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The Abstracts from the Technical Press this month have been extended to occupy the space usually devoted to the President's Address, which on this occasion has been unavoidably postponed till December owing to Sir Robert Dixon's absence in Australia.

A NEW HARWICH-HOOK STEAMER. "The Engineer," 19th July, 1929.

At the beginning of this week the new cross-Channel steamer *Vienna*, recently constructed by John Brown and Co., Ltd., of Clydebank, Glasgow, for the Harwich-Hook of Holland service of the London and North-Eastern Railway, made her maiden voyage. The new steamer is one of three new vessels for this route, and the other steamers, the *Amsterdam* and *Prague*, will be commissioned early next year. In regard to size, the *Vienna* is considerably larger than the previous steamers employed on the Harwich-Hook service, and she is reported to be one of the largest and most luxurious cross-Channel steamers in the British Isles. Her overall length is 366 ft., with a beam of 50 ft., and a depth to shelter deck of 27 ft. She has a loaded draught of 15 ft. 3 ins., and a gross tonnage of 4,218. The propelling machinery comprises a twin-screw arrangement of Brown-Curtis compound turbines, driving the propeller through single reduction gearing. The designed shaft horse-power is about 9,681, and the sea speed under normal conditions will be 21 knots. The boilers are of the single-ended cylindrical type, working under forced draught with coal firing, and are designed for a working pressure of 215 lb. per square inch. There are three turbo-generator sets, which supply current for lighting and power services. All the deck auxiliary machinery and most of the engine-room auxiliary machinery is electrically operated, and we understand that special attention has been given to the silent working of all the machinery. Sleeping accommodation for 450 first-class and 104 second-class passengers has been provided, along with several large public rooms, and a restaurant. Special facilities for the carriage of cargo and mails are provided, and the total stowage capacity for this purpose is over 40,000 cubic feet. The navigation and safety equipment includes all the latest devices for the safety of the ship and includes submarine signalling and "Echo" sounding machines.

NAVIGATION IN FOG. "The Engineer," 19th July, 1929.

An invention which, it is claimed, will prove of considerable value for the navigation of ships in fog has recently been tested on the Great Western Railway Company's cross-Channel steamer *St. Julien*, operating on the company's service between Weymouth and the Channel Islands. The trials have taken place over a period of three weeks, and they ended on Monday last, July 15th. The device, which has been invented by a Birmingham engineer, is styled the H.J.B. fog navigating compass and sound indicating unit. It picks up by means of an instrument, rather similar to a wireless receiving set, all sounds within a considerable area, indicating both the position and nature of the different signals. The instrument is said to be remarkably sensitive, and sounds which are quite inaudible to the ear are stated to be readily picked up and recorded. The value of such a device for the navigation of a ship in fog may be readily imagined; and if the recent tests establish the claims made for the new device there is every possibility of its soon becoming as definite a part of a steamer's navigating equipment as the compass. Other applications of the same instrument include aerial navigation, the location of distant gunfire, and the recording of the approach of aircraft, while, in a modified form, the device may be used for depth sounding and the fixing of the position of submerged objects.

During the trials recently carried out on the *St. Julien*, the inventor was assisted by other engineers and members of the ship's wireless staff.

PROPOSED NEW ATLANTIC LINERS. "The Engineer," 19th July, 1929.

According to Mr Sheedy, the Vice-President and general manager of the United States Lines, it has now been decided that the company will early in 1930 place orders for the construction of two superliners for Atlantic service. The price of each ship has been mentioned as five million pounds, but that price would seem to take into account the high building cost at present ruling in United States shipyards. It is stated that the length of the new ships will be about 956 ft., and that they will be designed to carry 4,000 passengers. The projected displacement has been given as about 56,000 tons, and the means of propulsion to be adopted is stated to be either quadruple screw turbo-electric or geared turbine drive. No indication of the power to be developed has been given, but it is stated that the proposed ships will be the fastest afloat. In Italy new construction of large liners for the North and South Atlantic services is to be begun. Two ships, each of over 40,000 tons, are to be built as soon as possible in Italian yards, to the orders of the Lloyd Sabaudo Company and the Navigazione Generale Italiana. The new liner for the last named company is to be built in one of the Ligurian shipyards, and will be named the *Guglielmo Marconi*, while the Lloyd Sabaudo ship will take the name of the *Conte Azurro*, and will be built by the Stabilimento Tecnico Triestino Company. The length of the new liner is to be over 800 ft., with a gross tonnage of 42,000 to 45,000, and a designed speed of 27 to 28 knots, with a service speed of 25 knots. Meanwhile on Tuesday evening last, the 16th inst., the new North German Lloyd liner, *Bremen*, left Bremerhaven on her maiden voyage for New York. In the course of her trials the *Bremen* is reported to have attained a speed of over 28 knots, but her owners state that they have no intention of attempting to beat records on the first voyage.

THE WORLD'S SHIPBUILDING AND MARINE ENGINEERING. "Engineering," 19th July, 1929.

The quarterly shipbuilding returns of Lloyd's Register, now available for the period ending June 30th, 1929, give some figures which, without undue optimism, may be taken to indicate that Great Britain and Ireland are regaining, to some extent, their pre-eminence as the World's shipbuilding countries. Thus the tonnage of the merchant shipping under construction in Great Britain and Ireland is 1,453,906, while the tonnage under construction abroad is 1,384,319. On the face of it this may seen only to mean that, of the total tonnage, viz., 2,838,225, the percentage building in Great Britain and Ireland is 51·2, while that building abroad is 48·8. The corresponding average percentages in the last twelve months before the war were 57·2 and 42·8 respectively. But there is a more encouraging fact in the subsidiary set of figures, which shows that there is an increase of 96,531 tons in the work in hand in Great Britain and Ireland compared with the figures for the quarter ending March 31st, 1929, there being a decrease of 96,118 tons in the work under construction abroad compared with those of the same quarter. Of the figure of 1,453,906 tons quoted above, it is interesting to note that 66,000 tons are intended for the British Dominions, and that about 208,000 tons are for sale or for foreign shipowners. Compared with last year, the tonnage now building exceeds by 251,296 tons that building twelve months ago. Of the foreign tonnage under construction, Germany heads the list with 80 vessels totalling 272,444 tons. Japan and Holland, with 22 vessels, 179,968 tons, and 39 vessels, 172,406 tons, respectively, make a good show for their size, being next on the list. France is building 21 vessels with a total tonnage of 139,316, and then comes Russia with 40 ships and 124,908 tons. The United States shows 27 vessels with a tonnage of 119,098. The remaining countries have all below 100,000 tons. During the quarter under review, 270,597 tons of shipping were commenced abroad and 321,877 tons launched, the latter figure showing an increase of 50 per cent. on the quarter ending March 31st. In Great Britain and Ireland, 428,400 tons were commenced, which is an increase of about 66,000 tons on the March quarter, and 392,888 tons were launched, showing an increase of 103,000 tons. All the tonnage figures quoted above are gross tons, and no account has been taken of vessels of less than 100 tons gross. The increasing adoption of the internal-combustion engine for the propulsion of the larger vessels is strikingly shown by the tonnage figures relating to motorships. Of the total tonnage under construction, motorships account for 40·6 per cent. Of these motorships there are 59 of 8,000 tons and upwards, while there are only 27 steamships of such size under construction. These figures include 14 motorships and seven steamships, each of 15,000 tons and upwards. This growth in popularity of the internal-combustion engine is partially reflected in the horse-power figures of the marine engines under construction throughout the world. The word "partially" is used, as there are no figures available for the shaft horse-power of the marine turbines building in Germany. Excluding these, the totals are: steam engines, 1,000,971 H.P., and oil engines 1,250,963 H.P. Perhaps a truer ratio, however, is given by the figures for Great Britain and Ireland alone. Reciprocating steam engines are now under construction totalling 360,216 I.H.P. and steam turbines totalling 250,760 shaft horse-power, the combined total being 610,976 horsepower as against the 381,046 I.H.P. of the internal-combustion engines. On the other hand, steam engines are in a marked minority in most foreign countries. It is satisfactory to note that such an essentially British institution as Lloyd's Registry is surveying no less than 62·6 per cent. of the tonnage now building throughout the world.

THOMAS NEWCOMEN: FATHER OF THE STEAM ENGINE, 1663-1729.
By H. W. Dickinson. "The Engineer," 26th July, 1929.

Thomas Newcomen, the bicentenary of whose death we commemorate this year, was not only a worthy of Devon, but a great Englishman. He may be claimed justly as one of the World's greatest inventors for he gave us the reciprocating steam engine from which at the hands of a great company of inventors and engineers, we trace in unbroken succession the development of the engine of to-day.

Too long have his merits, like the man himself, been obscured by the brilliant inventions of his successors, to mention only the great James Watt. This is not to be wondered at, because about both Newcomen and his invention we have only the scantiest knowledge.

We need only say that for upwards of half a century after its invention, Newcomen's engine was the only powerful and economical agent for draining mines. Without its aid the great industrial developments of the eighteenth century, which opened out a new era of material progress for the world at large, would have been, to say the least, greatly retarded.

Among those who know about Newcomen, it was considered fitting that recognition, tardy but sincere, should be paid to his memory on the occasion of the bicentenary of his death, and to this end, the Devonshire Association, looking at him as a man of Devon, and the Newcomen Society, looking at him as a great engineer, have combined forces in a joint meeting to do him honour.

Ancestry and Education.—If we judge by the surname, we conclude that in the thirteenth century when such names were beginning to be used, the original bearer of it was a stranger newly arrived—" comen " or " cumen " is the Middle English past participle of the verb " to come." The family is found in county Lincoln in 1273, and the main branch appears to have been settled at Salfleetby in that county. A certain Elias Newcomen of that family, educated at Cambridge, master of a Grammar School in London, was the first who came to reside in Devon. He was presented to the living of Stoke Fleming in 1600, and held it till his death in 1614. His great-grandson, the inventor, was born in Dartmouth in 1663, and was baptised on February 28th in St. Saviour's Church. The baptismal register, it is hoped, will be on view during the commemoration. He was apprenticed to an ironmonger at Exeter, and subsequently set up in that business in his native town, in Lower-street, in a house that was pulled down in 1860. He married, in 1705, Hannah Waymouth, by whom he had two sons and a daughter.

We are in complete ignorance as to the education or attainments of Newcomen, and we can only suppose that his schooling was of the character then obtainable by those in the middle rank of society. But he must have been a man of high mental calibre, for how else should he have turned his attention to such an abstruse practical problem as the utilisation of the energy released by burning solid fuel?

Birth of the Steam Engine.—We learn from Marten Triewald, a contemporary who knew Newcomen, that the latter's attention was directed to the need for a better means of raising water, when visiting the tin mines in the course of business as a dealer in mining tools, from the consideration of the heavy cost of horse gins. But it is a long mental process from this to the knowledge that water can be boiled in a vessel over a fire and from this to the discovery that the steam given off can be utilised as a means of doing mechanical work.

It is true that the problem of how to raise water, as the mines increased in depth, was very much " in the air " at the time, because the need was so pressing and many acute minds were being directed to its solution. Among them we need only mention Thomas Savery, who in 1698 invented and patented an apparatus for " the raising of water and occasioning motion to all sort of mill works by the impellent force of fire." Savery's engine was a suction and forcing apparatus, of which the pulsometer is the modern exemplar, requiring a pressure of steam proportionate to the height of lift. Newcomen's idea was fundamentally different in that he condensed steam under his piston and by a giant pump handle worked the pump rods, thus requiring steam of atmospheric pressure only for the highest lift. It is for this reason that the engine is frequently referred to to-day as the atmospheric engine.

We are informed by Switzer, who like Triewald, was a contemporary of Newcomen and knew him personally, that "Mr. Newcomen was as early in his invention as Savery was in his," which places the invention prior to 1698. Triewald says that Newcomen worked on his "fire engine"—for so it was termed at the time—for ten consecutive years before he achieved success. How much we should like to know the stages through which it passed, just as we know about Watt's invention of the separate condenser engine which, by a curious parallel, was almost exactly the same length of time in the development stage.

Now supposing Newcomen to have been a man of wide reading and to have been in touch with the scientific men of the day, what could he have known? There was the discovery by Evangelista Torricelli, in 1643, that the atmosphere had weight. There was the vacuum experiments of Otto von Guericke, of Magdeburg, the account of which was published in 1672. There was the idea of Denis Papin in 1690, of using a cylinder and piston under which a vacuum was produced by the slow cooling of the steam; there was the brewer's copper and its setting for boiling worts; the pump handle and the pump barrel was an every-day domestic appliance, and some considerable progress in pump practice on the large scale with horse gins had been effected by the labours of Sir Samuel Morland and others.

But what are we to say of the great intellect that, availing itself only of the existing craftsmen, constructional materials and simple tools, could weld these elements into a machine and endow it with a means—the valve gear—that enabled it to repeat its motion at reasonably quick intervals for an indefinite number of times? With the exception of the clock, the world had never before seen the like of this automatic motion! Again have we anything but admiration for the way in which Newcomen got over what could not have been otherwise than an unforeseen difficulty—the accumulation in the cylinder of air released from solution in the feed and injection water by boiling—a difficulty known as "wind-logging"?

As to the injection of cold water into the cylinder, Triewald says that this was found out by accident, owing to a defect in the cylinder allowing water to get inside. We infer that Newcomen had previously condensed by pouring water over the outside of the cylinder in a similar way to what Savery did. Triewald quaintly attributes this discovery to the intervention of Almighty God, for he found it "impossible to believe otherwise than that which happened was caused by a special act of Providence."

