is used. Altogether the model is a remarkable piece of work and is well worth inspection.

FIRES IN BUNKER AND CARGO COAL.

"Shipbuilding and Shipping Record," July 31st, 1930.

The Board of Trade has just issued a "Notice to Shipbuilders, Shipowners, Masters and Engineers" (Notice No. 106), calling attention to the findings of the Committee of the Fuel Research Board, which has been investigating the problem of the causes of fires which occur in steamship bunkers and in cargo coal. We have already given an abstract of this report (see "Shipbuilding and Shipping Record," January 16th, 1930, pages 71 and 72), and it is of interest to note that while the Board of Trade strongly recommends all interested to make a careful study of this report, it gives, in the notice under review, the main suggestions as to the precautions which are desirable to prevent spontaneous fires in bunker and cargo coal. These precautions include the prevention of local heating by stowing the coal away from boiler-room bulkheads wherever possible, or, failing this, the provision of a screen, preferably of metal, at some distance from the bulkhead, through which cool air can circulate, or, failing this, the effective and substantial lagging of the bulkhead with heat-insulating material. At the same time, whereas the circulation of air behind the screen is desirable, air paths through the coal must be prevented, and, in particular, the practice of using temporary wooden bulkheads is condemned, since the air can flow through imperfect joints or cracks between the planks. Special precautions are given for dealing with coal cargoes destined for long voyages in view of the serious fires which occurred on vessels engaged in carrying coal on long-distance voyages last year, and it is urged that provision should be made for taking the temperature of the cargo, particularly at the lower levels, three times daily. This notice, although only covering four pages, contains much valuable information and merits careful study.

DOES SPEED PAY?

" Shipbuilding and Shipping Record," July 31st, 1930.

The question " Does speed pay?" is put now to all classes of vessels, and we discussed it recently as applied to tramp cargo ships. In a general way owners must be finding that speed does pay, for the average speed of ships is much higher than was formerly the case. This does not prove that on the basis of a fixed freight rate it is more profitable to carry cargo at a high speed, but rather that the promise of reasonably fast deliveries can ensure employment for vessels which might otherwise be standing idle. Regular cargo liners, such as the new Canadian Pacific *Beaver* ships, are capable of maintaining an ocean speed equal to some of the older passenger ships, and the regular and rapid transit of cargo is of benefit to shippers on both sides of the Atlantic.

This same question has often been asked with regard to the largest type of vessel. How it is possible for the express Atlantic ships to pay is a problem which perplexes the uninitiated. Unfortunately little light is afforded by the large owning companies regarding the economics of these mammoth vessels, and without some definite guidance from them it remains a mystery as to how their enormous initial costs and running expenses can be met by the avenues of income. During the busy season the passenger returns must be adequate, but for many months of the year the complement of passengers must be much below the available accommodation. If the cost of fuel alone for a really fast ship amounts to £10,000 or more per trip, the economic question must be one of considerable difficulty.

High speed is frequently a necessity and thus economic considerations must give place to the special requirements of the case. Particularly is this so with cross-Channel vessels linked up with definite services. In this connection the superiority of turbine machinery over all other types for these particular vessels is undoubted. Many advocates of the internal combustion engine are making much of the adoption of this type in cross-Channel vessels, but the ships which have been thus powered are possessed of speeds which are altogether inadequate for the requirement of many cross-Channel routes.

In the case of ordinary cargo vessels it does not appear that high speeds can be at all profitable. Given the possibility of freights being there for the vessels and a given freight rate being stated whether the transit be fast or slow, the advantage is clearly with the ship of moderate power and moderate speed. In the "Burntisland Shipyard Journal" an instance was given of a vessel of the long bridge type of 7,800 tons total dead weight on 23ft. 11½in. draught, and these features are constant throughout the series of designs of differing speeds. The speeds for which the information is given are 9½, 10, 10½, 11 and 11½ knots in service. The changes which occur within these five vessels are: (*a*) a gradually increasing amount of power necessitating larger machinery in the higher-speed vessels; (*b*) a gradually reducing degree of coefficient of fineness providing a form suitable to the speed of the higher vessels.

Both of these have a very serious effect in the direction of increasing the dimensions of the hull necessary in the case of the vessels of higher speed. The increased weight of machinery requires a larger hull to carry it, as otherwise the deadweight capability would be reduced. Again, the finer lines essential to the higher speed would further reduce the deadweight capability, and this also necessitates larger dimensions.

The following dimensions were arrived at for the vessels of $9\frac{1}{2}$, $10\frac{1}{2}$ and $11\frac{1}{2}$ knots speed:—

Sea speed loaded	knots	9½	10½	11½
Length	ft.	367·5	378	390
Breadth	,,	52·2	53	53·88
Draught	,,	23·96	23·96	23·96
Block co-efficient	...	0·7775	0·755	0·7335
I.H.P.	sea	1,270	1,670	2,145
Tonnage	gross	4,220	4,300	4,395
,, ...	net	2,615	2,665	2,720
Price	...	£68,000	£73,000	£79,250
Price per ton	d.w.	£8·72	£9·36	£10·16

As a matter of interest it may be pointed out that the above power and speed figures represent a high standard of efficiency. They are based on results obtained by the Burntisland "Economy" ships. Further, the powers stated are 72% of the maximum power which the machinery is capable of producing on trial. The prices stated afford some indication of the efficiency which has been reached in shipbuilding, for notwithstanding the increased costs of materials and wages in comparison with pre-war days, the cost for the slow-speed ships is approximately £9 per ton d.w., a very low figure when these conditions are taken into consideration.

In order to arrive at the total amount of cargo which could be carried per annum by the various vessels, the following assumptions were made: (1) a 6,000 mile voyage, outward loaded and the same homeward loaded; (2) bunkered for the round voyage on sailing outward; (3) 45 days spent in port each complete round; (4) stores and fresh water taken as being a deduction of 30 tons from the deadweight during each voyage outward and homeward in the case of the 10-knot ship with suitable slight variation in the case of the others. The final statement of fuel consumed per annum and the cargoes carried per annum indicated these results:—

Speed	knots	9½	10½	11½
Coal consumed	tons	4,460	5,517	6,674
Cargo carried	,,	51,400	53,000	54,050

When the greater initial costs of the faster ships are taken into consideration and the much greater fuel consumptions per annum, the advantages are definitely with the slow-speed vessels. Two considerations may weigh in favour of the higher-speed ships. It is quite probable that the maintenance of sea speeds can be accomplished by the higher-powered ships with greater certainty than by those low-powered. This probability has not been taken into consideration in the tabular statements. Further, the possibility that quicker deliveries may influence in the securing of cargoes has not been considered, and this is an advantage which cannot be assigned a value in any comparison such as has been made.

The choice of speed ultimately lies with owners. With their knowledge of the requirements of shippers they are called upon to decide whether the extra costs involved in increase in speed will be justified by the demands for their new tonnage. According to the figures in the case, the advantages are clearly with the moderately-powered ship, but the needs of owners as determined by their knowledge of trade conditions will be the factor which will determine the speed required notwithstanding considerations of cost.

ANOTHER CHAPTER IN MARINE ENGINEERING HISTORY. By Engineer-Captain Edgar C. Smith, O.B.E., R.N. (Abridged.)

"Engineering," 1st August, 1930.

The first steam vessels built as fighting ships were the *Dee*, *Medea*, *Rhadamanthus*, *Phœnix* and *Salamander*. All these were fitted with side-lever engines by the firm of Maudslay. Of the five vessels mentioned, the *Medea* was regarded as the most successful. She was 179ft. 4½in. between perpendiculars, 46ft. wide over the paddle-boxes, and 835 tons by the old measurement rules. Her engines were of 220 n.h.p., the weight of the engines being 165 tons, that of the boilers 35 tons, and of the water in the boilers 45 tons. With 320 tons of coal, 18 tons of water and three months' provisions aboard; she drew 13ft. 10in. forward and 14ft. 6in. aft. She could, altogether, steam 1,190 miles at 8½ knots, 1,258 miles at 9 knots, and 1,360 miles at 10 knots, and was considered fit for any long-distance passage save a westerly voyage across the Atlantic in winter.

Launched in September, 1833, the *Medea* was soon commissioned, and two incidents, recorded by Baldock, illustrate one of the uses she was put to. On January 18th, 1835, the fleet of line-of-battleships had arrived about 10 miles off Malta when it became becalmed. Orders were then given to the *Medea* to raise steam, and she proceeded to tow each vessel in turn into harbour. About a fortnight later it was desired to get the fleet to sea, but heavy weather prevented the ships from sailing. Again the services of the *Medea* were requisitioned, and on February 8th, with the ramparts of Valetta crowded with spectators, she proceeded to tow the *Caledonia*, of 120 guns, and five 80-gun ships clear of the harbour. "In this manner all the fleet were taken out, the whole being effected in four hours and ten minutes, after which the fires were extinguished on board the *Medea*, and she pursued her course as a sailing vessel in company with the squadron; the whole cost of coal and other engine stores expended on this occasion amounting only to £3 6s."

That the machinery was well constructed and equal to its task may be presumed, for during the whole commission, which lasted from February, 1834, to October, 1837, no repairs were done by any one but the ship's staff.

AN HISTORIC CHAIN.

"The Engineer," 18th July, 1930.

An interesting addition to the Royal United Service Museum, Whitehall, is one of the links of the "mightie chaine of yron" which formed part of the early defences of Portsmouth Harbour. The chain was made to be buoyed up across the mouth of the harbour by means of three barges, and it is mentioned in a Navy Account, presented in February, 1522, as having been constructed at a cost of £40. The value of money was much greater in those olden times. From ancient records, however, it appears that the chain was not put into use until 1545, and for a number of years prior to that date it was probably lying on the bottom of the sea at the mouth of the harbour. When, about 100 years later, another chain was made, the original one was left in the mud, and until recently the shore end could be seen at low water, to the south of King Edward's Tower. A little time ago the President of the Staffordshire Iron and Steel Institute suggested recovering some of the links with a view to subjecting them to metallurgical examination. This was done, and one of the links, measuring 3ft. 8in. by 14in., was presented to the Royal United Service Museum, but, as it had been cut for the purpose of removal, before it was put on exhibition it was repaired by the Barimar welding process and restored to the condition it was in when it was removed from the water.

THE C.P.R. LINER "EMPRESS OF BRITAIN."

"The Engineer," 25th July, 1930.

Some further interesting particulars are now available concerning the propelling machinery of the quadruple-screw

42,000 ton C.P.R. liner *Empress of Britain*, which is being completed at Messrs. John Brown's Clydebank yard. In order to meet the combined requirements of the winter Atlantic service and summer cruising services, the two inboard propellers, will be driven by turbines in the forward engine-room, designed for an output of two-thirds the total power required, while the two outer propellers will be driven by turbines in the after engine-room, which will develop one-third the total designed output. When cruising, it is intended only to employ the forward turbines and so to run the liner as a twin-screw ship. The astern turbines are, therefore, embodied in the forward engine-room turbines, which drive the inner screws, and the after turbines, driving the outer screws, are to be used only for ahead running. A similar division of power has been arranged in the boiler-rooms. In the after boiler-room there are six 425 lb. pressure Yarrow boilers, which normally supply the forward inboard turbines and two Yarrow and one Johnson boiler in the forward boiler-room, which will normally supply steam to the outboard turbines in the after engine-room. The steam connections are, however, such that any or all of the boilers can supply steam to the forward engine-room with the larger inboard ahead and astern turbines. In the forward boiler-room there are also two 200 lb. pressure Scotch boilers, which will supply auxiliary steam and heating steam for ship's use. Most of the engine-room and deck auxiliary machinery will be electrically driven, current being provided by four oil-engine-driven generator sets and two turbo-generator sets. The whole of the machinery has been designed on the basis of experience gained with the *Duchess* and *Empress* class liners now in service, and very economical fuel consumptions are confidently expected.

THE NEW P. AND O. LINERS.

"The Engineer," 1st August, 1930.

The two new passenger liners for the P. and O. Company's Straits-China-Japan mail service, orders for which were recently placed with Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow, will have a length of 520ft. with a beam of 70ft., with about 30ft. maximum draught. They are to have cruiser sterns, and with their two funnels and two pole masts will be quite attractive in appearance. The gross tonnage of each ship will be about 14,000. Cabin accommodation is to be provided for about 154 first-class and 150 second-class passengers, with appropriate public rooms, and we understand that the schemes of decoration which are proposed will be on somewhat similar lines to those of the *Viceroy of India*. For the propelling machinery single-reduction geared turbines of the Parsons type, taking steam at about 375 lb. and working with 400 lb. pressure Yarrow water-tube boilers, have been chosen, and the most modern auxiliary machinery will be installed. The first ship is due for completion in August, 1931, and the second will most likely follow in the autumn of the same year.

A NOTEWORTHY DUTCH MOTOR LINER.

"The Engineer," 1st August, 1930.

On July 25th, we were invited by the London agents of the Rotterdam Royal Mail Line, to inspect at Southampton the Company's latest motor liner *Baloeran*, which has been specially designed for the owners' service to Singapore and the Netherlands East Indies. The party included representatives of shipping and shipbuilding interests, and the same evening the *Baloeran* left Southampton on her second voyage to Batavia. The new liner is a twin-screw motor ship of 17,000 gross tons, and is propelled by twin screw Schelde-Sulzer two-stroke, single-acting oil engines, having a total designed output of 14,000 S.H.P. The ship was built at the Fijenoord yard in Rotterdam to the drawings of the Royal De Schelde Company, of Flushing, which firm also constructed the propelling machinery under licence from Sulzer Bros., of Winterthur. The overall length of the *Baloeran* is 574ft., with a beam of 70ft. outside the frames, and a depth to the main deck of 44ft. Her summer load draught is 28ft. 4½in., and the corresponding deadweight carrying capacity is 8,740 tons, representing a hold capacity of 370,000 cubic feet. A very complete equipment of electric cranes is provided for handling the cargo.

The ship has a cruiser stern, and with her single short funnel and her two pole masts she presents a pleasing appearance. An interesting feature is the increased width of the promenade deck, which has enabled a very generous arrangement of public rooms and deck spaces to be provided. Having in view the tropical service in which the ship is engaged, the rooms are all light and airy, and a pleasing effect has been obtained by schemes of concealed lighting, and an effective use of the staircases connecting the different decks. On the boat deck there are large clear spaces for sports and an open-air swimming bath is provided. There is cabin accommodation for 236 first-class and 280 second-class passengers, in addition to third and fourth-class passengers.

We noted with interest that some of the lifeboats are arranged for propulsion by hand on the Fleming principle, whilst there are also the usual motor lifeboats with wireless equipment. The navigation equipment includes a Sperry gyro compass, with an automatic steering device, and a Langevin-Florisson echo-sounding machine. The steering gear was supplied by Brown's, of Edinburgh, and is of the hydraulic-electric type. We found the engine-room to be particularly well laid out. The two main motors are ten-cylinder engines, having a cylinder bore of 760 mm. and a stroke of 1,340 mm. They are designed to run at a normal speed of 93 r.p.m., and the maximum speed is 104 r.p.m., corresponding to the full output of 7,000 S.H.P. for each engine. The starting and manœuvring controls are neatly arranged at the forward end of the engine. For the scavenging air there are two electrically driven Brown-Boveri blowers, and the power for the auxiliary machinery and the lighting of the ship is provided by four 510 kw. Schelde-Sulzer, six-cylinder generator sets, driving Smit 220 volt dynamos. The engines have a cylinder bore of 380 mm., with a stroke of 660 mm. and run very silently and free from vibration at 180 r.p.m. For lighting the 220 volt current is transformed to 110 volt current by two 150 kw. rotary converters. The engine-room auxiliary machinery includes the usual complement of pumps and auxiliary air compressors, and we noted that Sharples centrifugals were used for both fuel and lubricating oil.

Two of the fuel tanks serve the purpose of anti-rolling tanks on the Frahm system, with a cross air connection and regulating valve, and we were given to understand that on the last voyage through the Indian Ocean, when rough weather was encountered, with waves broadside on, the ship proved exceedingly steady, and only rolled 4½ deg. to either side. In order to use the waste heat from the exhaust gases, a large tubular exhaust gas boiler is fitted, and is available for either or both the main and auxiliary engine exhausts. It supplies low-pressure steam for heating the salt and fresh water and for use in the kitchens.

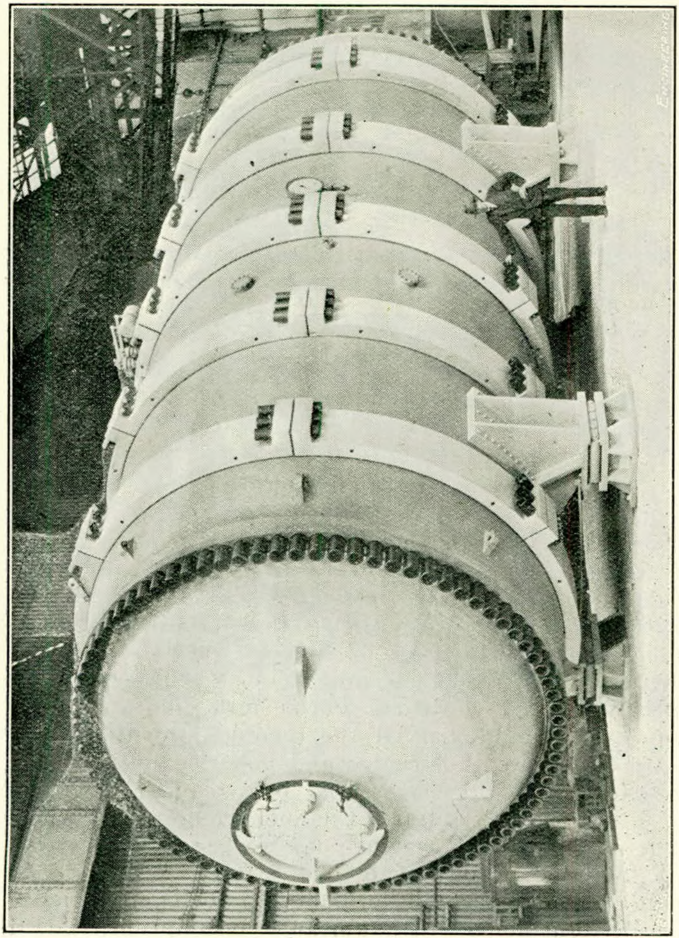
On her full power trials the machinery developed 16,900 I.H.P. at 99 r.p.m., corresponding to a ship's speed of 18·8 knots, and the fuel consumption from the main engines alone was 0·31 lb. per I.H.P. hour, or about 0·375 lb. per S.H.P. hour. A feature of the installation is the high economy of the engines at all speeds from 16½ to 19 knots. A sister ship to the *Baloeran*, which is named the *Dempo*, is now under construction in Holland, and will be commissioned early next year. The new liners will operate with the existing motor liners *Sibajak* and *Indrapoera* and the steamship *Slamat*, the propelling machinery of the two last-named ships being slightly modified in order to give an increased speed.

VARIABLE-DENSITY WIND TUNNEL FOR THE NATIONAL PHYSICAL LABORATORY.

"Engineering," 26th June, 1930.

An important stage in the construction of the variable-density wind tunnel for the National Physical Laboratory, Teddington, has recently been reached by the completion of the built-up steel cylinder which constitutes the outer casing of the tunnel. Its object is to enable aerodynamic tests to be made on models at values of Reynolds' number, $\frac{Vl}{v}$, equal to those obtaining in full-size aircraft. In this expression, V is the wind velocity, l a linear dimension of the model and v the kinematic viscosity of the air, and it will be obvious that, if v is unaltered, a very high velocity will be required in the case of a small-scale model to make the value of the Reynolds' number equal to that of the full-size machine. The kinematic viscosity, v, however, varies almost inversely as the pressure, so that by carrying out the test in air at a high pressure, it is possible to obtain the same number with a moderate velocity, and it is to enable this to be done that the variable-density tunnel has been provided. It will be possible with this tunnel to carry out tests at pressures up to about 25 atmospheres, and at this pressure a value of Reynolds' number equal to the full-scale value could be obtained with a 1/12th scale model aeroplane and a wind velocity about half the speed of flight.

A photograph of the tunnel erected at the works of the makers, Messrs. John Brown and Co., Ltd., Atlas Works, Sheffield, is reproduced on this page, and an idea of its impressive dimensions will be obtained from the figure of the man standing alongside. Actually, the overall length is 50ft. and the internal diameter 17ft. The cylindrical portion is built up of four seamless hollow-rolled rings, the production of which is a noteworthy achievement in steel manufacture. They are, we believe, the largest rolled rings which have been produced so far in any country, weighing 50 tons as rolled and measuring, in the finished state, 17ft. in diameter internally, 7ft. 6in. in width, and $2\frac{1}{2}$in. in thickness. The butt straps for the circumferential joints are constructed in six segments and connected by bolted flange joints, as will be clear from the illustration.