Whatever reliance we place on the foregoing surmises and pleasing stories, we are on safe ground in saying that in 1711 Newcomen had brought his invention to sufficient perfection for him to be able to offer to erect an engine. The proposal fell through, but we have Triewald's evidence that the first engine erected was in the county of Stafford, as evidenced by the now well-known engraving, dated 1719, of "The Steam Engine near Dudley Castle. Invented by Capt. Savery and Mr. Newcomen. Erected by ye later 1712."

The coupling of the names of Savery and Newcomen on this print is suggestive and lends colour to the statement of Switzer that Savery, by being nearer to the Court, got his patent before Newcomen knew of it, and the latter was consequently glad to come in as a partner to it. It might be asked why should not Newcomen still have applied for a patent—indeed, it is frequently stated, erroneously, that he did so and that one was granted—but a little consideration will show that the claim of Savery was so wide that it covered any and every method of raising water by fire. It should be stated here that in 1698 by Act of Parliament Savery got his patent, which was for the usual period of fourteen years, extended for a further twenty-one years, so that it did not expire till 1733.

This Dudley Castle print was for fifty years the earliest document known establishing the date and mode of construction of Newcomen's engine, but in 1925 a print which takes us two years further back was discovered at Worcester College, Oxford. The print is inscribed: "H. Beighton delin. 1717"; the engraver's name has been erased. One other copy of this very rare print has since been discovered. On this the self-acting valve gear and the injection in the cylinder are shown. From what we know of Beighton, who was a Fellow of the

Royal Society of London, it is fairly safe to conclude that the engine depicted was that erected by Newcomen at Griff, near Coventry, in the county of Warwick.

There is little doubt that Savery's engine was a failure, at any rate, for the duty for which is was intended, viz., that of draining mines. Its lift was limited by the pressure of steam that could be employed, and in the then state of the arts and with the materials available, this was insufficient for more than, say, 20 ft. to 25 ft., and not reliable at that. It could suck from about 20 ft., so that in draining a mine a series of engines would have to be put in at a distance of about 40 ft. to 45 ft. apart, vertically in the shaft, one delivering into the sump of the next above it. We have no positive knowledge that a Savery engine was used in a mine; we do know that it was used for waterworks where the lift was moderate.

Coming of the Atmospheric Engine.—Savery had many occupations, official and otherwise; indeed, he was the most prolific inventor of his day. We are inclined to believe that he quietly dropped his engine. Newcomen, on the other hand, matured his invention a decade after Savery, and went on quietly ignorant of or ignoring the patent, but after he had erected a few engines the fact would begin to get known, and his success would be talked of. Some clever person, perhaps Savery himself, would see that it was possible to exploit Newcomen's engine under the former's patent. We can imagine how chagrined Newcomen would be when he was brought up against the situation, but he would realise that he had no case. He had the experience, however, so that he had to be brought in; hence Switzer's statement that " Mr. Newcomen was glad to come in as a partner to it." It would appear that this occurred about the time of Savery's death in 1715; indeed, it might have been precipitated by that event, for in 1716 we find Savery's extended patent vested in the hands of a company. We know this by an advertisement in the " London Gazette " for August 11th-14th, 1716, which reads:—

" Whereas the Invention for raising Water by the impellant force of Fire, authorized by Parliament, is lately brought to the greatest Perfection; and all sorts of Mines etc. may be thereby drained, and Water raised to any Height with more Ease and less Charge than by the other Methods hitherto used, as is sufficiently demonstrated by diverse Engines of this invention now at Work in the several Counties of Stafford, Warwick, Cornwall, and Flint. These are therefore to give Notice that if any

Person shall be desirous to treat with the Proprietors for such Engines, Attendance will be given for that Purpose every Wednesday at Sword-Blade Coffee-house in Birchin Lane, London, from 3 to 5 of the clock; and if any Letters be directed thither to be left for Mr. Elliott, the Parties shall receive all fitting Satisfaction and Dispatch."

It will be observed that in his advertisement, engines are mentioned as having been erected in several counties of England. The one in Stafford is no doubt the one near Dudley Castle, while that in Warwick must be the Griff engine, both of which have been already mentioned. The first engine in Cornwall is probably that at Huel Vor—*i.e.*, the Great Work—in the parish of Breage, between Helston and Marazion. The one in Flintshire was most probably that at Hawarden. Whoever drafted the advertisement does not allude to an engine in the county of Cumberland, erected by Newcomen; that there was one near Whitehaven in 1715 is established by reliable evidence.

There is no mention, in fact, of any engine in the North of England, but it was very shortly after that the engine penetrated to the Newcastle coalfield. Triewald states that he was engaged in 1717 by Mr. Nicholas Ridley to assist Samuel Calley in the erection of an engine at a rich coal mine belonging to Mr. Ridley close to Newcastle-on-Tyne. This engagement was due partly to the fact that the inventors were so busy erecting fire engines in other places as to be unable to give skilled attention to it. Then Henry Beighton in 1718 erected an engine at Washington, also near Newcastle. All this goes to show that the engine was rapidly finding favour, and it is interesting to know that Newcomen lived to see his engine employed in Scotland at Edmonstone, 1725; in Hungary at Königsberg, in 1722-24; in France at Passy, near Paris, in 1726; in Sweden at Dannemora, in the same year; at Vienna and at Cassel, but of the latter two we have no certain knowledge.

The increase in the size of cylinders and consequent power was gradual at first. The Dudley Castle engine had a cylinder 21 in. diameter; that at Dannemora was 36 in. After the expiration of the patent in 1733 the number of engines and their size increased rapidly. John Smeaton, in 1769, found that there were or had been 99 engines in existence in the North of England district alone; of these the largest had a cylinder 75 in. diameter. He found that the duty of fifteen engines of different sizes was 5·6 million foot-pounds per bushel of 84 lb.

of coal, and the average effective pressure 6·7 lb., or, roughly, half an atmosphere. The advance in engineering practice in this short time testified by the existence of such large engines is remarkable, but, unfortunately, our knowledge of the period is almost a blank.

Memorials of Newcomen.—It is passing strange that a man like Newcomen, who was engrossed so much in business affairs, should have left behind him practically no documentary records; such is the case, however. The only known letter written by him is in the Prussian State Library, Berlin. Doubt was thrown upon this letter, but the discovery in the Dartmouth archives of two deeds signed by him in 1707, all the signatures of which tally, removes any such doubt. Mr. Thomas L. Lidstone, Diocesan Surveyor, about 1870, made extensive searches to find out something about Newcomen, with hardly any result.

Newcomen died on August 5th, 1729, in London, in the parish of St. Mary Magdalen, and being a Baptist by religious conviction, was buried in Bunhill Fields—the Nonconformist burying ground. The burial is recorded in the Register still preserved, but the exact spot cannot now be identified. He had two sons, Thomas and Elias, besides a daughter, Hannah, who married a Mr. Walcot. Thomas was a serge-maker at Taunton, but Elias assisted his father with the engine business. Newcomen continued to carry on his business at Dartmouth, at least as late as 1717, and probably till his death. This suggests that, like most of our great inventors, he did not find that his invention paved the road to wealth, and he died apparently a poor man. We have neither portrait of him nor description of his appearance; we know nothing about him personally, but we judge him to have been modest and unassuming.

The only memorial to him in existence is that in the Town Gardens. It does seem desirable that some national memorial should be set up to him possibly in London, the heart of the Empire, to whose expansion his engine has contributed so greatly.

PULVERISED FUEL AT SEA. "The Engineer," of 2nd August, 1929.

The past week has been one of note in the history of the development of pulverised fuel for marine use. On Tuesday, July 30th, a party of engineers visited Avonmouth, on the invitation of Captain P. C. Grening, the director for Europe of the United States Shipping Board, in order to inspect the installation of the Todd unit system on the cargo steamer *West Alsek.* It was of interest to learn that an increased speed of $1\frac{1}{2}$ knots had been attained, with a 10 per cent. saving in the fuel used, while the installation readily dealt with Scotch, Welsh and American coals. The visitors who joined the *West Alsek* at Avonmouth crossed over to Cardiff on her, and had an opportunity of seeing the plant under actual sea-going conditions. On Wednesday, the following day, demonstration basin trials were carried out on the cargo steamer *Swiftpool,* equipped with the Brand system of powdered fuel burning. On Thursday, August 1st, special trials were run on the Clyde of the self-trimming collier *Berwindlea,* built by the Blythswood Shipbuilding Co., Ltd., at Scotstoun, for the Berwindmoor Steamship Co., Ltd. This steamer is a notable example of modern coal-carrying practice, and she was engined by David Rowan and Co., Ltd., of Glasgow. Her boilers are fired on the Clarke-Chapman system of pulverised fuel burning, embodying all the latest improvements. Another recent Clyde development is the application of the Yarrow pulverised fuel system on the steamer *Amarapoora,* belonging to P. Henderson and Co., Ltd., of Glasgow, and also to an experimental works boiler designed for a working pressure of 1,200 lb. per square inch.

THE "VESTRIS" INQUIRY.—"The Engineer," of 2nd August, 1929.

Judgment was delivered on Wednesday, July 31st, by the Board of Trade Tribunal, under the presidency of Mr. Butler Aspinall, K.C., Wreck Commissioner appointed to inquire into the loss of the steamer *Vestris,* which sank in November last off the American coast, with a loss of 112 lives. The court found that contributory causes of the disaster including overloading, the tender condition of the ship, leaks from the starboard ash ejector and hatches, water finding its way into the coal, and the non-fitting of wing sections in all the ballast tanks. In a judgment which takes the form of answers to fifty-eight questions put to the court by the Board of Trade in sittings which extended over forty days, we can in this note only single out the principal findings. The evidence is characterised as generally unsatisfactory. In the opinion of the Court, the S.O.S. signal should have been sent out earlier, and some criticism is made of the order of the lowering of the port and starboard boats.

While the owners are generally exonerated from blame, some blame is attributed to the New York agents of the owners and their officials for not taking adequate measures to ensure that the vessel was not loaded below her marks. The recommendations made include the suggestion that foreign-going passenger ships should be afforded the same protection as regards safety of life at sea as is now given to emigrant ships by the Board of Trade supervision and inspection. It is further suggested that the draughts of British vessels sailing from foreign ports should be officially observed and reported to the Board of Trade. The fitting of wing sections to all ballast tanks having longitudinal divisions is considered necessary, and special attention should, it is held, be given to the construction of all hatchways, coal trunks and shoots, etc., through which water might gain access to the ship. It is also proposed that the boat list should be prepared and the boat stations exercised before sailing.

A full Report of the above Inquiry has been published in pamphlet form by the Journal of Commerce, Liverpool. The Official Report is being published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2, and branches.

PULVERISED FUEL AT SEA—THE "WEST ALSEK" INSTALLATION. "The Engineer," 19th July, 1929.

Some months ago the cargo steamer *West Alsek* was set apart by the United States Shipping Board for conversion from hand-firing to pulverised fuel burning on the Todd unit system. The work was carried out at the works of the Todd Shipyards Corporation, following the official tests of the Todd system, which were made jointly with the United States Naval Authorities at the oil fuel testing plant of the League Island Navy Yard, Philadelphia.

The trials of the converted ship were made on June 19th from Hoboken, New Jersey, to Fire Island, and during two runs over a measured mile course and a 12-hour trial, a mean speed of 12·7 knots was attained with the engines running at 80 r.p.m. The trial results were so satisfactory that the Shipping Board immediately took delivery of the steamer and ordered her to proceed to Baltimore for loading. On her run to Baltimore she averaged 11·8 knots with the engines making 75 to 78 r.p.m.

The *West Alsek* was chosen for conversion because she is a typical cargo-carrying steamer. She was built in Seattle in 1918, and is of the two-deck three-island type, with the following dimensions:—Length between perpendiculars, 410ft. 5½in.; breadth moulded, 54ft.; depth moulded, 29ft. 9in. Her deadweight carrying capacity is 8,529 tons and her gross tonnage 5,573. She is propelled by a single set of triple-expansion steam engines of 2,750 I.H.P., the steam being supplied from three single-ended Scotch boilers each provided with three furnaces. The designed speed of the ship before her conversion was nine knots on a daily consumption of 42 tons of coal, but difficulty was met, we learn, in maintaining this speed in Transatlantic service. With the new pulverised fuel equipment not only has the speed of the ship been considerably increased, but it is anticipated that a considerable saving in operating costs will be made.

The coal-crushing and pulverising equipment was specially designed to meet the requirements of the ship. The run of mine coal is fed to a crusher of the high-speed fixed hammer type, which is provided with a hinged bottom in order to facilitate the removal of tramp iron or other solids. Coal may be taken to the crusher, either by gravity from the upper deck or by means of an elevator from the lower cross bunkers. It is crushed to ½in. size, and it then passes by gravity from the crusher to a screw conveyor running athwartships. The trough of the conveyor is furnished with nine downcomers discharging into hoppers placed immediately above the pulverising mills—as shown on the left of Fig. 1. Each hopper contains about an hour's supply of fuel, and the fuel passes down by gravity through a disc feeder to the individual pulverisers. Arrangements are made to insure that, under sea-going conditions, the same amount of fuel enters each of the nine pulverising mills. When operating under reduced loads, when manœuvring, or when entering port, the supply from one or more of the pulverisers can be cut off as desired.