Each of the hemispherical ends is formed by two steel castings, each pair weighing 26 tons, made at the Norfolk Works of Messrs. Thomas Firth and Sons, Ltd. One casting of each pair is in the form of a ring for the shoulder and the two are connected by a flanged joint with closely-spaced bolts. The nuts of these bolts, and of those connecting the butt straps, are cylindrical externally, hexagonal recesses being formed in them to enable them to be turned. As will be seen, a manhole, held in place by four bridges, is provided in the end to give access to the interior, and the mountings include a pressure gauge and two deadweight safety valves, all of which are visible in the figure. The method of supporting the tunnel, which weighs about 250 tons, in its present form, can also be followed from the illustration. It will be seen that two cast-steel brackets are fixed to each of the end rings, those at the rear end being bolted on to cast-steel pedestals, and those at the front end being carried by rollers resting on similar pedestals. With this arrangement, the slight longitudinal movements accompanying temperature and pressure changes can take place without setting up additional stresses in the shell. The tunnel, we understand, has been subjected to, and successfully sustained, a hydraulic test pressure of 550 lb. per square inch. It will shortly be dismantled and transported by road to Teddington, where it will be erected in a special building now approaching completion.

TRIALS OF H.M.S. "DORSETSHIRE."

"The Engineer," 8th August, 1930.

Successful trials have been recently carried out by H.M.S. *Dorsetshire*, and she is now being prepared for commission. She is the eleventh and last of the 10,000 ton cruisers laid down for the Royal Navy since the Washington Conference, and the second to be completed of the Class "A" cruisers ordered under the 1926 programme. The *Dorsetshire* was built by H.M. Dockyard at Portsmouth, and was launched on January 28th, 1929. All the turbine propelling machinery and boilers were constructed and installed by Cammell Laird and Co., Ltd., of Birkenhead. The steam trials, which were carried out in the English Channel, comprised a preliminary trial, during which the turbines worked for one hour at the full designed output of 80,000 S.H.P., a twenty-four-hour steam and fuel consumption trial at 48,000 and 64,000 S.H.P., and an eight hours full power and consumption trial, in addition to which there were the usual steering, starting and stopping and astern tests. Throughout the whole of the trials the main and auxiliary machinery, we are given to understand, worked satisfactorily and fulfilled the requirements of the Admiralty in all respects. The principal dimensions of the *Dorsetshire* are: Extreme length, 633ft.; breadth, 66ft.; and depth, 17ft.; with a standard displacement of 10,000 tons, and a shaft horse-power of 80,000. The oil fuel capacity of the ship is 3,200 tons, and her speed 32¼ knots. Her complement is 685. Her armament includes eight 8in. turret guns, four 4in. anti-aircraft guns, and eight torpedo tubes arranged in quadruple mountings, and is generally similar to that of the earlier "County" ships.

H.M. AIRSHIP R 100.

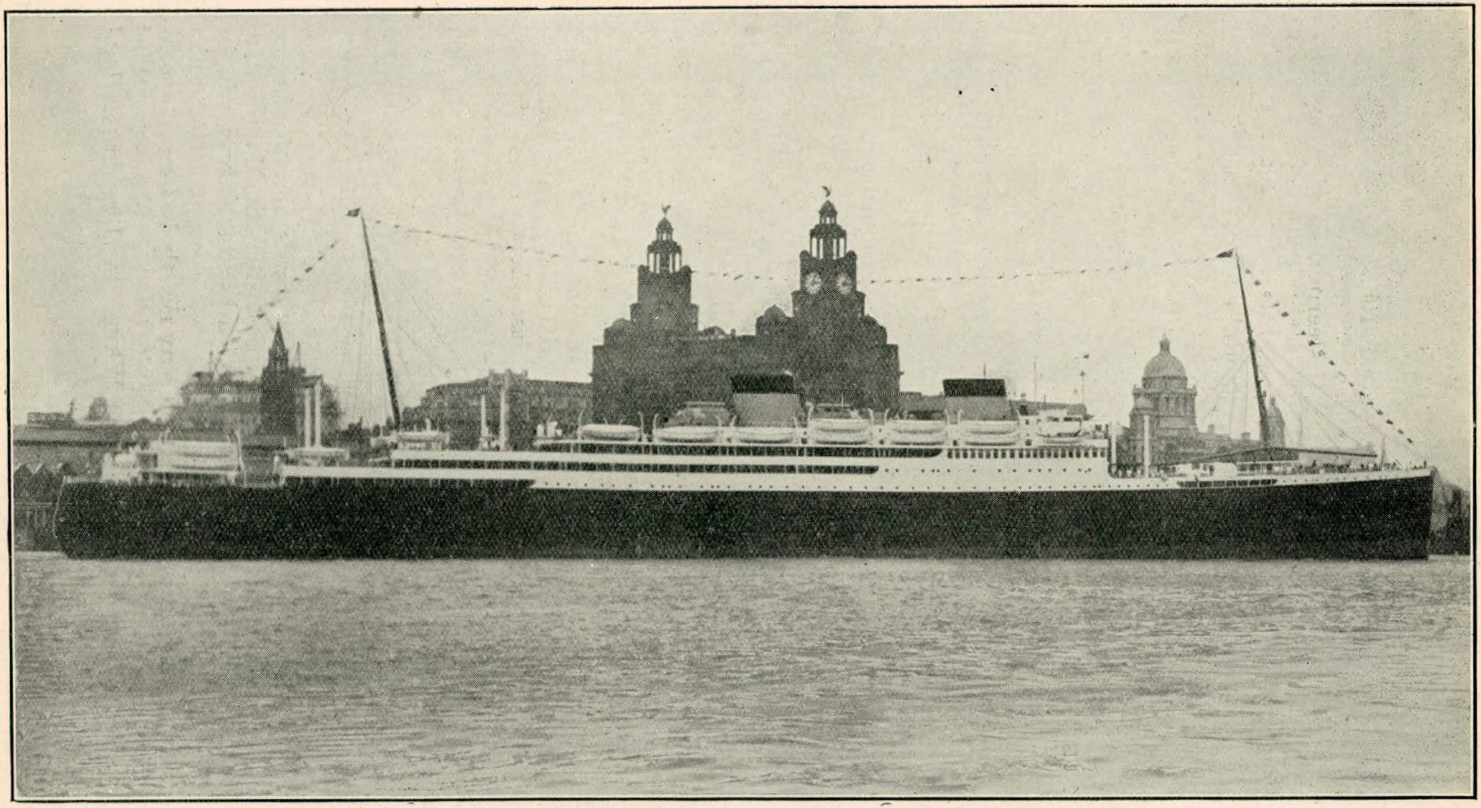
"The Engineer," 8th August, 1930.

The airship R 100 completed her voyage to Canada by arriving safely at the St. Hubert Tower near Montreal at 10.37 a.m. (B.S.T.) on Friday, August 1st. On the last stage of her trip, when she was following the course of the St. Lawrence, she encountered a severe storm which delayed her progress. Additional delay was caused by damage to the fabric of the tail fins. The fabric was temporarily repaired in the air. Subsequently, at the tower, 200 square feet of fabric was replaced in a permanent manner. No engine trouble of any kind was experienced throughout the voyage, and on arrival minor replacements only were found to be required. The total distance travelled by the airship since she left Cardington at 3.45 a.m. (B.S.T.) on Tuesday, July 29th, was 3,415 miles. As her flight lasted just short of seventy-nine hours, her average speed works out at about 43¼ miles an hour. Of the 34 tons of petrol with which she started she is reported to have had five tons remaining at the end of the trip. It may be recalled that in 1919 the British airship R 34 made her east-to-west flight from Edinburgh to Long Island, New York, in 108 hours 12 minutes, and just succeeded in arriving before exhausting her petrol supply.

"THE BRITANNIC." The White Star Line's new 27,000 ton Transatlantic Liner. The Largest British Motor Ship, with 20,000 s.h.p. Twin-screw Machinery. (Abridged).

"The Motor Ship," Mid-June, 1930.

It is fitting that a vessel which may rightly be termed epoch-marking should be christened the *Britannic*. She is the third of the name to be built for the White Star Line by Harland



The "Britannic" alongside the Landing Stage at Liverpool.

and Wolff, and the first which sailed on her maiden voyage in 1874 had a career which may, without affectation, be termed long and honourable. She was a ship 455ft. long, with a beam of only 45ft., a gross tonnage of 5,004 and was rigged as a four-masted barquentine with square sails on fore, main and mizzen masts.

The name at least is thus a good augury for the success of the new *Britannic*, which is over five times the tonnage of the first *Britannic* and has machinery nearly thirty times the power. The old *Britannic* was something of a pioneer; the new ship, more so. Records, as such, do not always mean much, but those which the new *Britannic* creates are such as spell advance in shipbuilding and engineering without, as will be shown later, causing any risk to be taken beyond that which every progressive shipbuilder and shipowner must be prepared to accept.

The *Britannic* is by far the largest British-built and British-owned motor ship, and she is equipped with two Diesel engines which individually, are the highest powered that have been built for installation in any ship. She has a substantially bigger electrical installation than that in every vessel of her size and possibly larger than in any liner afloat.

We may pause for a moment to note the course of events which has rendered it possible to build, as a motor ship, with assurance of complete success, a vessel so large and so costly as the *Britannic*. The first large oil-engined craft, the *Selandia*, was completed a little more than 18 years ago. The first motor passenger ship constructed mainly as such was the *Adda*, which went into service in 1922. She is of about 8,000 tons gross and is equipped with Harland-B. and W. machinery of about 4,500 B.H.P. Powers and sizes increased, the largest in this country being reached with the *Asturias*, of 22,000 tons and 15,000 B.H.P., in 1926.

The progress made over a period of eight years is thus rapid, but it has been steady, each step following logically from the last. No undue risk has been taken by the builders of the *Britannic* in any of the motor liners which they have produced and, as a consequence, there have been no failures, a record of some weight when it is considered that the new ship is the largest motor vessel built by them mainly or wholly for passenger carrying. From the normal single-acting four-stroke design of diesel engine as used in the *Adda*—and still adopted with the newer improvements, such as pressure charging, in the smaller classes of ships—the double-acting four-stroke motor was evolved, first with six cylinders in the Burmeister and Wain-engined *Gripsholm*, then as an eight-cylinder unit in the *Asturias*, *Alcantara*, *Carnarvon Castle*, constructed by Harland and Wolff, and now as ten-cylinder engines—for the first time—in the *Britannic*.

In all of the biggest liners with this class of machinery built in this country, Italy and Japan, the same cylinder size (840 mm. bore) has been employed, also the same general design, but hitherto the piston stroke has been 1,500 mm. In the *Britannic* it has been increased to 1,600 mm. with the same diameter, but this does not involve any departure from main and tried features of construction of parts, such as cylinders covers, fuel pumps, camshafts and valves. For the first time in a Harland and Wolff-built ship, however, the injection-air compressors are driven separately and not by the main engines.

The *Britannic* will be an easily recognised ship on the North Atlantic run, for she has the two characteristic low funnels utilised in all of the latest motor liners of companies which Lord Kylsant controls, first introduced in the *Asturias* four or five years ago. She has a straight stem and cruiser stern, and is fitted with two masts, and her external appearance is undoubtedly attractive. The low broad funnels are obviously well suited to liners of the dimensions of the *Britannic*.

The *Britannic* was built at Harland and Wolff's Belfast yard, the machinery being constructed also at Belfast. She was ordered in April, 1928, launched in August, 1929, and left Belfast on her official technical trials on May 26th, 1930. She is the builders' crowning achievement in motor liner construction, in which field they may fairly claim to be pre-eminent since the *Britannic* represents the fourteenth big oil-engined passenger ship turned out by Harland and Wolff during the past few years.

Hull.

The principal characteristics of the *Britannic* are as follows:—

Length overall	712 ft.
Length between perpendiculars	680 ft.
Breadth moulded	82 ft.
Depth to C deck, moulded...	43 ft. 9 ins.
Height from keel to sun deck	78 ft. 9 ins.
Load draught	32 ft. 9 ins.
Gross tonnage	26,943
Engine power	20,000 s.h.p.

The vessel has been built to Lloyd's 100 A1 class, and it is noteworthy that this is the first of the White Star Line fleet to be built under Lloyd's special survey; she has also passed the Board of Trade survey for passenger certificate, and complies with the latest regulations regarding safety of life at sea.

The *Britannic* may be described as a flush deck ship with complete superstructure, and having a combined bridge and forecastle extending for 403ft. over the vessel's length from the stem. There are eight steel decks clear of the machinery spaces: the sun deck, promenade, bridge deck A, upper deck B, main deck C, middle deck D, lower deck, orlop deck, and at the ends in Nos. 2, 3 and 8 holds a lower orlop deck, making nine steel decks in these particular sections.

The keel is formed by a single thickness of plating 1·08in. thick, and a flat bar 18½ins. wide by 2½ins. thick.

The whole of the outer bottom plating from the keel to the upper turn of the bilge, which is ·94in. thick, was hydraulic riveted, for which purpose Harland and Wolff's special type of rivet was used, which ensures a very shallow snap on the outside of the plating, and thus does not offer the same resistance as the usual type of hydraulic rivet.

A cellular double bottom with floors on every frame is fitted from the fore peak to the after peak bulkhead, and extends out flat to the sides of the ship at a height of 4ft. 9ins., thus affording ample protection at the bilges. In way of the main motor room this depth is increased to 7ft. 6ins., and the main engines are bolted direct to the tank top plating, special recesses or pits being provided for the crankshafts. Each engine is carried on four girders 1·12in. thick, which are run continuous through both the main and auxiliary motor rooms, providing ample longitudinal strength and rigidity. In addition, all the engine holding-down bolts are fitted between each pair of girders, which space, being a cofferdam, is accessible at all times for the inspection or tightening up of the bolts. Outside the engine-rooms there are four lines of girders each side of the centre girder, three worked intercostally and one continuously dividing the double bottom into four tanks longitudinally. The main frames, which are formed of 9in. channels, extend from the tank top to A deck, and are spaced 32ins. apart amidships, reduced to 27ins. forward of 3/5 length and 24ins. in the peaks, where 11in. bulb angles are substituted for the channel frames.

A special system of web frames on every fifth frame is worked throughout the length of the main and auxiliary motor rooms, in which the web-frame system is incorporated with heavily built pillars and strong beams at B deck level, thus forming very efficient ties in way of the machinery openings and affording great transverse strength.

Bitumastic enamel and heat-proof cement are applied to the tank tops in the main and auxiliary motor rooms and bitumastic solution and covering to the tank top in the forward pipe and shaft tunnels and in the tunnel recess.

The beams of the main structure decks are all 8in. channels fitted in one length 82ft. long, and supported on four complete rows of widely spaced columns and girders, extending up to D deck and on closely spaced solid pillars above. There are 12 transverse watertight bulkheads all terminating at C deck, with the exception of the fore peak bulkhead, which runs up to B deck, providing eight cargo holds in addition to isolating the motor rooms and oil-fuel bunkers.

No. 4 hold, up to the height of the orlop deck, is fitted with a double skin, and all stiffeners and brackets have been eliminated so far as possible from the inside of the hold to present a smooth surface, which can be thoroughly cleaned and polished for the carriage of palm kernel oil. No. 1 lower orlop 'tween deck, which is 11ft. deep, has been especially arranged for the carriage of uncrated motor cars.

No. 2 lower and orlop 'tween decks, and No. 3 lower, orlop and lower orlop decks are insulated for the carriage of refrigerated cargoes.

In accordance with the builders' usual practice for North Atlantic ships, the top flange of the equivalent girder has been made heavy; thus the shell plating from the upper turn of the bilge to B deck sheerstrake is ·84in. thick, the strake above ·90in. thick, while A deck sheerstrake is 1in. thick with a ·90in. thick doubling carried over the 1/2 length amidships. The A deck stringer is formed of two thicknesses of 1in. thick plating, with an inner stringer 1in. thick, and the remainder of the A deck plating amidships ·84in. thick.

A deck sheerstrake and the strake below are hydraulic riveted over the amidship half length, and then gradually stepped down at the breaks to the two strakes below and terminating at about 3/5 length forward and aft. A deck stringer bar and stringer plate butts are also hydraulic riveted inside 1/2 length amidships, thus ensuring the highest class of workmanship and great longitudinal strength at this very important part of the structure. In order to prevent the heavy stresses associated with a vessel of the length and depth of the *Britannic* being transmitted to the comparatively light superstructure, an expansion joint is fitted in A deck just forward of 1/2 length forward. A second expansion joint through the top deckhouses, boat and promenade decks amidships, and a third are through the promenade deck about 1/2 length aft, thus dividing the deckhouses into shorter lengths and relieving them of the more serious hogging and sagging stresses. The promenade and boat decks, which are 350ft. and 276ft. long respectively, are of comparatively light construction, and are supported on frame legs spaced about 8ft. apart; the boat deck overhangs the ship's side by 1ft. 6ins., thus providing ample deck space between the boats and the deckhouse side.

As has been the practice of the White Star Line in their most recent ships, the officers, both deck and engineroom, are housed in a large deckhouse on the boat deck, so that the deck officers are adjacent to the navigating bridge, while an electric elevator provides a quick means of transporting the engineers from their quarters to the engineroom. A striking feature in the appearance of the *Britannic* is her two large oval funnels, which are 32ft. by 23ft. 6ins., while their height above the casing top is only 27ft., which together with their big rake and horizontal tops, adds to the suggestion of power and speed.

Stern Castings.

The stern frame, which is designed to accommodate a semi-balanced rudder, is arched up to a height of 9ft. 6ins. for a distance of 24ft. forward of the after perpendicular, was manufactured by the Darlington Forge Co. of mild cast steel, and is made in four pieces, consisting of the sole piece, back post and two contour pieces, the combined weight being 30½ tons.

The boss arm castings, in two pieces bolted on the centre line of the ship, and weighing 30¼ tons, have, along with the shaft bossing, received special attention as regards their shape to ensure an easy run of water to the propellers and rudder.

As previously mentioned, the rudder is of the semi-balanced single-plate type, having an immersed area of 360 sq. ft.; the main piece of forged ingot steel is 25¼ins. diameter at the coupling, tapering to 15½ins. diameter at the heel, and the rudder stock is 18½ins. diameter. The total weight, which is 43 tons, is supported on three collars turned on the rudder stock and carried in a special bearing at the lower deck, so that no weight comes on the two pintles, the lower of which is 14¾ins. diameter and the upper 11ins. diameter. The stern bar is of the usual rolled-steel section, and is connected by a cast-steel fore foot piece to the keel and centre keelson of the ship.

Double-Bottom Tanks.

There are 11 double-bottom tanks, in addition to the fore-and-aft peak tanks, and all are utilised for water ballast, except No. 5, which carries about 350 tons of fuel oil. There is, moreover, a deep tank above No. 4 tank for water ballast, and in all the amount of water ballast that can be accommodated is over 4,000 tons.

The remainder of the fuel oil is carried in deep tanks and several of these are located between the main and auxiliary engine-rooms. The oil-filling compartments are arranged at the sides of the ship on deck C.

The arrangement of the passenger accommodation is as under:—

Cabin class	504
Tourist third cabin	551
Third-class	498
Total	1,553

Cabin. *Disposition of Berths.*

Single-berth rooms	27
Two-berth rooms	111
Three-berth rooms	85
Total rooms	223

504 berths.

Tourist Third Cabin.

Single-berth rooms	13
Two-berth rooms	93
Three-berth rooms	4
Four-berth rooms	85
Total rooms	195

551 berths.

Third Class.	
Two-berth rooms	90
Four-berth rooms	75
Six-berth rooms	3
Total rooms	168

498 berths.

Officers' and Engineers' Accommodation.

The whole of the deckhouse on the boat deck is occupied by the cabins for the officers and engineers, the former forward, the latter, aft, in one continuous deckhouse which extends to the sports deck. Right forward is the captain's suite, with a very large sitting-room, an office, a bedroom and a bathroom. The officers have their own messroom and a smoking-room, while the engineers are provided for in a similar way. There is also ample promenade space for officers and engineers, and the latter, of course, have direct access to the engine-room, either by ladders or by the electric lift, which brings them up in the middle of their own quarters. The whole accommodation and arrangements for the comfort and health of officers and engineers are excellently planned.

The crew, for the most part, is berthed forward, with entrance to the accommodation located forward on deck A.

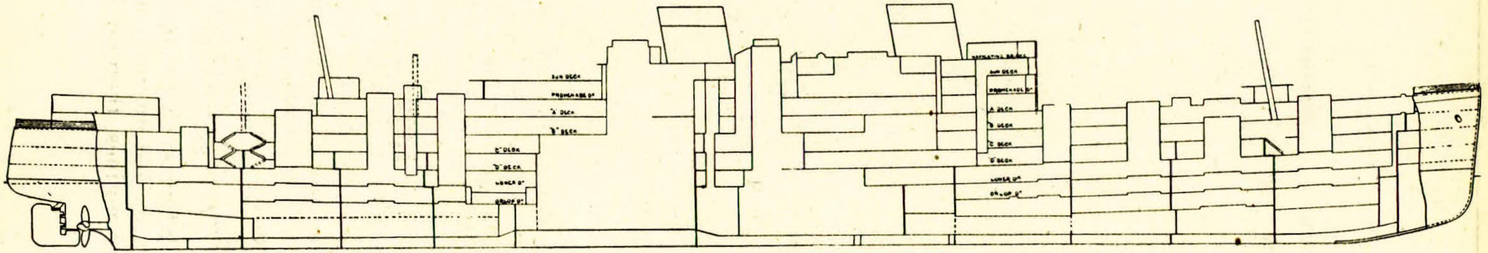
A Use for Funnels.