The arrangement for pulverising shown differs somewhat from that used in the land tests, which were described in an article contributed to the issue of the "Journal" for the American Society of Naval Engineers for May, 1929. In the test plant the pulverisers were motor driven, and were directly attached to the burners. In the actual installation —as will be clearly seen from Fig. 1—the three pulverising units for each boiler are grouped into one unit, which is directly driven by a small Westinghouse steam turbine. The three pulveriser groups are neatly arranged along one side of the stokehold facing the boilers, and are thus handy both for supervision and inspection. Had the original arrangement of an electric motor for each pulveriser and burner been adhered to, it would have been necessary to install special alternating-current generators. To save the initial cost of such

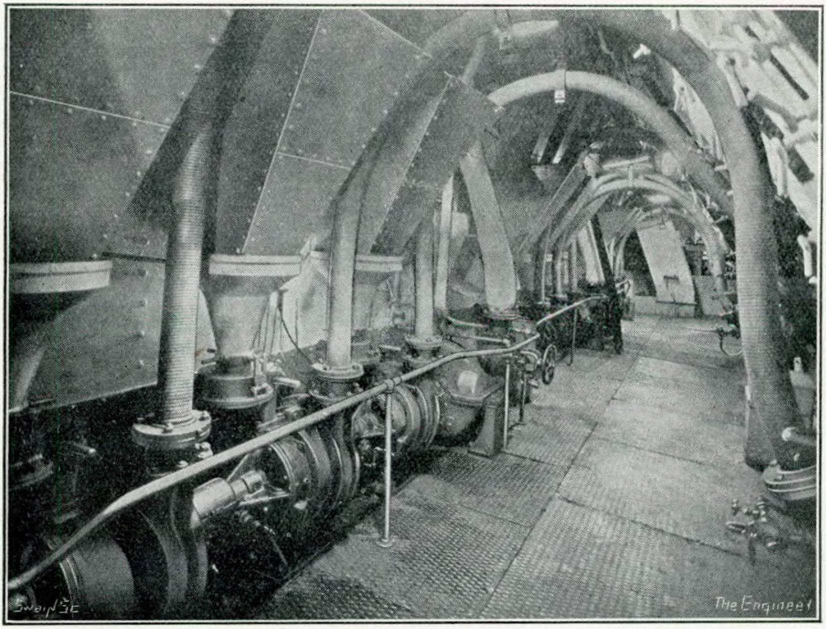

Fig. 1—Coal Pulverising Mills.

new plant, it was decided to use small steam turbines, and to exhaust the steam from them directly to the main and auxiliary condensers. If such an arrangement should be decided upon for a new installation, the heat of the exhaust steam might be effectually employed for raising the temperature of the feed water.

As will be seen from Fig. 2, the pulveriser units, which are of the two-stage centrifugal type, along with an integral fan having a tangential discharge, are connected to the burners by flexible tubing. The burners are fixed to the ordinary

Howden furnace fronts, and provision is made for starting up by the filling of a small capacity oil burner as an ignition torch. Should the relative prices of oil fuel and powdered coal make it more economical at some future date to use oil fuel for a part or a whole voyage, the furnace fronts are so designed that oil-fuel burners of large capacity can be readily adapted if they are required. The stream of powdered coal and primary air enters the furnace through an internal diffuser which imparts to it a rotary motion. The rotation of the coal dust

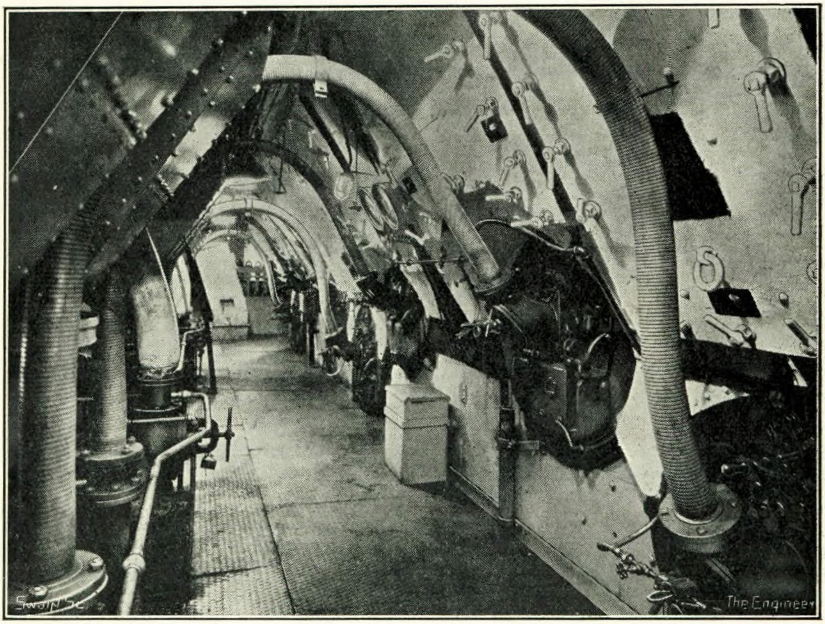

Fig. 2—The Stokehold Showing Burners.

particles is further assisted by the secondary air, which enters the furnace through registers provided in the Howden type furnace fronts.

An interesting feature in the design of the boiler uptakes and funnel is the provision of a separate compartment for each of the three boilers right to the base of the funnel and throughout its length. During the official trials coal from the Upper Freeport seam from Preston County, Pennsylvania, with a calorific value of 13,500 B.Th.U's per pound was employed. Its fusing point was 2,700 deg. Fah., and the ash content was 12 per cent., with 27 to 28 per cent. of volatiles 58 to 59 per cent. fixed carbon, and about 2 per cent. of moisture. The system showed great flexibility in control, and the installation may be looked upon as a further forward step in American powdered coal-burning practice for marine service.

The blocks for the foregoing illustrations have been kindly lent by the Editor of "The Engineer."

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*SHIP FUMIGATION. "The Nautical Gazette," 8th June, 1929.

The attention of the Executive Committee of the Marine Section of the National Safety Council was directed to an accident occurring last November, which resulted in the death of three members of the crew of an American steamship, and the special committee on ship fumigation, of which Charles H. Flathers is chairman, and John S. Hunter and Fern Wood are members, prepared the following report on the general subject of fumigation.—EDITOR.

The vessel in question had been fumigated on Saturday at 9 a.m., and was opened for ventilation at 3 p.m. On the following Monday three members of the crew were found dead in their bunks. Other members of the crew had been aboard Saturday night and Sunday without any ill effects. A review of the Government regulations on fumigation indicates that there are three commonly used fumigants—sulphur dioxide, carbon monoxide and hydrocyanic acid gas. A comparison of these three fumigants reveals many facts favouring the use of hydrocyanic acid gas as a routine fumigant in both ships and buildings for the destruction of rodents.

Sulphur Dioxide.—Sulphur dioxide, while fairly effective, is not very penetrating. It diffuses very poorly, and in actual practice it has seemed that air pockets in articles of cargo or between packages will afford to rats a sufficient protection against the effect of the sulphur fumes. Grubbs' observations along this line were confirmed by the experiments of the writers. Its use is highly destructive to various articles, and its generation requires cumbersome apparatus and the expenditure of considerable time. Being less toxic than hydrocyanic gas or carbon monoxide, sulphur dioxide requires a much longer exposure. The exposure to sulphur fumes required from six to twelve hours in contrast to less than one hour when

* Paper and Discussion on this subject at the Royal Sanitary Institute Congress, 1928.

nydrocyanic acid gas is used. The lack of diffusive qualities limits the use of sulphur dioxide almost exclusively to the fumigation of vessels in ballast.

Carbon Monoxide.—Carbon monoxide, while highly efficient, requires such complicated apparatus for its generation that the use of this gas as a fumigant is restricted to quarantine stations or other localities where proper care and attention can be given to the apparatus required. Moreover, this gas is valueless for the destruction of the lower forms of animal life, fleas, flies and mosquitos. To the disadvantages of both of these fumigants must be added the danger of fire, a necessary attendant to the generation of either of these gases.

Hydrocyanic Acid.—Hydocyanic acid gas is the most penetrating and the most toxic of those fumigants. It is easily and quickly generated, requires very little apparatus, is not destructive to inanimate objects, and in the hands of experienced operators its use is not attended by more danger to persons than is the use of carbon monoxide.

From the records of the Public Health Service at Washington the following interesting but alarming figures are obtained:—

For a period of 13 years, from 1916 to 1929, the number of accidents due to fumigation of vessels totaled 22; resulting in deaths to total of 41. These fatalities are shown to have happened as follows:—In connection with fumigating operations, 4; during fumigation (of this number 11 were stowaways), 24; after fumigation, 13.

Causes of Fatalities.—A study of the accidents in the first group showed that all four met their untimely deaths by falling into the holds of the vessels while preparing the vessel for fumigation, while this operation was going on, and in attempting the rescue of a fellow crew member who had been overcome by gas.

An analysis of the second group discloses the fact that six of the deaths were the result of one accident and all were members of the Quarantine Station directly connected with the fumigation of the vessel.

The remaining 18 of this group were on board and found when the vessels were opened up for ventilation.

All of the third and last group met death after fumigation when entering the vessel before completely ventilated or after the vessel had been declared safe.

From the study undertaken it is interesting to note that but one accident, causing six deaths, resulted from the handling of the fumigants. It appears, therefore, that preventive measures should be directed against the other causes. In group two the records indicate that proper precautions were not taken to see that all members of the crew were accounted for, and that the vessels were not thoroughly searched for stowaways.

Precautions During Fumigation.—Reference is made to the quarantine laws and regulations of the United States, from which the following is quoted:—

"On account of the great danger to human life from hydrocyanic acid gas, specific arrangements should be made for the disposition of the crew during the fumigation process, especially if one or two compartments of a vessel are to be treated. A written statement from the captain or first officer of the vessel that the latter is ready for fumigation, and that every member of the crew has been accounted for, as not being in the vessel or else not exposed to the fumes of the gas. Persons in one compartment have been killed by fumes escaping from another compartment undergoing fumigation. Compartments above deck should have danger labels pasted on doorways after fumigation has commenced."

The committee is indebted to the Atlantic Refining Company for the following contribution in which it is noteworthy to observe the precautions taken to make sure that nobody is left aboard or returns to the vessel while fumigation is in process: "The vessel must be in condition to be left with safety for from five to six hours. All ventilators or similar openings shall be closed or covered. All top hatchways shall be covered (leaving off the wooden wedges); all between-deck hatch-covers shall be removed; all compartments in the forepeak, midship, and aft sections shall be left open (all lockers unlocked also) and keys left in Yale type locks; drawers shall be pulled partly open, mattresses raised to a peak in the centre; all ports shall be closed tightly and *lightly* secured with one screw; galley fires shall be banked and dampers and vents closed; *all members of crew shall be removed from the vessel and accounted for;* captain has a right to stay aboard if he so desires. A ship's officer *must certify* in writing to the effect that these *requirements have been complied with.* The fumigation officer must receive this certificate before proceeding with fumigation. A copy of the certificate is enclosed. Each instance of deficient preparation resulting in delay will be reported in writing to agent for the vessel concerned.

"The fumigation officer on taking charge of vessel, at once places a guard at gangplank with instructions *to permit no one except fumigators to board vessel unless O.K.'d by said officer. Two signs are placed on the boat reading: 'Danger: This ship being fumigated with cyanide gas.'* One placed at the gangway and the other on the opposite side of the boat to warn other ships or tugs coming alongside that no person is to climb aboard. Any member of fumigating team leaving vessel must notify other fumigators first and again on reboarding the ship (thus all persons are accounted for during the fumigation). The forepeak and cargo spaces are first inspected and where necessary further prepared by sealing, etc., then aft section, after-deck houses, and finally midship section. Vessel then searched for presence of anyone being aboard unauthorised."

The committee believes that this company has no record of fatal accidents in connection with the fumigation of its vessels.

The committee strongly recommends that those charged with the responsibility of accounting for all persons likely to be aboard, and with the warning of possible entrants increase their efforts, in order that further casualties under such circumstances may be prevented. The importance of such precautions will be apparent when we note that more than half of the fatalities occurred to men who were left on or had returned to the ship.

Danger after Fumigation.—The next to be considered is the danger after fumigation. Thirteen deaths resulted after the vessels had been opened for ventilation, some returning too soon and others after the vessels had been declared safe.

In this connection the U.S. quarantine laws and regulations state:—

"When a vessel is fumigated with cyanide gas no one shall be permitted to enter the various compartments of the ship until entry to such space is declared safe by the medical officers in charge of the fumigation. Decision as to safety of entering compartments shall be made by the officer in charge of the fumigation and on board the vessel concerned; but during the interval between the sealing of compartments undergoing fumigation and the time appointed for determining the safety of entering, the officer may designate a trustworthy employee, or employees, to attend to the opening up of compartments, the supervising of installation of blower or windsail, and the prevention of any persons entering compartments before permission of the officer in charge."

The following is also of interest and is taken from the contribution of the Atlantic Refining Company:—

"At present a new system of fumigating is being used by us which is known as the Zyklon-B method. This material comes in cans and is a mixture of cyanide and chloro-picrin gas. It is spread on canvas or something similar. This requires men being in the gas a longer period of time than the Pot System and they must be equipped with light clothing such as unionalls, gloves and special gas masks which will take care of the combination gas. It is also recommended that milk be supplied to the men before and after shooting, which appears to neutralise any poison that may have been absorbed through the pores of the skin. Care should be taken that the men who are to actually open the cans are not perspiring, as they would then be more apt to absorb the hydrocyanic vapours. This special method has the advantage of doing away with buckets, water and acid, and is considered safer for the fumigation team. Also the transportation of cyanide incurs much less risk when in cars.

"After the gas has been generated for the prescribed time, men working in pairs will open all outside hatches, ventilators, etc., and permit compartments to ventilate for ten minutes before anyone goes inside the gas area. After which two men working always together, don gas masks of approved type, and open all ports, doors, etc. The men must work in pairs for mutual safety.

"After the compartments are ventilated sufficiently, the chief fumigator will make a final inspection before anyone is permitted to come aboard. A special chemical test as recommended by the United States Public Health Service is employed to further assure that the gas has been expelled to well below the safety margin.

"This new method is being used exclusively in the ports of New York and New Orleans, and its use is being extended to other ports. One of the greatest advantages in this present method over the old cyanide method is the fact that the tear gas being the heavier, remains in the compartment after the cyanide has disappeared, thus affording an additional margin of safety to the men entering after the fumigation."

The same company also required the certificate below to be filled out by the officer in charge of the vessel:—

To Officer in Charge of Fumigation.—This is to certify that I have been duly informed of the poisonous nature of cyanide gas being used in fumigating the tanker —— and that all members of the crew have been removed from the vessel with the exception of —— and that no one is to be allowed on board until so permitted by officer in charge of fumigation.

The vessel has been properly prepared for fumigation, that is, all ventilators and similar openings covered; all top hatchways covered (leaving off the wood wedges), between-deck hatch-covers removed; all compartments in forepeak, midship and aft opened (all lockers unlocked, also) and keys left in Yale type locks; drawers pulled partly open, mattresses raised to a peak in the centre; all ports closed tightly and *lightly* secured with one screw; galley fires banked and dampers and vents closed; vessel in condition that it can be left with safety for from five to six hours.

Furthermore, it is my understanding that I shall pass instructions to all members of the crew after boarding vessel, that immediately upon occupying living quarters all bedding and mattresses shall be thoroughly shaken out and that all port holes shall remain open for at least six hours. Forepeak, cargo hold and bunkers are to be kept open all night and no one is to enter same until the following day.

(Signed) ——————

Officer in Charge of Vessel.

From the consideration of the last group it is plainly evident that more care is needed in guarding against persons going aboard the vessel before it is gas-free, and that proper methods of ascertaining that the same is safe for occupancy be employed.

The committee recommends that the utmost care be exercised in the ventilation, the applying of proper tests before declaring the vessels gas-free and the guarding of entrances before the vessel is declared safe.

Complete instructions on ventilation are contained in "Ventilation After Fumigation," issued by the U.S. Public Health

Service. This pamphlet covers both natural and artificial ventilation.

The fumigation of ships is primarily for the purpose of exterminating germs and disease-carrying vermin and animals, but its object is defeated to some extent when due consideration is given to the loss of life resulting from such operations.

The Marine Section of the National Safety Council recommends stricter observance of the Rules and Regulations of the U.S. Public Health Service and further study and research for more effective tests for determining the safety of vessels after fumigation.

In connection with this report the following letter was received by the National Safety Council from F. A. Carmelia, Assistant Surgeon-General:—

" I find this report a rather remarkable exposition of the problem under consideration, particularly in view of the comparatively short period of time the committee had the matter under consideration. I find no basis for adverse criticism on this report, but accepting your kind invitation, will offer the following comment:—

" With respect to sulphur dioxide fumigations, it is not clear whether sulphur acts directly as a lethal agent or whether the combustion of sulphur within air-tight spaces by reason of the oxygen demand reduces the oxygen below that point required to sustain animal life. Personally, I am strongly inclined to the latter view. In that case it is not a question of diffusion of sulphur dioxide into small recesses and remote spaces as much as it is a withdrawal of the oxygen in the air throughout the ship and finally from such spaces. I rather suspect sulphur as being more rapidly effective in remote recesses than cyanide, as the penetration of cyanide into such spaces must depend on laws of diffusion.

" With respect to carbon monoxide, from experiences I have had with this gas, I regard its use just as dangerous, if not more so, than hydrocyanic acid.

Stowaways.—" The problem of stowaways is not as simple as it would appear. It is not simply a matter of careful search, as in the accident last summer in Baltimore during which seven stowaways were killed, the most careful search reasonably expected could not and did not reveal the presence of those stowaways as they were hidden below cargo with the connivance of certain of the ship's personnel, who failed to reveal their presence to the fumigation officer. The Public Health Service is considering the practicability of preliminary introducing an irritating gas into holds and such parts of a vessel not amenable to proper search for the purpose of driving out stowaways or causing them to make their presence otherwise known, prior to beginning the cyanide fumigation. Our experience indicates that no reasonable search alone will suffice, no matter how carefully applied.

" In the Port of New York, the United Fruit Company also has had considerable experience with cyanide, as well as the Atlantic Refining Company in Philadelphia, and are understood to have an equally good record. In passing, it should be noted that the fumigation of a tank ship is a comparatively simple procedure as compared with the fumigation of a cargo-carrying vessel, especially those of the older type. The quotations of the Atlantic Refining Company requirements are practically identical with the instructions issued at the New York Quarantine Station and in general use at most of our stations. The regulations of the Public Health Service which were issued in 1920 have since been augmented at the various stations along the lines of those used by the Atlantic Refining Company. In fact, if I remember right, the Public Health Service employees assisted in the training of personnel and the application of the procedure used."

THE DEVELOPMENT OF THE EXHAUST BOILER. "The Motor Ship," August, 1929.

The provision of an exhaust gas boiler is now almost a standard feature of a ship equipped with four-cycle Diesel machinery, and it is becoming common even with two-stroke engines, where the gas temperature is lower and the amount of steam that could be raised is less. The success that can be achieved with two-stroke machinery in conjunction with exhaust boilers was indicated on the trials of the *Calgarolite* when 1,850 lb. of steam were raised per hour at a working pressure of 100 lb. per sq. in. from machinery having an output of approximately 5,000 B.H.P. The development of pressure charging has raised the question whether exhaust gas boilers are still practicable and efficient in view of the fact that the exhaust gases are employed for driving the turbine coupled to the blower for supplying the air for induction. This appears to be the case, for, on the Union Castle liners *Llangibby Castle* and *Dunbar Castle*, both of which are pressure charged, exhaust gas boilers are being utilised. This has involved a somewhat special design since back pressure must be avoided, but at any rate it seems clear that the employment of pressure charging does not preclude the use of waste heat boilers.

THE ECONOMY OF ELECTRIC WINCHES. "The Motor Ship," August, 1929.

Several instances have occurred of owners specifying steam-driven cargo winches on motor cargo vessels, the reason being largely—if not entirely—due to the fact that the first cost of the steam winch is lower than that of the electrically operated machine. Some years ago it was also contended that the electric winch was neither so flexible nor so reliable as the steam-driven unit. These claims, however, were disproved without difficulty.

What actually determines the question are the fuel consumption and cost of upkeep. Taking its current from Diesel engine-driven dynamos, the electric winch uses about one-seventh the fuel required by steam winches. Indeed, the economy may be even greater if—and this is frequently the case—the steam winch installation is not in a first-class condition. As regards the upkeep charges, we can do no better than quote the case of a well-known concern manufacturing electrically driven winches. The details are worth noting.

A list was made of the total spares ordered by all the users of this particular type of winch, numbering, we believe, between 30 and 40 shipowners and applying, in round figures, to over 1,000 winches. It was found that the average cost for spares annually, per winch, amounted to less than 9s. In other words, the owner of a motor cargo vessel employing ten or a dozen electric winches may expect to face a yearly expenditure of approximately £5 on the whole installation, assuming that the circumstances are normal. We do not suggest that the figures quoted apply unconditionally to all classes of ship, nor that they are bound to represent the annual cost of upkeep throughout the life of the vessel, but they form a useful and authentic guide.

THE RAPID PROGRESS OF PRESSURE CHARGING. "The Motor Ship," August, 1929.

The application of the system known as pressure charging as applied to four-stroke single-acting marine Diesel engines is making greater headway than is generally recognised. The nine fastest cargo liners being built for British owners, five for the

Blue Funnel Line and four for the Silver Line, will adopt this method, which will be applied also to the two 10,000 ton Union Castle passenger liners, of which the first, the *Llangibby Castle*, was launched last month. It will be fitted on the new Elder Dempster passenger liner and probably on a British-built passenger ship with machinery of 20,000 h.p. We understand that if the new 60,000 ton White Star liner is a motor ship, it will be employed in that case. The new mixed passenger and cargo liner recently ordered in Holland, the *Colombia*, is to be provided with pressure-charged machinery, and two tankers just built for the Anglo-Saxon Petroleum Co. follow similar practice. It is to be applied to a submarine for the first time in the near future, and the system will also be adapted to other classes of war vessel.

A further development of the supercharging system may be anticipated. But the practice is by no means standardised and there are four methods already being adopted. The Blue Funnel Line is following the enterprising course of carrying out the competitive systems on similar ships, but possibly the result will be, as has been the case with Diesel-propelling machinery, that there is comparatively little to choose between the various means employed, taking all circumstances into consideration.

PRESSURE CHARGING FOR AUXILIARY ENGINES. "The Motor Ship," August, 1929.

There are two main objects for the adoption of the so-called pressure charging system with four-stroke Diesel engines. First, a higher output can be obtained with given cylinder dimensions, thus reducing the cost of construction per B.H.P. Secondly, or perhaps alternatively, in some cases, the method enables a larger power and therefore bigger ship's speed to be attained when required at very short notice, even when the pressure charging is not normally in operation. It is understood, for instance, that in many passenger ships in which the pressure charge is to be applied, it will only be utilised in circumstances when it is desired to speed up the vessel temporarily.

There appears to be no reason why the method should not be used in some cases with the auxiliary Diesel engines driving dynamos. One of the largest stationary oil engines constructed in this country for dynamo drive has just been completed and this will be pressure charged. In the engine-rooms of motor ships there are definite advantages in the adoption of such a means of increasing power. Anything that might reduce the cost would, in any event, be desirable, but even if the intention is not to operate the engines as supercharged continuously, it may be recalled that most Diesel engines driving generators run at about three-quarter power for a greater part of their life. It is only occasionally that they are required to operate at 100 per cent. output. There would appear to be little objection to designing them for a normal output of 75 per cent. of that now adopted and considering the extra 25 per cent. as a peak load to be attained when desired by the adoption of pressure charging. In other words, the cost of these engines would be that of units of 75 per cent. of the present normal output plus the expenditure on the equipment for pressure charging, which resolves itself mainly into a certain amount of piping and means for delivering the required quantity of supercharging air.

DESCRIPTION AND REPORT OF TRIALS OF THE S.S. *California*. Abstracted from Paper read by Roger Williams, Esq., to the American Society of Naval Architects and Marine Engineers, New York, November 15th and 16th, 1927.*

Preliminary.—In 1915 the International Mercantile Marine Company established the Panama Pacific service between New York and San Francisco, through the Panama Canal, using two of the American flag Red Star steamers. The service was soon interrupted by canal slides and the war, but was resumed in October, 1923. It was realised that the trade required ships especially designed for the purpose, and, as the prospects were good, the Company began planning new tonnage. As a result, on October 27th, 1925, the contract was awarded to the Newport News Shipbuilding and Dry Dock Company, where, under the very helpful guidance of Mr. Homer Ferguson and his efficient staff, the many details were carefully worked out and the whole project brought to a successful completion.

Particulars.

Length over all: 601ft.
Length on water line: 595ft.
Length between perpendiculars: 574ft.
Beam, moulded: 80ft.
Depth moulded to shelter deck, side: 52ft.
Depth moulded to upper deck, side: 42ft. 6in.

* See note on the Trials and Maiden Voyage p. 214, Vol. 40, Institute of Marine Engineers.

Load draft to bottom of bar keel: 32ft. 3in.
Camber of all decks in 80 feet: 6in.
Displacement at load draft (tons): 32,450.
Deadweight capacity at load draft (tons): 17,800.
Gross tonnage: 20,325.
Net tonnage: 11,934.
Block coefficient at L.W.L.: ·70.
Prism coefficient at L.W.L.: ·71.
Mid-section coefficient at L.W.L.: ·986.
Cargo, general (cubic feet): 478,500.
Cargo, refrigerated (cubic feet): 74,900.
Propulsion: Turbo electric.
Shaft horsepower, full: 17,000.
Designed speed (knots): 18.
Cruising radius (miles): 16,000.
Fuel capacity (tons): 5,349.
Boilers (water tube Babcock and Wilcox): 12.
First class passengers: 386.
Tourist class passengers: 363.
Crew (deck, 59; engine, 65; steward's, 227), total: 351.
Classification (Class A 1 E): American Bureau.
Keel laid: August 3rd, 1926.
Sea trial: January 7th, 1928.
Delivered: January 13th, 1928.

General Description.—The ship is subdivided by water and oil-tight bulkheads, the subdivision being such as to comply with the U.S. Steamboat Inspection Rules, as well as with the regulations proposed by the International (1914) Convention for Safety of Life at Sea. On an initial mean draft of about 32ft., the subdivision is such as to permit the ship to float safely with any two compartments open to the sea and at the forward end with the three compartments flooded, the factor of subdivision being not more than 45 except in way of the three forward compartments, where it is 34. The main transverse bulkheads extend watertight to the shelter deck, except those in way of the dining saloons and galleys, which extend to the upper deck only. This subdivision provides three cargo holds forward, two sets of athwartship deep tanks which are further subdivided for fuel oil, two boiler rooms, one engine room and three cargo holds aft. Longitudinal bulkheads extending to the main deck are fitted at each side of the two boiler rooms to form wing tanks for fuel oil, the compartments thus formed being subdivided into four tanks on each side. There is a pipe tunnel extending from the forward boiler room through the deep tanks and cargo holds Nos. 2 and 3.