Part of the forward funnel, approximately half in section, is formed into a smoking-room for the engineers, with direct access from the engineers' quarters up a short stairway. It is, of course, covered in, and the height is about that of an ordinary room on a ship, say, 10ft. or so. Its shape lends itself to an attractive room, and with shaped settees, easy chairs and tables it forms quite the most delightful engineers' smoking-room we have seen on any ship.

The remainder of the funnel on the same level is occupied by two hot-water tanks and a fresh-water tank, also the skylight over the deck officers' smoking-room.

Propelling Engines.

With a large installation such as in the *Britannic*, the machinery is naturally divided up into compartments, that aft being for the propelling engines, their auxiliaries and a number



Deck and Hold Arrangement.

of ship's pumps. Forward, and separated from the main engine-room by the boiler room and settling tanks is the auxiliary machinery space in which are fitted the four compressors coupled to Diesel engines and supplying compressed air for the propelling plant, as well as the Diesel-driven dynamos, their auxiliary pumps and certain other machinery.

In the main engine-room, which is so situated as to allow the exhaust pipes to be taken almost vertically up to the aft funnel, the great beam of the ship allows a distinct sense of spaciousness, not only between the two propelling engines, but also in the wings where the auxiliary machinery is located. There are no pumps or other auxiliaries between the engines—only a telephone booth—and the control stations for both are in the centre.

The two Harland-B. and W. four-stroke double-acting engines are practically identical in general design to similar machinery fitted in about a dozen of the largest motor liners, including the *Asturias*, *Alcantara*, *Carnarvon Castle*, *Kungsholm*, *Gripsholm* and the *Chichibu Maru*, but in order to render the description of the *Britannic* complete, particulars of the construction will be given.

The designed output is 10,000 s.h.p. for each engine, when running at a speed of 102 r.p.m., the mean indicated pressure for normal power being about 6½ atmospheres or slightly over 92 lb. per sq. in. The engines are the first of the type to be built with ten cylinders, and although the cylinder diameter (840 mm. or 33 ins.) is the same as that of the engines in the liners mentioned, the piston stroke is greater than has previously been employed, namely, 1,600 mm. or 63 ins. The stroke in the engines of the *Asturias* and other ships is 1,500 mm., but the piston speed is not above that in some of the other vessels. At 102 r.p.m. it is 1,070 ft. per minute. The main engines drive no auxiliaries, unless their own fuel pumps be considered as such.

The Double-acting Design.

The upper portion of the cylinders is similar to that in the B. and W. single-acting engine with square covers, bolted together in groups of five. In the covers are arranged the inlet, exhaust, starting and fuel valves (four for each cylinder) all actuated from the camshaft through push-rods and horizontal valve levers.

As it is impossible to arrange the necessary valves around the stuffing box through which the piston rod passes at the bottom, a separate combustion chamber is provided which forms the bottom compression space, and it is cast on one side of the cylinder cover. The piston thus has only a negligible clearance at the bottom.

The various valves at the bottom are arranged in this combustion or compression space, the inlet valve being at the top, slightly oblique, and the exhaust valve at the bottom, vertical. The fuel and starting valves are situated on the inclined surface of the combustion chamber. The atomized oil particles and compressed air mixture are delivered between the opening in the compression space and the cylinder, and as there is a considerable distance between the fuel valve and piston rod, the spray does not strike the rod direct.

The stuffing box through which the piston rod passes is a loose chamber in the bottom cover and has ten cast-iron rings similar to those in the piston of a normal Diesel engine, but cut so that they may expand towards the rod. The piston is built up in halves and is cooled by lubricating oil, delivered through a telescopic pipe fitted on the end of the crosshead pin. The oil enters the lower part of the piston, passing thence to the upper portion and being discharged through a channel in the piston rod, out through a pipe, into a slotted stand pipe on the engine column.

There is a common camshaft for the valves at the top and the bottom of the engine, two cams being provided for each valve, the second set being for reversing. The level of the camshaft is about half-way between the top and bottom cylinder covers, and the camshaft is driven by chains in an enclosed casing. For reversing two layshafts are turned, by which means the valve levers are lifted off the cams, after which the camshaft is moved fore and aft to bring the astern cams beneath the rollers. The rollers are then dropped down on to the cams and starting air is admitted to the cylinders through the starting-air valves. The whole operation is effected by a single lever.

For starting and manœuvring there are two control levers (in addition to the reversing lever), but these can, if necessary, be operated together, each controlling one set of five cylinders.

When the levers are pushed inwards to the starting position, compressed air is admitted to the cylinders through the starting-air valves at the top and bottom. After making a few revolutions the levers are pushed further inwards, when the starting-air supply is cut off and fuel is admitted through the fuel valves to the cylinders both at the top and the bottom. Increased speed is obtained by further movement of the levers.

The crankshaft is fully built and has two symmetrical halves, each with five cranks. Only small balance weights are required on cranks Nos. 1, 5, 6 and 10. The webs are elliptical and there is no flywheel apart from a light turning wheel aft, driven by a 25 h.p. turning motor.

Through bolts which extend from the top covers to the bedplate take the stresses due to the combustion loads. These tie bolts are in two parts and are joined by nuts resting on the bottom cylinder cover.

Safety Devices.

An unusually comprehensive system of alarms of the Monitor type has been fitted on the engines, and these are all of the electric type. There is one to port and starboard on the main salt-water circulating system, and the electric horn sounds when the pressure reaches 10 lb. per sq. in. A similar pair of alarms is installed in the auxiliary engine-room for the salt-water circulating system there, whilst there are also one to port and one to starboard for the main propelling machinery lubricating-oil circulating circuit. The horn sounds at from 10-15 lb. per sq. in.

For the piston cooling service there is an electric-flow indicator for each main engine, and similar indicators are supplied for the Diesel engines driving the compressors and for those coupled to the generators, the units being of smaller size for the latter purpose. Immediately the flow ceases or the pressure rises too high, as the case may be, the alarm sounds, and it can be silenced whilst the failure of the flow is receiving attention.

The lubricators for all the main and auxiliary engines are of the T. and K. type.

Cooling-water System.

So far as lubricating oil and fresh-water supplies are concerned, each engine is independent, although suitable cross connections are provided for use in case of necessity. Fresh water is employed for cooling the cylinder covers and jackets, and there is a closed circuit, the water being pumped through the cylinders and thence to a fresh-water cooler (one for each engine) with a surface of 4,000 sq. ft. The cooling water for this plant is supplied by a sea-water pump, and the water it delivers is also used for cooling the exhaust manifold as well as the cylinders of the compressors in the auxiliary engine-room. The fresh water for cooling the engines also circulates around the Diesel engines driving the compressors in each case, and there is a make-up tank for adding fresh water to allow for losses.

Lubricating-oil Circuit.

It has already been mentioned that lubricating oil is utilized, as is normally the case in Harland-B. and W. engines, for cooling the pistons of the propelling engines as well as those of the auxiliary engines. For each main engine there are two tubular lubricating-oil coolers located in the wings, but in cold weather one will be sufficient. In fact, it is unlikely that two will be required at any time during the Atlantic crossing. As the *Britannic* will cruise and, during such times as she is engaged on this service, may operate in tropical climates, the second cooler is essential. Each of the coolers has a surface of 1,400 sq. ft.

The lubricating oil, after passing through the engines, is discharged to the drain tanks below the floor, and it may be recorded that the main engines have no oil pan as such, but the sump is formed by the sides of the bedplates and the hull. The vertical lubricating-oil pumps, of the Drysdale type, are each driven by a 90 h.p. to 100 h.p. Allen motor, and these pumps are so located at the after end of the engine-room (two to port and two to starboard) that the suction is primed, fitting into an arm of the lubricating-oil drain tank. From the drain tanks the oil is passed through the filters and thence to the oil coolers, from which it is delivered to the mains which feed the pistons and the bearings. For purifying this oil there are two Sharples centrifugal machines on each side of the engine-room, one pair for each main engine. These are of the open type and have a capacity up to 300 gallons per hour, being driven independently by 2½ h.p. motors.

Compressed-air Supply.

The compressed air for starting the engines is stored in two cylindrical reservoirs on each side of the main engine-room in the wings, above the auxiliary pump. Each has a capacity of 1,000 cubic ft. and is maintained at the usual pressure of 25 kg. per sq. cm., or approximately 360 lb. per sq. in.

There are, in all, 16 reservoirs for the supply of blast air for injection for the main and auxiliary Diesel engines, located partly in the main engine-room and partly at the after bulkhead in the auxiliary engine-room. Of these, eight, of 550 litres each, are for the propelling engines, four, of 550 litres, are for the Diesel engines driving the compressors, and four, of 150 litres each, for the generator engines.

Auxiliary Pumps for the Main Engines.

There is only one main circulating fresh-water pump for each engine, for the reason that, in the event of its failure, salt water may temporarily be utilized. These pumps are of the Allen vertical spindle single-suction type, delivering 350 tons of water per hour with a total head of 60 ft., the speed range being 650 r.p.m. to 1,300 r.p.m. The driving motor is rigidly connected to the pump shaft and is of 37 b.h.p. It is of the light compound type.

The four main circulating salt-water pumps delivering water around the coolers, to the manifolds and to the cylinders of the compressor engines are similar in design to the fresh-water sets, except that the casing is manufactured of gunmetal instead of cast iron, whilst the delivery is 450 tons of water per hour, against a total head of 70 ft., the speed range being as before. The pumps are 10 ins. in diameter and are driven by 56 h.p. vertical-spindle Allen motors. There are two in each wing.

A certain number of other accessories and pumps are installed in the main propelling machinery compartment, apart from those of which descriptions have been given.

On each side to port and starboard in the wings are three boxes of lubricating-oil filters, of which two are in service and the third can be cleaned at leisure. On the port side at the after end is a Drysdale emergency bilge pump. Also on the port side, aft, are the two Weir single-cylinder direct-acting vertical boiler feed pumps, which serve the four exhaust-gas boilers receiving the gases from the propelling engines. They are each capable of delivering 12,600 lb. of water when running at 13½ double strokes per minute.

On the starboard side room is found for a small workshop, and beyond the auxiliaries already mentioned is a Drysdale bilge pump of the Centrex type, driven by a 26 h.p. motor. Aft, placed centrally, is a 10-ton drain-oil pump, whilst in the shaft tunnels, just on the other side of the bulkhead from the main engine-room, are two small gear-wheel pumps supplying oil for lubricating all the tunnel bearings which are lubricated under pressure. These pumps deliver to an overhead tank.

Engine-room Ventilation.

Ventilation to the engine-room is secured by large trunks through which air is delivered by fans on deck, these trunks having branches at various sections of the engine-room. Fresh air is also supplied to the shaft tunnel and enters the engine-room through the open doors in the bulkhead under a certain pressure. Trunks are extended below the engine-room floor, so that in the event of any vapours entering there they can be discharged into the engine-room and thence out through the skylight at the top.

Over each engine are two Harland and Wolff electric cranes, each capable of lifting 10 tons, and in addition there are two 2-ton pulley blocks.

Heating the Engine-rooms.

For the purpose of heating the engine-rooms, should the temperature become too low at any time during the North Atlantic crossing, numerous heaters are distributed both in the main and auxiliary propelling machinery spaces. They are of the Standard and Pochin type and have a steam coil at the base. Air is drawn in at the bottom by an electric fan, passes over the steam coil and is discharged at the top of the vertical cylindrical tube, with the temperature substantially raised. In the main engine-room there are two close to the forward bulkhead and two more in the wings, one being located at the upper grating. In the auxiliary engine-room there are two, well spaced at the forward end, and one in each wing, at about the centre.

Auxiliary Diesel Machinery.

The main engines do not drive their own compressors, and as the power needed for the supply of the necessary compressed air for starting and injection purposes is considerable, the Diesel-driven compressors fitted in the auxiliary engine-room represent a big installation, probably the largest plant of its type yet provided in a motor ship. There are four of these sets arranged across the width of the vessel in line, and forward of them are the four generator sets on the same centre lines, so that the four cranes overhead may each serve one generator and one compressor unit respectively.

Each of the engines driving the compressors is capable of an output of 850 b.h.p. at 160 r.p.m., and has four cylinders 550 mm. bore with a piston stroke of 1,000 mm. These engines, like those coupled to the generators, are of the trunk-piston type, and all are arranged with enclosed chain drive to the camshafts, their operation being particularly silent.

Two of the compressors are capable of supplying all the compressed air needed for both main engines, but in normal service three will be kept running. Each set consists of a pair of three-stage units, the cylinders being sea-water cooled.

The four Diesel engines driving the dynamos are six-cylinder units, 500 mm. bore with a piston stroke of 750 mm., whilst they are coupled to generators of 500kw. built by Harland and Wolff, the speed in this instance also being 160 r.p.m. The adoption of a relatively low rate of revolutions for both classes of engines may be noted. The grating at the top of these engines is made continuous right across, giving ready accessibility to all moving gear.

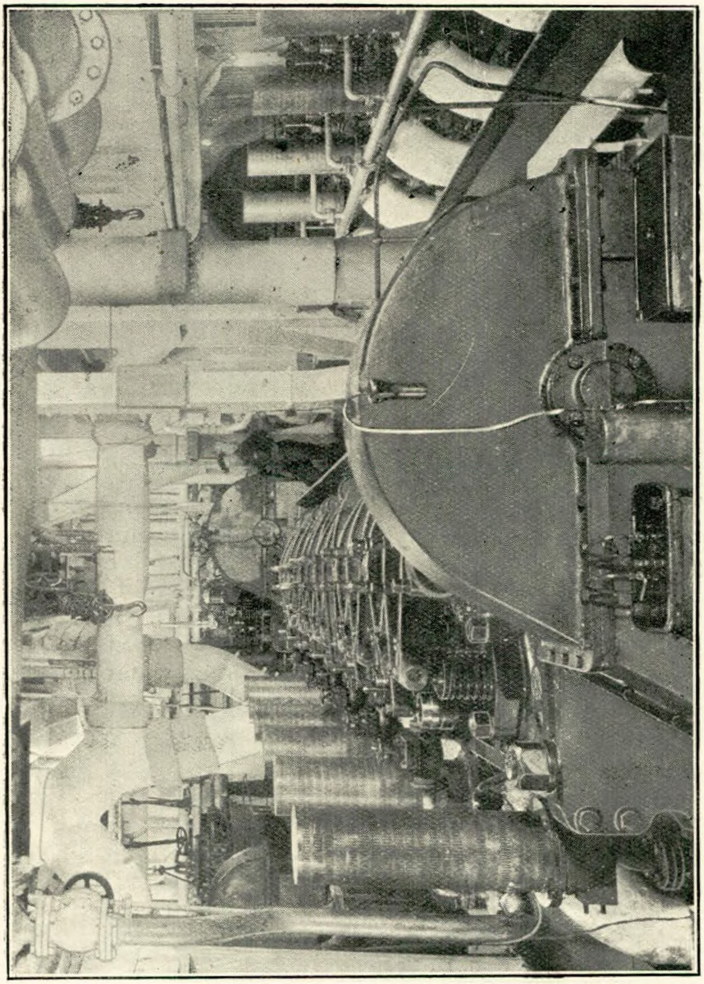
Whilst the cylinders of the Diesel engines driving the generators and compressors are cooled by fresh water, lubricating oil is used for the pistons.

Auxiliary Water and Lubricating Oil Systems.

The circulating water pumps and coolers for the auxiliary Diesel engines are duplicated, one set being on each side. Each of the two fresh-water coolers has a cooling surface of 750 sq. ft. The two fresh-water pumps circulating the cooling water to the cylinders are of the Allen vertical-spindle centrifugal type, with a casing of gunmetal, the shaft being of Staybrite steel. They have 4½-in. branches and deliver 75 tons water per hour, against a total head of 55 ft., with a speed range of 650 r.p.m. to 1,300 r.p.m.

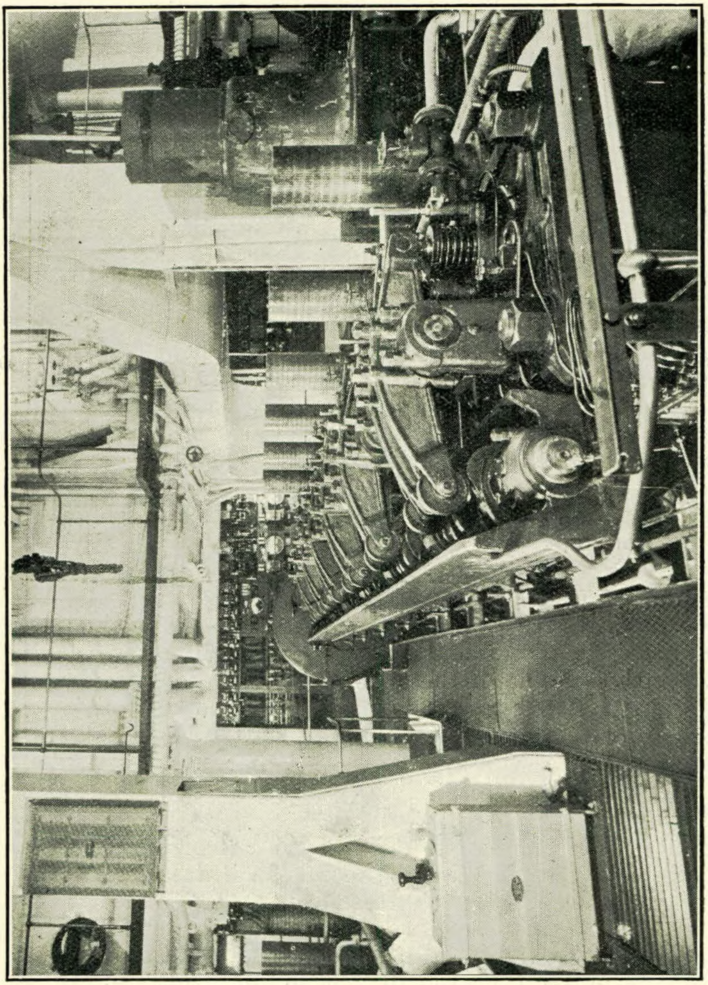
The salt-water pumps circulating water around the coolers have 5-in. branches and deliver 100 tons of water per hour against a head of 60 ft. They are also of the Allen vertical type with a speed range of 650 r.p.m. to 1,300 r.p.m. and each of the two pumps is coupled to a 12½ b.h.p. motor. The electric motors driving the fresh-water pumps are 8¾ b.h.p. and the coolers are at the forward end of the auxiliary engine-room, well to port and starboard respectively.

In the starboard and port wings of the auxiliary engine-room are located the remainder of the auxiliary pumps. Working from forward on the port side, first comes the fresh-water cooler and pump, next the sea-water circulating pump already mentioned. Next is a Drysdale Centrex bilge pump driven by a 26 h.p. motor, this, of course, being of the vertical design and similar to one in the main engine-room.



Looking aft from the switchboard in the auxiliary engine room, showing the top of the generator engine and compressor engine in the background.

Two hot salt-water pumps are located adjacent, these being of the Allen horizontal-spindle single-stage centrifugal type with casings and impellers of bronze. Each pump has 3-in. diameter branches and delivers 25 tons of water per hour against a total head of 150 ft., the speed range being 2,000 r.p.m to 1,600 r.p.m. The pump and motor are mounted on a common bedplate, the motor in each case being of 12 h.p. The control of these pumps is automatic, being effected electrically. The motors are started or stopped according to the



The top of one of the generator engines looking aft towards the switchboard.

amount of salt water in the tank to which it is delivered. Further aft, still on the port side, is a single-cylinder steam-driven Weir feed pump supplying the exhaust-gas boiler receiving the exhausts from the auxiliary engines. There are also a steam-driven emergency compressor, the auxiliary condenser into which the exhaust steam from all the auxiliaries drains (this has a surface of 800 sq. ft.), and a combined air and circulating pump, electrically driven, for the auxiliary condenser. Finally come the North-Eastern feed-tank filter for the auxiliary condenser drains and a Weir evaporator, installed to comply with Board of Trade regulations. This is capable of evaporating 3,000 gallons per day of 24 hours, supplied with direct boiler steam. It is fitted with automatic feed regulator and is furnished with the usual mountings.

On the starboard side, aft of the fresh-water pump and cooler and salt-water pump (duplicates of those in the port wing), are two small fuel-oil pumps of the gear type, one dealing with purified and the other with unpurified oil (each driven by a 4 h.p. motor), together with a third similar auxiliary lubricating oil drain pump. Aft of these is a Drysdale upright ballast pump similar to that installed in the main engine-room coupled to a 34 h.p. Allen motor. Adjacent is a Drysdale upright refrigerating circulating pump and two sanitary pumps of the horizontal type driven by 45 h.p. electric motors. Nearly aft in the auxiliary engine-room on the starboard side are a couple of fresh-water pumps for ship's use, these being each of 20 tons. Close to the bulkhead is a Turn-over plant for fresh-water purification, which is described and illustrated later. On the starboard side of the auxiliary engine-room is a Kent oil-fuel meter and there are two large purified fuel oil tanks. In the centre of the engine-room between the generator and compressor units are three of the large air reservoirs.

Boiler-room.

The boiler-room is entered through a door in the after bulkhead of the auxiliary engine-room. In it are two single-ended Scotch boilers with the necessary auxiliaries. They are 10 ft. 6. ins. in diameter and 9 ft. 6 ins. long, having two furnaces 2 ft. 10 ins. in diameter. They are constructed for a working pressure of 150 lb. per sq. in., and are designed to burn oil under natural draught conditions on the Todd system. The oil-burning plant consists of a Duplex pumping, heating and filtering unit. Two Weir feed pumps with single cylinders of the direct-acting vertical type are installed in this compartment. Each is capable of delivering 10,000 lb. of water per hour when running at 13½ double strokes per minute.