General cargo is carried in the three holds forward, on the main deck over the deep tanks and forward boiler room, in the two compartments on the lower deck aft and in one compartment on the orlop deck aft. Three of the general cargo spaces on the main deck forward are also arranged to carry automobiles. Refrigerated cargo is carried in the six insulated compartments aft, four of which are brine cooled and two air cooled. The two forward and two after cargo spaces are served by trunked hatches, cargo booms and deck winches. Other cargo spaces are served by cargo port doors located above the main deck, 'tween deck cranes and winches.

Propelling machinery consists of two sets of General Electric turbo-electric generators and motors, 12 Babcock and Wilcox water-tube boilers operating under forced draft. The boilers are arranged in batteries of six each, three abreast, located in two separate compartments and all connected to one stack. The generators, motors and auxiliaries are located in a separate compartment connecting with the shaft alleys. The refrigerating machinery is located directly abaft the engine room.

There is an auxiliary electric plant for lighting and power, an emergency lighting set, refrigerating plant for cargo and ship's stores, hydro-electric steering gear, steam windlass, steam warping winch, electric capstan, electric winches, electric boat winches, mechanical ventilation to living spaces and engine room, two passenger and one engine room electrically-operated elevators, steam and electric heating systems, electrically-operated power watertight doors, plumbing, drainage, fire and other systems, the particulars of which will be referred to later.

Hull and Cargo Machinery.—A steam windlass and a warping winch comprise the only steam hull machinery of importance. Steam was chosen for these purposes because it was found that the piping could be led through the pipe tunnel conveniently and therefore it was possible to take advantage of the cheaper cost of equipment and to guard, as well, against the difficulties of using electrical machinery in spaces so exposed to salt water. All other hull and cargo machinery is motor driven.

The steering gear is of the hydro-electric type, such as is used on some of the newer battleships. The control from the bridge is by two separate systems, one of which is by telemotor, and the second, electric, which is used in conjunction with the Sperry automatic steering. The steering gear is designed to allow the rudder to be turned through an angle of 70 degrees in thirty seconds at a ship speed of 18 knots.

There are three electrically driven, non-reversible capstans for handling heavy lines, designed to exert a pull of 25,000 pounds at a speed of 50 feet per minute and capable of speed up to 125 lbs. per minute at lighter loads.

The electric winches for cargo handling consist of sixteen Lidgerwood single-geared, high-speed winches and two Sheppard high-speed winches on the weather decks; eight double-geared, medium-speed winches between decks. The high-speed winches will lift 1,500 pounds at a speed of 300ft. per minute. Heavier loads lessen the speed, but our experience with the ship in six months has shown that the choice of winches has been amply justified both for handling average cargo as well as for heavier general cargo. The Shepard winches were installed largely for test purposes, as they contain several advantageous features for marine work and so far have functioned well. The 'tween deck winches have been satisfactory. They operate through swinging cranes, which method of handling cargo from blind hatches is reasonably satisfactory when used in conjunction with towing trucks and trailers.

Access to the 'tween deck hatches is provided through large side doors, hinged, in pairs, or single, each door being 7ft. 4in. in height by 4ft. 6in. in width. Doors are also provided for the fuel oil connections, for embarking passengers, and for handling engine and victualling stores, making a total of twenty-four side ports in the ship. The doors are guttered inside and scuppered and have given no trouble.

Watertight doors are electrically operated throughout and controlled through a centralised panel in the wheelhouse. The system operates on the direct-current system and also by the emergency lighting and power sets.

The navigating equipment comprises the Sperry gyroscopic compass system and automatic steering; a Brown telemotor; standby magnetic compasses; a Kolster radio direction finder; motor-driven sounding machines; submarine signal sets; a course recorder; revolution indicators and other useful instruments. Two 1,000 watt Sperry searchlights are placed on top of the bridge.

Fire Protection.—The boiler rooms have the Foamite system. The Rich system is provided for detecting fires in the holds and other inaccessible places with the control cabinet in the wheel-house. A steam smothering system is provided for the holds. Throughout passenger spaces, storerooms and other spaces is installed the Cory electric-pneumatic system for giving the alarm. Fire screen bulkheads and fire doors are located in the passenger spaces. The usual equipment of portable extinguishers and fire hydrants is provided.

Auxiliary Electric Plant.—Lighting and power is supplied by four General Electric 500 kilowatt, 240 volt, direct-current, geared turbine-driven generators, operating on full boiler pressure. Two of these machines take care of the normal load at sea. The generators are arranged for normal operation as two wire machines in parallel supplying the 240 volt, two-wire lighting system and power bus and with compensators as modified, three-wire machines supplying the 120-240 volt excitation and auxiliary bus.

The lighting sets exhaust into the auxiliary condensers, interchangeably. These condensers are of 2,800 square feet of cooling surface, have motor-driven circulating pumps, condensate pumps and two-stage Wheeler radojets.

The emergency sets consist of two 15 kilowatt, 120 to 240 volt, direct-current generators, driven by 30 horsepower gasoline engines. These, together with a large storage battery outfit for lighting or radio, are located in a special room built on top of the boat deck houses. Emergency lights will go on automatically if the main sets fail.

The main switchboard is located in the engine room flat abaft the lighting sets. It has forty-three power circuits, thirteen lighting circuits, four propulsion excitation circuits and spares. The four 500 kilowatt generators are connected through selective circuits mechanically interlocked so that only one generator can be used for propulsion excitation.

Refrigerating Plant.—Two systems of refrigeration are provided, namely, 60,000 cubic feet of cool air chambers for the carriage of bananas, citrus fruits, fresh vegetables or the like requiring ventilation and a temperature of around 50° F., and 40,000 cubic feet of frozen space for meats. Fifteen thousand additional cubic feet of frozen space is provided for domestic use, and there are also a number of smaller ice-boxes, ice-cream rooms or cool places. This large amount of refrigeration is provided by four Brunswick-Kroeschell CO_2, three-cylinder motor-driven compressors, adjustable speed, 250 to 350 revolutions per minute. There are four condensers and four brine coolers. All equipment is located in a separate room abaft the engine room. Access is given from the refrigerating engine room to the fan rooms overhead. The brine circulating pumps and condenser circulating pumps are motor-driven. An excess machinery capacity of 25 per cent. is provided in case the owners wish at any time to increase the capacity by this amount.

Boilers.—The twelve Babcock and Wilcox boilers supply steam at 275 pounds pressure and 120° superheat. Each boiler has 4,598 square feet of heating surface and 1,344 square feet of superheating surface. Each boiler is twenty-four sections wide, and they are arranged in batteries of three with six boilers per boiler room. Feed water regulators and Diamond soot blowers are fitted. There are four Peabody burners per boiler, operating under forced draft supplied by motor-driven fans located in recesses at the sides of the boiler rooms, the air passing through ducts under the gratings to the double front.

Fuel Oil Capacity and Storage.—The total fuel oil capacity is 5,349 tons, which is considerably greater than required to allow the ship to make the round trip from New York to San Francisco and return. The fuel is stored largely in deep tanks as shown on the plan and also in the forward double bottoms. Wing tanks in the firerooms are used as settling tanks. An overflow system, also suitable vents, filling and discharge lines are fitted.

Propelling Machinery.—Power is supplied by two marine type General Electric steam turbines, each rated at 6,750 shaft horsepower at 2,640 r.p.m., corresponding to 110 r.p.m. propeller speed. The full capacity of each turbine is 8,500 shaft horsepower, 2,880 r.p.m. corresponding to 120 r.p.m. propeller speed. These turbines are each directly connected to an alternating current generator rated 5,250 kilowatts, 2,640 r.p.m., 3,700 volts, 3-phase, and having a maximum continuous rating of 6,600 kilowatts, 4,000 volts. These turbo-generators are located in the machinery flat as shown in plan, the condensers being placed directly beneath the turbines.

There are two main propelling motors, one directly connected to each propeller shaft, of the synchronous-induction type rated at 5,250 kilowatts, 110 r.p.m., 3,700 volts, 3-phase, 6,750 shaft horsepower, full rating 6,600 kilowatts, 120 r.p.m., 8,500 shaft horsepower.

Normally, each propelling motor takes its current from the corresponding turbo-generator, but it is arranged so that one turbo-generator can operate both motors.

The generators are self-ventilating. The motors are ventilated by motor-driven exhaust fans, 17,000 cubic feet of air per minute being exhausted through the dummy funnel.

The control panel is placed in the after part of the machinery flat. The operating levers are directly in front of the panel. The panel carries a full set of electrical indicators and gauges showing steam pressure and vacuum.

The propellers are three-blade manganese bronze, built up, 18ft. in diameter and 17ft. 9in. pitch.

Condensing Apparatus.—The main condensers take steam from the main propulsion turbines only and are underneath and directly connected to them. Each condenser has 11,000 square feet of cooling surface. They are circular, two-pass, and are fitted with 5,300 tubes each. The Warren circulating pumps are centrifugal, motor-driven, two pumps per condenser, each being capable of taking care of its condenser at normal load. The capacity of each pump is 8,000 gallons per minute. The motors are 100 horsepower, 230 volts, 325 to 600 r.p.m., magnetic control. Each condenser is provided with motor-driven, two-stage condensate pumps and Wheeler two-state radojet air ejectors.

Feed Water Heating.—There is installed a system of two-stage feed water heating. The first stage heater raises the temperature of the feed water from 100° to 200° F. and is supplied with steam bled from the main turbines. The second stage heater raises the temperature to about 230° and is supplied by auxiliary steam. The Davis heaters are of the vertical straight tube type and are on the pressure side of the feed pumps.

Other Auxiliary Machinery.—Motor-driven: 3 sanitary pumps, 2 oil cooler circulating pumps, 1 standby condensate pump, 1 ice water circulating pump. Reciprocating: : 1 lubricating oil pump, 1 fresh water pump, 1 ballast pump, 1 sediment pump, 1 fire and general service pump, 1 engine room bilge pump, 1 boiler room bilge pump, 1 hot fresh water pump, 1 evaporator feed pump. Evaporating plant: 3 Davis Paracoil 50-ton evaporators, 2 Davis Paracoil 10,000 gallon distillers, 1 De Laval lubricating oil separator, 1 Bethlehem fuel oil separator, 2 motor--driven, dry pit sewage pumps.

Completion and Trials.—During Christmas week, 1927, the ship was drydocked and painted. Inclining tests were made while floating in the drydock. One week later, on January 7th, 1928, the builders' trials were held outside Cape Henry. These trials were completed in one day, the ship leaving the yard at daylight and returning shortly after sundown. Runs were made between the Cape Henry sea buoy and False Cape buoy, a distance of 16$\frac{5}{8}$ miles. Two runs were made with one generator connected with both motors, and two runs with both generators connected, using enough power to give full speed. The mean depth of water on this course is 58ft. and the ship was ballasted to 24ft. draft.

The trials were a pleasant experience. The weather conditions were perfect. The performance of the machinery was excellent in all particulars. The most noticeable features of the trials were the complete absence of vibration in all parts of the ship and the excellent manœuvring qualities. The speeds attained were 13·6 knots using one generator and 18 knots using both generators. Owing to the shallow water, no attempt was made to exceed the contract requirements and, owing to the shortness of the runs, a close check on fuel expenditure was not practicable, although a very fair indication was given that the fuel efficiency was well within the expectations of the owners. No attempt at fuel economy was made; all boilers were in use except on the last run, when two were cut out.

The following data were obtained:—

FULL POWER RUNS—AVERAGE RESULTS.