Exhaust Arrangements.

Each propelling engine is arranged so that the two exhaust manifolds for the upper and lower parts of the cylinders unite into one pipe, which is led vertically upwards, thence branching out into two sections.

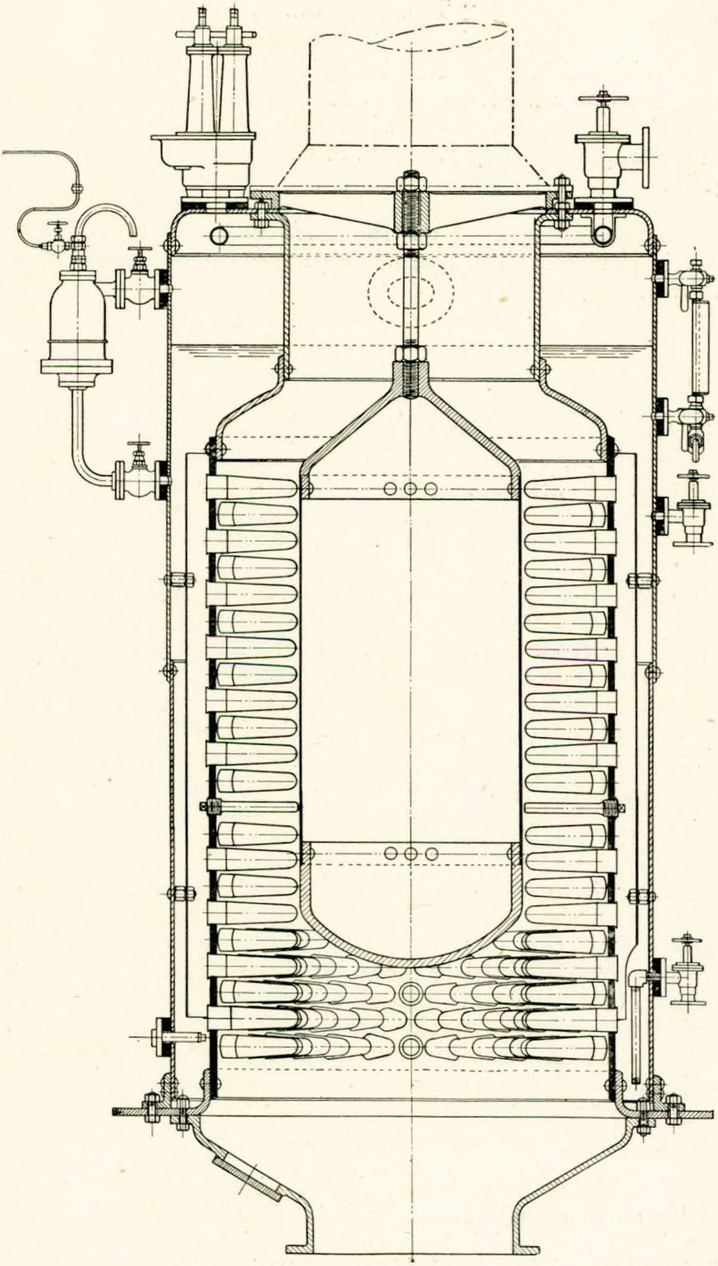
One section leads to a pair of exhaust-gas boilers and the other direct to the uptake in the funnels, so that the gases may either pass through the exhaust-gas boiler or not as desired, and the volume of the gases so by-passed can be varied.

The exhaust gas change-over valves can be actuated from handles close to the starting platform, where, as already mentioned, are also arranged the boiler steam-pressure gauges and the distance-water level gauges.

There are thus four main exhaust-gas boilers to deal with the exhaust gases from the main propelling engines. They are designed to provide the maximum amount of steam that is recoverable without increasing the back pressure, and they serve also as silencers. They are of the Clarkson type and each has a heating surface of 500 sq. ft. They generate steam at 100 lb. per sq. in. working pressure, and each boiler is 5 ft. 3ins. in diameter with a height of 11ft. 2ins. They actually occupy less space than ordinary silencers.

There is a fifth boiler installed to deal with the exhaust gases from the Diesel generators, but not from the Diesel engines driving the compressors. It may be estimated that approximately 10,000 lb. of steam per hour can be generated when required from the exhaust gases, representing a very considerable economy in fuel when the vessel is under way.

It is claimed that the chief advantage of this type of exhaust-gas boiler is that there is a scrubbing action of the thimble tubes on the exhaust gases, which are made to impinge more or less at right angles to the heating surface of the thimble: secondly, the rapid cooling of the gases reduces their volume and decreases their pressure, whilst the percussive action set up by the generation of steam in the thimbles has the effect of driving out the scale. This is the first time that exhaust-gas boilers have been used so extensively, and, in fact, so far as we are aware, the *Britannic* is the first ship engaged on the transatlantic service to be so equipped.



One of the Clarkson exhaust gas boilers.

All the auxiliary generator engines have their exhausts led to the auxiliary waste-heat boiler. Normally there will be three in service at sea, and these will supply sufficient exhaust gases to raise approximately 1,800 lb. of steam per hour at 100 lb. per sq. in.

The Diesel oil used on the *Britannic* is supplied by the Asiatic Petroleum Co. and has an approximate specification as follows:—

Flashpoint above 150° F.
Viscosity Red. 1 at 100° F., 50 secs.
Calorific value 19,200 B.T.U.s per lb.

Three separate oils are used for lubrication. For the cylinders Dick's Ilo S.R. cylinder oil is employed, and for the crankcases Ilo Diesel oil (heavy), whilst for the compressors Ilo compressor oil is utilized.

Heat and Sound Insulation.

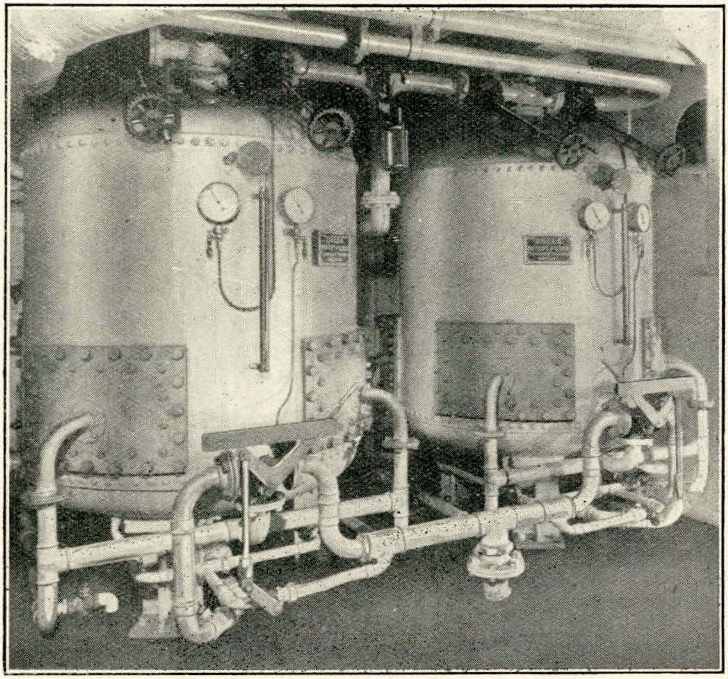
Reference may be made to the means employed for deadening sound and for heat and sound insulation generally, which has been carried out on a large scale by Messrs. Thomas Anderson. The heat insulation is laid around the galleys, pantries and bakehouse, the main and auxiliary and boiler rooms, casing sides and undersides, the hot and cold salt and fresh-water pipes, tanks and flanges, the exhaust pipes of the main and auxiliary Diesel engines as well as flanges in the silencers, the waste-heat boilers, steam reservoirs, fuel tanks, main boilers and boiler funnel.

The casings of the engine-room and the undersides of the deck have been insulated on the internal surfaces to prevent both the passage of heat and sound, but on the external sides they are insulated solely for sound deadening. So far as we can gather, this represents a more complete system for the prevention of the sound of machinery reaching the passenger accomodation than has been previously carried out on any motor ship, and we understand it has been designed and perfected after experiments were made with a view to determining the best means to employ for the purpose.

Throughout the vessel all the hot-air trunks are covered with Delta cork manufactured by John Davies Insulating Co., excluding those which lead to the engine-room. This cork is finished off with a special layer of "Pipco" composition.

Water Purification.

In the description of the auxiliary engine-room, it was stated that the water filters were installed in this compartment. They are of the Uneek sand-filter type of the Turn-Over Filter Co., an illustration being seen on this page. The filters are worked until the filtering media become partly clogged and the water pressure required to force the water through the bed rises to the limited figure, the average rise being about 10 ft. to 20 ft. water pressure. When this is reached, the bed is cleaned by a reverse flow, the cleansing action being to scour every particle of the bed from top to bottom, by forcing it through the sand tube from the bottom to the top of the filter, where the sand falls by gravity into its place and the dirty water flows to waste.



Fresh-water filters.

The necessary coagulant and sterilizing agents are added to the water before it passes through the filter. The chemical action is a copy of the natural method of purification, when polluted water drains through the ground and collects in a pure well supply.

For fire extinguishing throughout the ship Foamite apparatus is used in the passenger accomodation, also in the machinery spaces and boiler-room.

Steering Gear.

The steering gear is on the Hastie electro-hydraulic principle, the main part of the gear being manufactured by Harland and Wolff, but the Hele-Shaw pumps were built and supplied by Hastie. There are four rams working on a double-ended tiller, in accordance with the usual design.

The pumps are two in number and each is capable of steering the vessel at full speed. The gear is arranged so that both pumps run together or separate, and either unit may be instantaneously started up from the engine-room. The two Scott motors are rated each at 100 b.h.p. at 500 r.p.m. The gear is controlled by a telemotor of MacTaggart-Scott manufacture. The steering gear house is exceptionally spacious.

* * *

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 13th July, 1930:—

NAME.	GRADE.	PORT OF EXAMINATION.
Moore, Clarence K.	1.C.	London
Bradford, Douglas V.	2.C.	,,
Howard, Eric W.	2.C.	,,
Norris, James H.	2.C.	,,
James, John F.	Ex.1.C.	Liverpool
Hughes Goold, Thomas	1.C.	,,
McConnell, Joseph P. A. ...	1.C.	,,
Piercy, Walter	1.C.	,,
Burnett, Ernest	2.C.	,,
Christian, Frederick	2.C.	,,
Foster, John	2.C.	,,
Lear, Balfour	2.C.	,,
Rankine, Thomas N.	2.C.	,,
Currie, Henry P.	1.C.M.	,,
Croll, John F.	2.C.M.	,,
Wall, Charles E.	1.C.E.	,,
Bolton, Stanley	2.C.	Newcastle
Lawrie, Charles	2.C.M.	,,
Pearson, Arthur J.	1.C.M.E.	,,

For week ended 13th July, 1930—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Alderson, Thomas H.	1.C.	Sunderland
Emerson, Frederick	1.C.	,,
Wardropper, Stephen	1.C.	,,
Bowden, Albert E.	2.C.	,,
Chesney, Robert H.	2.C.	,,
Lumsden, Harry	2.C.	,,
Steel, Philip	2.C.	,,
Harrison, George W.	1.C.	,,
Burnett, William	2.C.M.	,,
Munro, Edward	1.C.	Glasgow
Colthart, Malcolm	2.C.	,,
Kerr, Robert	2.C.	,,
Ross, William	2.C.	,,
Hodgson, Alexander D.	1.C.M	,,
Ablett, William	1.C.M.E.	,,

For week ended 19th July, 1930:—

McKenzie, Kenneth	1.C.	Newcastle
Carr, Wilfrid A.	2.C.	,,
Ferguson, Angus	2.C.	,,
Pilling, William G.	2.C.	,,
Whincop, Charles A.	2.C.	,,
Coulson, Norman	1.C.M.E	,,
Burfitt, Robert	2.C.	Cardiff
Webb, William J.	2.C.	,,
Williams, Ralph F.	2.C.M.	,,
Adamson, James	1.C.	Glasgow
Ligertwood, James	1.C.	,,
Steel, James L.	1.C.	,,
Cook, Robert S.	2.C.	,,
Gillespie, David	2.C.	,,
Glass, George C.	2.C.	,,
Warnock, Thomas W.	2.C.	,,
Dinwoodie, David	1.C.M.	,,
Gash, William H.	1.C.	Hull
Roberts, Frederick E.	1.C.	,,
Soanes, Ernest G.	1.C.	,,
Adamson, Alfred A.	2.C.	,,
Beighton, Eric H.	2.C.	,,
Ellerby, Harry	2.C.	,,
Lockey, Bernard A.	2.C.	,,
Wilson, Albert M.	2.C.	,,
Allan, Charles	1.C.	Liverpool
Gilliland, John	1.C.	,,
Roberts, John D.	1.C.	,,
Smith, Francis B.	1.C.	,,
Fulton, William G.	2.C.	,,
Manifold, Norman W.	2.C.	,,
Todd, Arthur N.	2.C.	,,
Varty, Joseph	2.C.	,,
Heughan, Robert D.	2.C.M.	,,
Bell, Moray W.	1.C.	Leith
Cowper, John	2.C.	,,
Johnson, Thomas F.	2.C.	,,
Mitchell, John	2.C.	,,
Nisbet, Thomas S. D.	2.C.	,,
Walker, John Law	2.C.	,,
Mortimer, John D.	1.C.M.	,,

For week ended 19th July, 1930—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Green, George W.	2.C.	London
Haines, Charles H.	2.C.	,,
Laws, Herbert M.	1.C.M.	,,
Hough, Edward B.	2.C.M.	,,
Collins, Henry G.	2.C	Southampton
King, Thomas	2.C.	,,
Mauger, Reginald L.	2.C.	,,
McBride, John F. A.	2.C.	,,
Campbell, Finlay	1.C.M.E.	Leith
Love, Frederick E.	1.C.M.E	Liverpool
Morrow, Samuel H.	1 C.M.E.	London
Park, Edward T.	1.C.E.	,,
Fallows, William E.	1.C.M.E.	Newcastle

For week ended 26th July, 1930 :—

Brooks, Reginald C.	1.C.	London
Preece, Eric C.	1.C.	,,
Wilcox, William	1.C.	,,
Gillies, Alexander F.	1.C.M	,,
Hoyland, Thomas A.	1.C.M.	,,
Low, William R.	1.C.	Sunderland
Parkin, Fred	1.C.	,,
Baxter, Robert	1.C.	,,
Jones, Wilfred J.	2.C.	,,
Pyne, John M. M.	2.C.	,,
Young, James T.	2.C.	,,
Young, Wilfred	2.C.	,,
Sanderson, Emmerson R.	1.C.M.	,,
Crouch, George	2.C.M.	,,
Emmerson, E.	2.C.M.	,,
Rawlings, Robert	2.C.M.	,,
Arthur, Hugh M.	2.C.	Newcastle
Boast, Charles	2.C.	,,
Boys, William	2.C.	,,
Paxton, Stanley	2.C.	,,
Ramsay, Reginald	2.C.	,,
Robinson, Thomas L.	2.C.	,,
Davidson, James S.	1.C.M.	,,
Crosby, Frederick	2.C.M.	,,
Joynson, William J.	1.C.	Liverpool
Serjeant, William N.	1.C.	,,
Wetherell, Frederick W.	1.C.	,,
Burrows, John K.	2.C.	,,
Haggitt, Walter	2.C.	,,
Jones, David R.	2.C.	,,
McColm, William	1.C.	Glasgow
Robertson, Charles G.	2.C.	,,
Ross, William	2.C.	,,
Richardson, Frank E.	1.C.M.E.	Liverpool
McAuslan, Duncan F.	1.C.M.E.	Glasgow
Barker, William R.	1.C.M.E.	Sunderland
Archibald, William	1.C.M.E.	London
Norris, James H.	2.C.M.E.	,,

For week ended 2nd August, 1930:—

Bowman, George	1.C.	Liverpool
Fletcher, John	1.C.	,,

For week ended 2nd August, 1930—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Carrity, John F.	1.C.	Liverpool
Ormerod, Thomas	1.C.	,,
Richardson, George E.	1.C.	,,
Scragg, Godfrey B.	1.C.	,,
Smith, Frank	1.C.	,,
Tipper, Archibald N.	1.C.	,,
Toole, Robert H.	1.C.	,,
Ferguson, Alan S.	2.C.	,,
Marsh, Thomas E.	2.C.	,,
Nicholls, Leslie R. P.	2.C.	,,
Singleton, Joseph L.	2.C.	,,
Tod, Donald S.	2.C.	,,
Wood, William C.	1.C.M.	,,
Hewitt, Joseph	2.C.M.	,,
Fraser, William B.	1.C.	Glasgow
Thomson, John	1.C.	,,
McAllister, George	2.C.	,,
Prentice, William	1.C.M.	,,
Hopwood, Joseph H.	1.C.	Cardiff
Jenkin, Reginad T.	1.C.	,,
Winspear, Benjamin	1.C.	,,
Brown, Cecil E.	2.C.	,,
Hancooke, Herbert E.	2.C.	,,
Knight, Ervistus	2.C.	,,
McNinch, Herbert	1.C.	Belfast
Chisholm, Alan D.	2.C.	,,
Higginson, John F.	2.C.	,,
Brown, James E. E.	1.C.	Leith
Donald, Alastair K.	1.C.	,,
McDonald, George	1.C.	,,
Roy, William	1.C.	,,
Bowman, James N.	2.C.	,,
Dewar, Leonard S.	2.C.	,,
Duncan, William D. B.	1.C.	London
Hoadley, Percy J.	1.C.	,,
Rickard, Leonard	1.C.	,,
Bevan, George G.	2.C.	,,
Hill, George F. R.	2.C.	,,
Marshall, William	1.C.	Newcastle
Curry, Thomas	1.C.	,,
Craig, Thomas H.	1.C.	,,
Shacklock, Thomas H.	2.C.	,,
Smith, Robert C.	2.C.	,,
Laws, Alfred E.	2.C.	,,
Houston, John H. S.	1.C.M.	,,
Clinton, William H.	2.C.	Southampton
Hunt, Charles H.	2.C.	,,
Verge, Albert W. F.	2.C.	,,
Simpson, Arthur F.	1.C.M.E.	Liverpool
McLaren, Thomas	1.C.M.E.	Glasgow
Henderson, Frederick M.	2.C.M.E.	Cardiff
Roake, Alan E.	1.C.M.E	London
Bulman, Joseph M.	2.C.M.E.	Newcastle
Hardy, Benjamin	1.C.M.E.	,,
Hagan, William S.	1.C.M.E.	Southampton
Smith, Norman	1.C M.E.	,,

British Standard Specification No. 385-1930 for Pure Aluminium Tubes for General Engineering Purposes.

British Standard Specification No. 386-1930 for Pure Aluminium Bars and Sections for General Engineering Purposes (excluding Wire Bars). Published for the Association by Crosby Lockwood and Sons, 8, Stationers' Hall Court, E.C.4., July, 1930. Price 2/- net, post free 2/2.

"The Theory of Heat Engines," by Wm. Inchley. London: Longmans, Green and Co. 5½in. x 8¾in. x 1¼in. 500 pp. Price 12/6 net.

"Inchley" needs no introduction to the marine engineering student. It is one of the best-known, most widely used and least expensive works on the theory of heat engines. It is essentially a student's book, having been prepared for University engineering students and those reading for the examinations of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Board of Education, etc.; at the same time there is much in the book that is valuable to the sea-going engineer in these days of certificate examinations of high standard. Not the least valuable feature of the book is the number of excellent worked-out examples which it contains.

Commencing with a very clear chapter on thermodynamics and the properties of gases the author goes on to consider Carnot's cycle and the properties of steam (relation between p, v and t, measurement of the dryness fraction entropy, the Mollier diagram, etc.). In his system on the theory of the steam engine, wire-drawing, clearance cushioning, initial condensation, expansion ratios, effects of steam jacketing and superheating are all discussed. The whole chapter is naturally devoted to compound expansion, which applies also to the subject of mechanical refrigeration. Very properly the flow of steam through orifices and nozzles is dealt with before the theory of the steam turbine is examined, but it is rather to be regretted that the former chapter is now out of date. The chapter on heat transmission is quite good, but in view of the fact that the oil engine is now such an important prime mover, the section might have been improved by some consideration of heat transmission through the walls of pistons, cylinder liners and cylinder covers of Diesel and similar engines. The section on the theory of the oil engine is somewhat sketchy and could, with advantage, be considerably amplified in a next edition. The chapter on valve diagrams and valve gears will appeal to seagoing engineers, while the exposition of engine balancing is clear and useful so far as it goes.

The author was unfortunately killed in the Great War, but the revision of the book has been well carried out by Dr. Arthur Morley. While the work could, undoubtedly, be improved in certain respects, it is probable that the all-important matter of cost has been carefully considered in view of the fact that it is primarily a book for young students.

"Definitions and Formulae for Students (Marine Engineering)," by E. Wood, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. 4¼ in. x 5¼ in. 28pp. Price 6d. net.

This is another of the excellent little manuals published by Sir Isaac Pitman and Sons, Ltd. It is a handy little reference book and can confidently be recommended to the junior engineer.

G.R.H.