Run No.	Revs.	Dist.	Speed	Slip	Motor			
					K.W.	Loss	S.H.P.	Eff.
1	119.1	16$\frac{5}{8}$	18.09	13.3	13,200	240	17,350	98.2
2	118.9	16$\frac{5}{8}$	17.91	14.0	13,100	243	17,200	98.1
Average	119	—	18.00	13.65	—	—	17,275	—

	Generator.				Field loss	Vent loss	Overall eff.
	K.W.	Loss.	S.H.P.	Eff.			
1	13,200	347	18,150	97.4	143	45	94.2
2	13,100	347	18,000	95.4	143	45	94.2
Average	—	—	18,075	—	—	—	94.3

PLATE I

PERFORMANCE DATA

VOYAGE Nº 2 — NEW YORK TO SAN FRANCISCO & RETURN — S.S. "CALIFORNIA"

	BOUND	FROM PILOT STATION TO PILOT STATION	1928	TIME ELAPS.	DISTANCE BY OBSERV.	SPEED	P. & S.	AVG. R.P.M.	APP. SLIP	MOTOR					GENERATOR					S.H.P. / B.H.P.	FIELD LOSS				VENT LOSS	O.A. EFF.
										AMPS	K.W.	LOSS K.W.	S.H.P.	EFF.	AMPS	K.W.	LOSS K.W.	B.H.P.	EFF		VOLTS	AMPS. MOTOR	AMPS. GEN	K.W.		
			DATE	HRS.:MIN	N. MI.	K			%					%					%						K.W.	%
1	WEST	NEW YORK	3-10	69:56	1166		P.	114.72		885	6060	109	7970		885	6060	159	8330			120	337	243			
			3-13				S.	115.35		847	5982	107	7870		847	5982	160	8220			120	337	249			
		TO				16.68	AVG.	115.04	17.25	866				98.2	866				97.4	95.7	120					94.3
		HAVANA					TOTAL				12042	216	15840			12042	319	16550				674	492	140	45	
2	EAST	HAVANA	4-13	62:04	1172		P.	115.16		875	6300	108	8290		875	6300	160	8650			120	349	255			
			4-16				S.	115.69		871	6076	108	8000		871	6076	162	8350			120	343	254			
		TO				18.88	AVG.	115.42	6.63	873				98.3	873				97.5	95.8	120					94.4
		NEW YORK					TOTAL				12376	216	16290			12376	322	17000				692	509	144	45	
3	WEST	HAVANA	3-13	58:45	1003		P.	111.7		807	5392	99	7100		807	5392	148	7280			120	328	240			
			3-16				S.	112.6		786	5282	98	6940		786	5282	151	7430			120	325	240			
		TO				17.07	AVG.	112.2	13.11	796				98.2	796				97.3	95.5	120					94.0
		COLON					TOTAL				10674	197	14040			10674	299	14710				653	480	136	41	
4	EAST	COLON	4-10	61:35	1007		P.	105.38		711	4640	85	6110		711	4640	127	6380			120	330	244			
			4-13				S.	105.45		715	4592	85	6040		715	4592	127	6320			120	329	249			
		TO				16.35	AVG.	105.4	11.43	713				98.2	713				97.3	95.5	120					93.8
		HAVANA					TOTAL				9232	170	12150			9232	254	12700				659	493	138	40	
5	WEST	BALBOA	3-16	162:19	2827		P.	116.0		868	6136	108	8080		868	6136	162	8150			120	335	247			
			3-23				S.	116.4		865	5914	108	7770		865	5914	164	8440			120	330	241			
		TO				17.42	AVG.	116.2	14.5	867				98.2	867				97.4	95.6	120					94.2
		SAN DIEGO					TOTAL				12050	216	15850			12050	326	16590				665	488	138	45	
6	EAST	SAN PEDRO	4-2	169:34	2907		P.	112.4		815	5676	100	7470		815	5676	150	7810			120	336	247			
			4-9				S.	112.6		808	5492	100	7230		808	5492	150	7570			120	334	244			
		TO				17.13	AVG.	112.5	13.0	812				98.2	812				97.4	95.6	120					94.1
		BALBOA					TOTAL				11168	200	14700			11168	300	15380				670	491	139	42	
7	WEST	SAN PEDRO	3-25	19:13	353		P.	118.7		950	6550	119	8620		950	6550	173	9010			120	346	250			
			3-26				S.	120.0		950	6500	120	8550		950	6500	177	8950			120	348	247			
		TO				18.35	AVG.	119.35	12.28	950				98.2	950				97.4	95.6	120					94.3
		'FRISCO					TOTAL				13050	239	17170			13050	350	17960				694	497	143	45	
8	EAST	'FRISCO	3-31	19:09	353		P.	117.5		912	6525	114	8590		912	6525	168	8970			120	350	255			
			4-1				S.	118.5		912	6500	115	8560		912	6500	171	8940			120	350	250			
		TO				18.43	AVG.	118.0	10.8	912				98.2	912				97.5	95.7	120					94.4
		SAN PEDRO					TOTAL				13025	229	17150			13025	339	17910				700	505	145	45	

PLATE 2

PERFORMANCE DATA

VOYAGE Nº 2

NEW YORK TO SAN FRANCISCO & RETURN

S.S. "CALIFORNIA"

	BOUND	P. & S.	RUNNING TIME HRS.	Nº BLRS. IN USE	STEAM AT BOILERS PRESS	STEAM AT BOILERS TEMP	STEAM AT BOILERS SUP.	MAIN STM. PRESS	NOZZLES OPEN	STEAM AT H.P. CHEST PRESS	STEAM AT H.P. CHEST TEMP	STEAM AT H.P. CHEST SUP.	DROP BOILERS TO H.P. CHEST PRESS	DROP BOILERS TO H.P. CHEST TEMP	DROP BOILERS TO H.P. CHEST SUP.	H.P. 1ST STG. PRESS	BLEED STM PRESS	MAIN EXH. TEMP	VAC. AT * COND. INS.	COOLING WATER INJ. TEMP	COOLING WATER DISCH TEMP	TEMP RISE °F	F. & F. TANK TEMP	MAIN FEED 1ST ST. 2ND ST. TEMP	MEAN DISPLACEMT	SPEED IN KNOTS	FUEL CONSUMPTION TONS	FUEL CONSUMPTION #/SHP/HR.	FUEL CONSUMPTION #/100K	FUEL CONSUMPTION TONS/DAY
1	WEST	P.						255	21-22	251	503	97	19	7	0	83	½	96	28½		81	13								
		S.						255	21-22	253	502	95	17	8	2	83	5	94	28½		83	15								
		AVG.	69.93	10	270	510	97	255	21-22	252	502	96	18	8	1	83	2½	95	28½	68	82	14	111	192 / 233	24200	16.68	386	.779	74200	132.7
2	EAST	P.						255	22	254	512	104	16	3	-2	91	1	98	28½		75	8		196 / 235						
		S.						255	22	255	515	107	15	0	-5	89	3	93	28¾		76	9								
		AVG.	62.07	10	270	516	102	255	22	254	513	105	16	2	-3	90	2	95	28½	67	75	8	115	194 / 234	24750	18.88	347	.769	66300	134.1
3	WEST	P.						255	18-22	250	505	99	20	0	-7	75	0	98	28½		89	10								
		S.						255	18-22	250	498	92	20	7	0	77	6	98	28½		90	11								
		AVG.	58.75	10	270	505	92	255	18-22	250	501	95	20	4	-3	76	3	98	28½	79	89	10	120	192 / 235	24150	17.07	300	.814	67000	122.5
4	EAST	P.						255	18	230	499	100	40	10	-4	66	2	99	28½		88	9		189 / 236						
		S.						255	18	229	500	101	41	9	-5	64	9	95	28½		88	9								
		AVG.	61.58	9	270	509	96	255	18	229	499	100	41	10	-4	65	5½	97	28½	79	88	9	125	190 / 235	28100	16.35	266	.795	59100	103.6
5	WEST	P.						255	22-23	254	511	103	16	0	-5	88	1	99	28¼		86	10								
		S.						255	22-23	255	505	97	15	6	1	88	5	97	28½		86	10								
		AVG.	162.3	10	270	511	98	255	22-23	254	508	100	16	3	-2	88	3	98	28½	76	86	10	118	196 / 233	23150	17.42	897	.781	71000	132.8
6	EAST	P.			270			255	18-22	253	501	94	17	5	-1	81	1	99	28½		86	10		195 / 235						
		S.			270			255	18-22	253	505	98	17	1	-5	79	5	97	28½		87	11								
		AVG.	169.6	9 & 10	270	506	93	255	18-22	253	503	96	17	3	-3	80	3	98	28½	76	86	10	120	195 / 234	29500	17.13	868	.780	66900	123.0
7	WEST	P.						255	22	253	521	114	17	-1	-7	89	1½	90	29		70	14								
		S.						255	22	253	512	105	17	8	2	93	3	85	29		70	14								
		AVG.	19.22	10	269	520	107	255	22	253	516	109	17	4	-2	91	2	87	29	56	70	14	105	191 / 230	23100	18.35	115	.780	73000	143.4
8	EAST	P.						255	22	254	513	106	16	4	-2	92	1½	92	28¾		71	18		191 / 229						
		S.						255	22	254	513	106	16	4	-2	93	3	88	29		72	19								
		AVG.	19.15	10	270	517	104	255	22	254	513	106	16	4	-2	92	2	90	28¾	53	71	18	106	191 / 229	27400	18.43	115	.784	72900	144.2

* VACUUM AT CONDENSER BY VACUUM GAUGE

THE "BREMEN."

In the Liverpool Journal of Commerce of August 15th, there is an article on the "Bremen" of considerable interest, with comparative figures of other Liners as undernoted:—

	Campania	Mauretania	Bremen
Dimensions	600′ × 65′	760′ × 88′	888′ × 101·7′
Draft	23′ 0″	21′ 6″	32′ 8″
Approx. Displacement ...	18,000	35,000	50,000
Speed	21·82	25·4	27·865
H.P.	30,000 I.H.P.	68,000 I.H.P.	95,000 S.H.P.
Efficiency	·62	·63	·688

Further comparisons are given embracing results obtained from other vessels, with more data, as follows:—

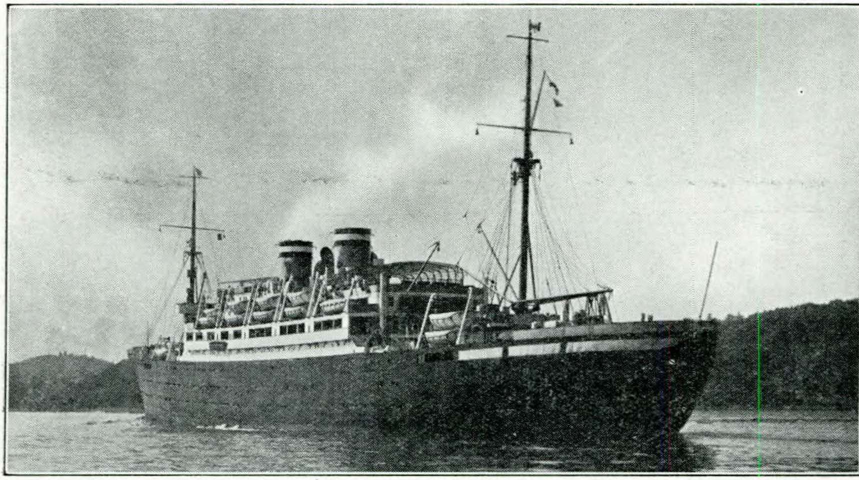
	Umbria	Paris	Campania	Kaiser Wilhelm Der Grosse	Deutschland	Kaiser Wilhelm II.	Mauretania	Bremen
Dimensions ...	500′ × 57′	528′ × 63′	600′ × 65′	625′ × 66′	602·75′ × 67′	625′ × 66′	760′ × 88′	888′ × 101·7′
Displacement ...	10,500	13,000	18,000	20,000	23,500	23,000	35,000	50,000
Draft	22′ 6″	23′ 0″	23′ 0″	—	29′ 0″	29′ 0″	31′ 6″	32′ 8″
Speed in Knots ...	19·3	20·01	21·82	22·35	23·01	23·12	*25·4	27·865
Type of Engine ...	Single Screw 3-Cylinder Compd.	Twin Screw Triple	Twin Screw 5-Cylinder	Twin Screw 4-Cylinder	Twin Screw 6-Cylinder	Twin Screw 8-Cylinder Quadruple	4 Screws Direct Turbines	4 Screws Geared Turbines
Boilers Work. Pres.	110 lbs.	150 lbs.	165 lbs.	170 lbs.	220 lbs.	225 lbs.	195 lbs.	350 lbs. Temp. 680 F°
Boilers Heating Surface (sq. ft.)	38,817	50,265	82,000	84,285	85,468	107,643	158,350	240,000
I.H.P.	13,000	18,000	30,000	31,000	36,000	40,000	64,000	—
S.H.P.	11,750	16,000	27,000	28,000	32,500	36,000	68,000	95,000
$\frac{\text{H.S.}}{\text{S.H.P.}}$	3·3	3·14	3·04	3·	2·64	2·98	2·32	2·52
$\frac{\text{Disp.}^{\frac{2}{3}} \times S^3}{\text{S.H.P.}}$ ...	292	277	264	294	308	300	260	310

* Recently increased to 27·04.

The first voyage is more or less a test voyage, and the "Bremen" may give a better performance on the coming runs. The form of the bow and the shape of the hull are somewhat out of the common, and doubtless the model was tested in the experimental tank at Hamburg before the design was passed. The plating is so arranged that when going ahead the "sight" edges of the joints look forward instead of aft as usual. It is said that this tends to force the water away from the following plate and so reduces the skin friction and resistance.

NEW HAMBURG-AMERIKA LINER "MILWAUKEE," WITH GEARED DOUBLE-ACTING DIESEL ENGINES. "The Marine Engineer and Motorship Builder," August, 1929.

The *Milwaukee*, which has just been built by Blohm and Voss, Hamburg, for the New York service of the Hamburg-Amerika Line, presents several novel mechanical features, having four Diesel engines geared to two propeller shafts. The ship will carry 456 cabin, 287 tourist-third, and 428 third-class passengers.



The principal dimensions are:—

Length, overall	175·07 m. (574 ft. 6 in.).
Length, on 8·84 m. (29 ft.) water-line ...	165·765 m (544 ft.).
Beam	22 m. (72 ft. 2 in).
Depth, moulded (to D deck)	11·2 m. (36 ft. 9 in.).
Draught	8·84 m. (29 ft.).
Deadweight capacity in above draught ...	10,320 tons.
Sea speed with wind force not exceeding 3 ...	16·5 knots.
Normal service speed	16 knots.
Gross tonnage	16,700.
Net tonnage	9,612.

The main machinery consists of four direct, reversible, double-acting two-stroke engines arranged in pairs and driving two propeller shafts through reduction gearing. The installation is the latest development of the Blohm and Voss system of marine drive. The object in view when this system was first adopted was the use of submarine engines in a merchant vessel where comparatively slow speed for the propeller shaft was essential. Extensive calculation and research were necessary to ensure that under all running conditions there was a positive pressure on the teeth of the gears, so that no tooth chatter could occur (see paper by Dr. Herm. Kahm, "Jahrbuch der Schiffbautechnischen Gesellschaft," 1924).

The above requirements were so satisfactorily met on the first two ships that were fitted with this type of drive (*Havelland* and *Münsterland*) that the Hamburg-Amerika Line, for whom they were built, ordered a passenger ship (the *Vogtland*) and a cargo ship (the *Friesland*), the former with the same drive as the *Havelland*, and the latter with two engines geared to a common shaft. As a further result of the satisfactory performance of these early ships, the Hamburg-South American Line placed orders for the *Monte Sarmiento* and the *Monte Olivia,* each with four oil engines driving two propellers through gearing. These ships have given satisfactory service for a number of years, and a third ship, the *Monte Cervantes*, has now been running for 18 months. All of the earlier ships were fitted with single-acting, four-stroke engines, but a further step forward with the geared drive is made in the present installation, where full advantage is taken of the small space occupied by, and the low weight of, the double-acting engine.

The main advântage of the indirect drive lies in the great saving in space and weight as compared with direct-coupled oil engines. The reduction in head room with fast-running engines is particularly valuable, as it makes the full length over the engine room through one or two of the deck spaces available for accommodation.

A further advantage claimed for the indirect drive on the *Milwaukee* is that the revolution speed of the engines is further removed from synchronism with the natural frequency of vibration of the ship's hull than would be the case if direct-coupled engines running at a lower speed were used. As a result of this, the probability of vibration is greatly reduced. Further, it must be remembered that a small, fast-running engine has less transverse force on the crossheads and smaller unbalanced forces and moments than a slow-running engine. Both of these facts assist in minimising ship vibration. A further advantage of the system lies in the fact that, even if one engine should, for any reason, have to be stopped, the ship can still continue her voyage at three-quarter power.

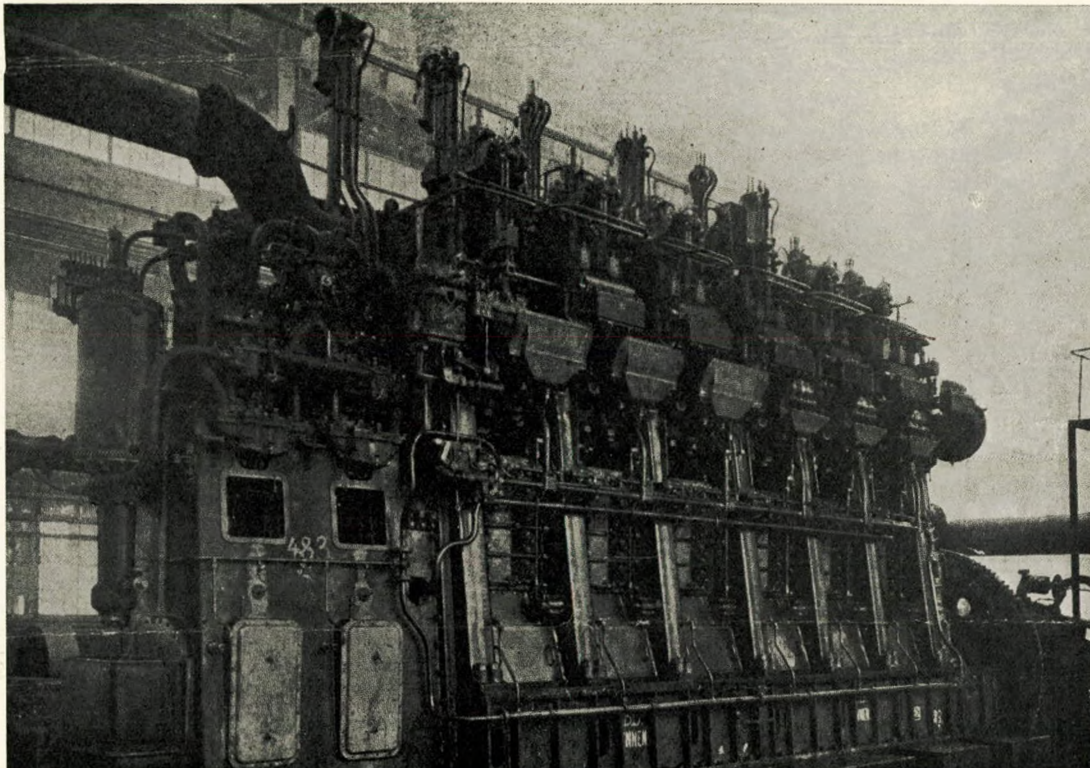
The small and light working parts can more easily be overhauled by the ship's personnel than could the heavy parts of direct-coupled engines.

On the early ships on which each engine drove its own propeller, elastic shafts were fitted in order to reduce the critical speeds. On later ships in which two engines are coupled to each propeller shaft, these flexible shafts have been omitted, as other means of avoiding torsional vibration have been found.

The crankshafts are direct coupled to the gear wheel couplings, and in this way the power is transmitted without loss between the engine and gearing. With direct coupling, the engines can be manœuvred as easily as a single engine, and the controls for both engines are arranged at a single control platform. The manœuvring of the engines is helped by stopping them quickly by means of automatic pneumatic brakes.

The main engines of the *Milwaukee* are of the M.A.N. six-cylinder, double-acting, two-stroke type built by Blohm and Voss. The cylinders are 500 mm. (19·7 in.) diam. by 640 mm. (25·2 in.) stroke and each engine develops 3,000 h.p. at 220 r.p.m. The gearing reduces the propeller shaft speed to 110 r.p.m. The engines are fitted with air injection. A closed system of fresh-water cooling is used for pistons, cylinders and cylinder covers. Scavenge air is provided by three electrically driven turbo-blowers, each having a capacity of 800 cub. m. (28,400 cub. ft.) per minute. Two blowers are sufficient to supply air for full-load running, the third acting as stand-by.

The exhaust gases of the main engine are passed through two waste-heat boilers of 200 sq. m. (2,150 sq. ft.) heating surface. The steam from these is used for heating, cooking, etc. The exhaust pipes are arranged so that the boilers can be by-passed, the exhaust gases going direct to the silencers, which are mounted in the forward funnel. Provision is made for oil firing in these boilers, so that steam is still available at times when the main engines are not running. Four electric generators are provided, driven by the latest type of six-cylinder, solid injection, four-stroke Blohm and Voss M.A.N. engines, having cylinders 400 mm. ($15\frac{3}{4}$ in.) diameter by 550 mm. (21·6 in.) stroke, and running at 275 r.p.m. The pistons are not cooled, but the rest of the cooling is carried out by fresh water as in the case of the main engines.



One of the Two-Stroke Cycle Double-Acting M.A.N. Engines of the Geared Motorship "*Milwaukee*" on the Test Bed in Blohm & Voss's Shops at Hamburg. The Engine develops 3,000 H.P. at a speed of 220 r.p.m.

The auxiliary machinery in the main engine room includes the following:—

2 fresh-water pumps for the main engine cooling system, each of capacity 820 to 1,200 tons per hour.

2 salt-water pumps for circulating the fresh-water coolers, each of capacity 900 to 1,200 tons per hour.

2 fresh-water coolers, each of 400 sq. m. (4,300 sq. ft.) cooling surface.

2 fresh-water drain tanks.

2 piston cooling water oil separators of the Blohm and Voss type.

1 make-up water pump of 5 tons per hour capacity.

3 gear-wheel type pumps for main engine lubrication system, each of capacity 90 tons per hour.

2 main engine lubricating oil separators, each of 90 sq. m. (970 sq. ft.) cooling surface.

2 lubricating oil separators.

1 combined oil transfer pump and 200 ton ballast pump driven by a common motor.

2 daily service tank fuel-oil pumps, each of 40 tons per hour capacity.

1 fire and sanitary pump of 75 tons per hour capacity.

1 bath pump of 20 tons per hour capacity.

2 drinking-water pumps, each of 20 tons per hour capacity.

2 sand filters for drinking water.

1 fresh water circulating pump.

1 hydraulic water-tight door-operating installation.

The equipment in the auxiliary engine room includes the following:—

2 starting air compressors, each of capacity 10 cub. m. (353 cub. ft.) per minute.

1 emergency compressor of capacity 15 cub. m. (530. ft.) per hour.

1 combined fresh water pump and auxiliary engine cooling pump for harbour service, both pumps having a capacity of 90 tons per hour, and driven by a common motor.

2 auxiliary engine lubricating oil pumps, each 25 tons per hour capacity.

2 auxiliary engine oil coolers, each 25 sq. m. (270 sq. ft.) cooling surface.

4 main engine starting-air bottles.

4 auxiliary engine starting-air bottles.

2 boiler forced-draught fans.

2 Simplex boiler feed pumps.

1 auxiliary condenser of 50 sq. m. (540 sq. ft.) cooling surface.

1 bilge pump of capacity 75 tons per hour.

1 evaporator and distiller installation.

The ammonia refrigerator plant is installed in a separate compartment between the two propeller shafts. It consists of two compressors, each of 250,000 kg. calories cooling capacity, together with their condensers, evaporators, moist-air cooler with ventilator, brine pump and cooling-water pump.

All auxiliaries are electrically driven, except the boiler-feed pump and the emergency compressor, which are coupled to a Diesel engine. The general arrangement of the machinery can be seen from the drawings of the engine and boiler rooms.

To provide the power required for the extensive electrical equipment, there are four 380 kw. oil-engine-driven generators. Three generators carry the normal load at sea, the fourth being a stand-by. The generators are compound wound, and work in parallel with safety switch arrangements of the type developed by C. Meyer. Above the water-line a 25 kw. emergency generator is provided. This is driven by an oil engine, and can be used for the most important services in case the main generating station has to be shut down. It is so arranged that it can be run in parallel with the main generators, if this should at any time be required. All electrical services on the ship are 220 volts, including the lighting installation, which has a total of about 5,200 points.

The ship ran 24-hour trials on June 11th. Six hours running on overload was carried out with complete satisfaction, no trouble being experienced during this period. After the full-power trial there was a manœuvring trial lasting for about an hour and a half. All orders were readily answered, and it was particularly noticeable that the working cylinder relief valves did not blow on any occasion when the engine was started. The engine was reversed from full ahead in 25 seconds, the time being counted from the moment when the order was given until the engine reached 110 r.p.m. in the reverse direction.

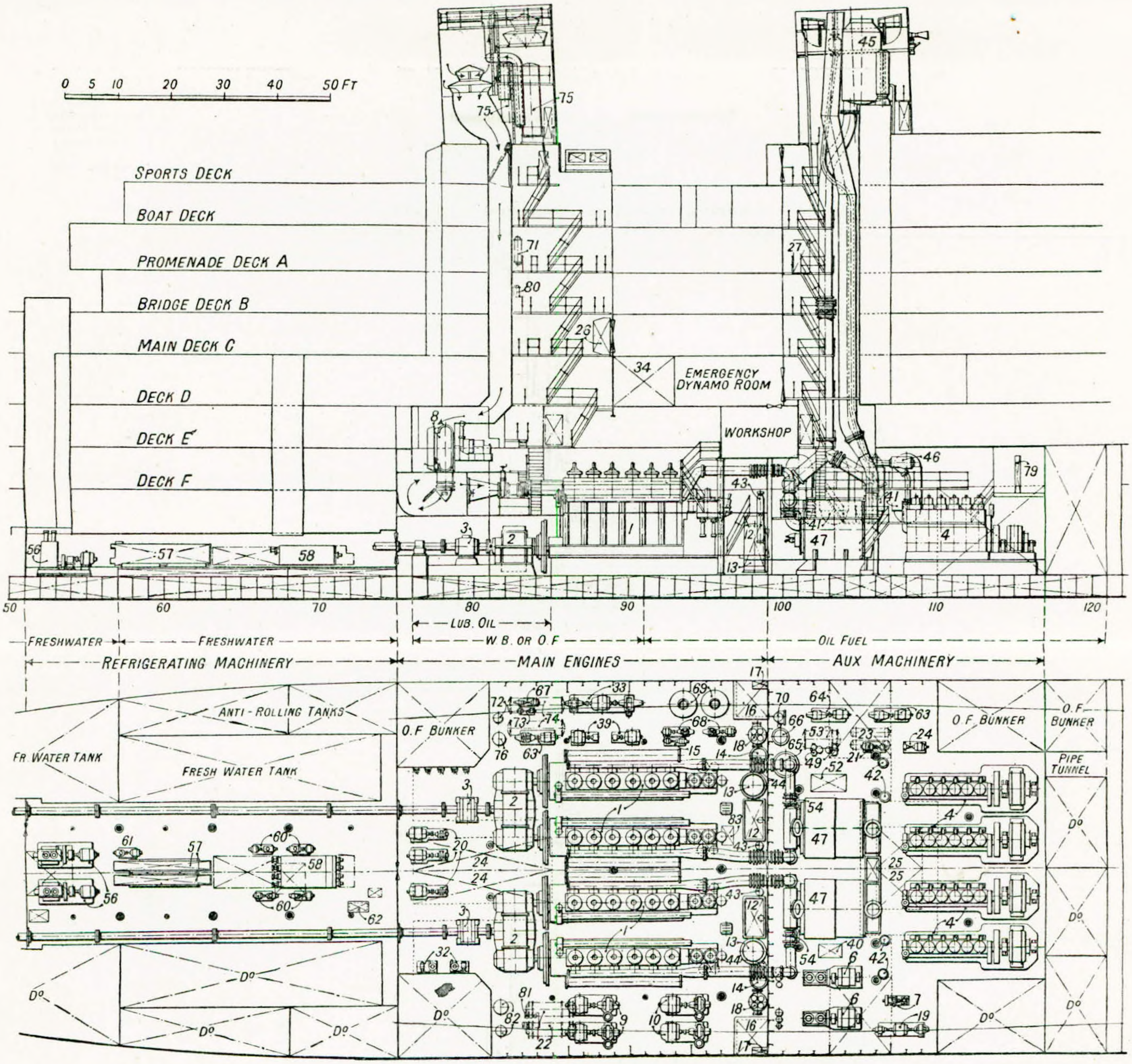
The lowest propeller speed at which the engines ran was 30 r.p.m. The ship circled for a considerable time with the starboard engine running full ahead, and the port engine running full astern. The ship also ran for some time with the outer engines only driving the propellers, the inner engines being disconnected at the gear coupling.

WELDING CAST IRON. "The Iron and Coal Trades Review," June 14th, 1929.

In a paper entitled "Metallic Electrodes for Cast Iron Arc Welding," Mr. Shun-Ichi Satoh,, of Tokyo, a member of the research staff of the Mitsubishi Research Laboratory, claims to have been able to obtain a series of cast irons, from grey to white, without using cast iron electrodes but by coating wrought-iron bars with mixtures of carborundum and graphite. Starting with a wrought-iron bar of the usual low carbon content, besides silicon, manganese and sulphur, the Japanese experimenter tried ten different mixtures of the graphite and carborundum coating. He found that the best mixtures were 60-40, 50-50 and 40-60 of the two ingredients. Each of the bars, or electrodes, was wound with a twine of asbestos and then coated with the mixtures (which were first reduced to paste by adding to them a solution of water glass) and then put in a glass tube of 9 mm. inner diameter, having a funnel-shaped mouth. The bars were then coated by passing them through this tube. Using the regular method of arc welding, the experimenter found that it was possible to imitate almost any analysis of grey iron. It was also found that electrodes which contain 1 per cent. of barium carbonate were the best. The fusion of an electrode could be retarded by adding barium carbonate to the coating of the electrode.

IRON OXIDE AND CARBON IN THE OPEN-HEARTH PROCESS. "The Iron and Coal Trades Review," June 14th, 1929.

In considering the mechanism of carbon elimination in the open-hearth furnace, it has always been assumed that the reaction between carbon and ferrous oxide produced carbon-monoxide gas at atmospheric pressure. Recent calculations from the best thermodynamic data available, made at the



General Arrangement of Engine Rooms.

1. Main engine.
2. Gear.
3. Thrust block.
4. Diesel engine generator set.
5. Emergency generator.
6. Starting-air compressor.
7. Emergency compressor.
8. Scavenge blower.
9. Fresh-water pumps for engine cooling.
10. Sea-water pumps for circulating fresh-water cooler.
11. Fresh-water cooler.
12. Fresh-water tank for cooling system.
13. Piston-cooling water oil-separator.
14. Filter for piston-cooling water oil-separator.
15. Make-up water pump.
16. Low injection valve.
17. High injection valve.
18. Weed trap.
19. { Harbour sea-water cooling pump. / Harbour fresh-water cooling pump.
20. Main engine lubricating-oil pump.
21. Generator engine lubricating-oil pump.
22. Main engine oil cooler.
23. Generator engine oil cooler.
24. Lubricating oil drain tank for main engines.
25. Lubricating oil drain tank for generator engines.
26. Lubricating gravity tank for main engines.
27. Lubricating gravity tank for generator engines.
28. Lubricating oil storage tank.
29. Lubricating oil settling tank.
30. Lubricating oil suction filter.
31. Lubricating oil heater.
32. Lubricating oil separator.
33. { Oil transfer pump. / Ballast pump.
34. Fuel oil daily service tank for complete installation.
35. Fuel oil rough filter.
36. Fuel oil turbulo type filter.
37. Fuel oil meter for main engines.
38. Fuel oil meter for generator engines.
39. Fuel oil pump for daily service tank.
40. Fuel oil collecting tank.
41. Air containers for main engines.
42. Starting air containers for main engines.
43. Injection air bottles for main engines.
44. Reserve injection air bottles.
45. Silencer for main engines.
46. Silencer for generator engines.
47. Waste-heat boiler.
48. Boiler forced-draught fan.
49. Boiler feed pump.
50. Boiler feed-water filter.
51. Feeder water meter.
52. Feed-water collecting tank.
53. Auxiliary condenser.
54. Sand boxes for oil-firing system.
55. Fire extinguisher.
56. Refrigerating machine.
57. Condenser for refrigerating machine.
58. Cooler.
59. Damp-air cooler and ventilator.
60. Brine pump.
61. Cooling-water pump for refrigerator plant.
62. Salt solution tank.
63. Sanitary and fire pump.
64. Bilge pump.
65. Oil separator for bilge water.
66. Filter for bilge water oil separator.
67. Bath pump.
68. Drinking-water pump.
69. Drinking-water sand filter.
70. Evaporator.
71. Distiller.
72. Fresh-water heater.
73. Fresh-water circulating pump.
74. Equalising tanks { for warm fresh water. / for warm sea water.
75. Fresh-water tanks in the funnel.
76. Sea-water heater.
77. Sea-water tanks in the funnel.
78. Foam fire-extinguishing apparatus.
79. Switchboard.
80. Drinking-water filter.
81. Pressure pump.
82. Pressure and water-separating tank.
83. Water-leakage collecting tank.

"MILWAUKEE." Key to Machinery Arrangement Drawings.

Pittsburgh Experiment Station of the U.S. Bureau of Mines, in co-operation with the Carnegie Institute of Technology and the Metallurgical Advisory Board, show that this pressure may be very much greater than atmospheric due to the large pressure exerted on a very small bubble by the surface tension of the liquid iron. This is analogous to the familiar phenomenon of superheating of liquids above their boiling points. The analogy can be carried still further to explain a number of disputed points in open-hearth operation. An ordinary liquid, once superheated, can be caused to boil violently by the addition of glass beads or small solid particles. The solid bodies serve as nuclei for the formation of gas bubbles at much lower pressures than if no solids were present. Similarly, the familiar sight of a bath of steel " boiling on a rod " or " boiling on bottom " may be interpreted as the effect of the solid in providing a point of origin for the bubbles of carbon monoxide. Since the amount of ferrous oxide in the bath necessary to cause carbon elimination at any given carbon content is proportional to this " excess pressure," it is felt that there are possibilities of lowering the iron oxide content of the bath, at a given carbon content, by reducing this " excess pressure " either by proper stirring or by some other method. The lower iron oxide content would reduce the amounts of inclusions formed on deoxidation, and, to a smaller extent, the amount of deoxidiser necessary.

INTERNATIONAL DAM CONSTRUCTION COMMISSION. " The Electrical Review," May 24th, 1929.

As a result of a movement started at the World Power Conference in Basle, Switzerland, in 1926, an International Dam Construction Committee has recently been organised, the object of which is the study of all technical questions in connection with the construction of large dams. The headquarters of the new Commission, on which twenty countries are so far represented, are in Paris. Signor Ponti, president of the Union of Italian Electricity Producers, has been elected the first president of the Executive Committee of the new body.

ELECTRICITY IN RICE CULTIVATION. " The Electrical Review," May 24th, 1929.

Experiments have been going on in China for some little time now in connection with the application of electric power to rice growing, and so much success has already been achieved that projects are being mooted for its intensive exploitation. One of the essentials in rice growing is water, and in many places irrigation by natural means is difficult and even impossible. On several farms pumping by electricity is now being carried on, motor-operated pumps of up to 20 h.p. capacity having been installed for this purpose. The Foochow Electric Co. is not only supplying the electricity in the neighbourhood of that city, but also wiring the farms and installing the pumps. The charge for energy is comparatively small and the water can be well controlled, promoting the growth of the plant and bringing it to maturity without risk of reverse from the moisture standpoint. It ensures a second crop within the year in places where only one crop can be grown under natural, or manual conditions. Proposals are now being made to run an overhead network of conductors over the rice swamps, to see whether the increased yield secured in experimental work by this course can also be secured on a commercial scale.

THE MERCANTILE MARINE. The reports of the British Association Meetings in South Africa are full of interest and from "The Times" of July 24th, the following is quoted:—

Dr. Smith dealt with "one of the oldest industries in the world—the first to which the results of pure research applied—the mercantile marine. The transformation of ships from the tiny cockles of Columbus's time to the present-day gigantic liners was made possible by the work of scientific men. Astronomers led the way in navigation. The gyrocompass was a development of the scientific triumph over the magnetic problem of the iron ship. Echo sounding was the latest development." After mentioning wireless telegraphy and the sextant, Dr. Smith declared that the "greatest advance lies in motive power." The mercantile marine "calls for more and more scientific help, for more knowledge of ship resistance, for better, lighter, and compacter engines, for further aid to the ship's fighting fog and ice. Perhaps the most difficult problem is the iceberg, but the sound echoes from a berg in the air or under the water. The day will come when the scientist will have command of excessively short wireless waves transmissible from the ship and reflectable from the iceberg, and receivable on a suitable receiver, so as to make detection a certainty."

THE "BRITANNIC." The "Electrical Review," August 23rd, 1929.

The White Star Co.'s new liner *Britannic*. claimed to be the largest motor ship in the world, was successfully launched at the Queen's Island, Belfast, at Messrs. Harland and Wolff's works, on August 6th. The *Britannic* measures 680ft. in length, has a beam of 82ft., a depth of 43ft., and gross tonnage of 26,840. She will provide accommodation for 1,550 passengers, and throughout is up-to-date in elaborate finish and detail. The vessel has an interesting electrical installation, energy being furnished by four Diesel-driven generators having a combined capacity of 2,000 kw., situated in a separate compartment next to the main engine room, and a 75 kw. Diesel-driven emergency generator, situated above the margin line. The cooking throughout is carried out electrically, including the main ranges and also such supplementary appliances as grills, roasters, fish friers, salamanders, griddle plates, and hot presses; the baker's oven, together with the oven in the confectioner's shop is also electrically operated. The ventilation is provided by about 75 electrically-driven pressure fans, ranging in size from 10 to 55in. in diameter; the fans include a number fitted with heating elements, by means of which the vessel can be kept comfortably warm in the coldest weather which may be experienced *en route*, the air-heating fans being supplemented by electric heaters distributed throughout the accommodation. The deck machinery includes sixteen electrically-driven winches, steering gear, four large capstans, and two large warping winches. Each of the four capstans is driven by a 170 h.p. motor, each of the after capstans by a 100 h.p. motor, and each of the warping winches by a 105 h.p. motor. In addition, a number of service motors drive such apparatus as dough mixers, potato peelers, dish washers, elevators, store hoist, pantry hoist, ice-rocking machine, and silver-cleaning machine. There is also a very complete wireless installation and two electrically-operated sounding machines.

All the engine-room auxiliaries, of which there are over 60, are electrically operated, the individual horse-power for driving the pumps varying from 100 down to $2\frac{1}{2}$. For the call-bell system, instead of the usual bell indicators, there are installed outside each stateroom two small electric lamps, one coloured red for the steward and the other green for the stewardess. They are operated by similarly coloured pushes in each stateroom, and the lamps remain lit until the attending steward or stewardess operates the push, which is fixed outside each stateroom door. Tell-tale lights are also placed in central positions throughout the vessel, not only to indicate the deck on which a call has been made, but also to guide the attendant to the stateroom. By this means it is anticipated that a very efficient and silent service will be maintained. The extent of the lighting may be gathered from the fact that the equivalent of over 7,000 30 watt lamps is installed throughout the ship.

The propelling machinery, which has been constructed by Messrs. Harland and Wolff, consists of two ten-cylinder, double-acting, four-cycle, oil engines of the Harland-B. & W. type, the cylinders being cooled by fresh water and the pistons by oil. Four independent injection air compressors, each driven by four-cylinder trunk-type motors of the same make, are fitted, and these also supply air to four reservoirs for manœuvring purposes. Four generators have been arranged to supply the necessary electric power for engine room and ship's purposes, and are driven by six-cylinder trunk motors of the same general type as the air compressors. One small steam-driven emergency compressor is also fitted. Four main engine exhaust-gas-fired boilers will generate steam at sea; also one auxiliary engine exhaust-gas-fired boiler and two cylindrical single-ended boilers, oil-fired only, will be available for generating steam in port and at sea for heating and cooking purposes.

THE SHIPPING AND ENGINEERING EXHIBITION.—At the invitation of the authorities of the Shipping, Engineering and Machinery Exhibition, Olympia, the Association of Supervising Electrical Engineers is paying an official visit to the Exhibition on Saturday, September 21st. The programme is as follows:—1 p.m.—The President, Past Presidents and the Board of Control will lunch with the Exhibition authorities; 2.15 p.m.—Reception and registration arrangements; 3 p.m.—Conference, at which a paper will be given on "Electricity as Applied to Modern Commercial Shipping," by Mr. E. M. Johnson; 4.45 p.m.—Members and Associates will take tea with the Exhibition authorities; 5.30 p.m.—Official inspection of the Exhibition.

The Association, in arranging for the paper on "Electricity as Applied to Modern Commercial Shipping," has in mind the important developments which are taking place in this connection, and the need for further publicity and education with regard to the matter.

TELEPHONIC COMMUNICATION AT SEA.—According to an announcement in "The Nautical Gazette," N.Y., the *Leviathan* is about to be fitted with a radiophone so that communication will be established between the vessel, where-so-ever it may be at sea or in port, and America, with the 18,000,000 telephones in the United States. It is intended to have a switchboard fitted on board with connection to each of the cabins. The connecting station is to be at Deal, New Jersey.

S.S. "VIRGINIA."—"The Marine Review" refers to the turbo- electric driven *Virginia*, as being economical and doing good service following the *California*. They are sister ships save that the *Virginia* is slightly larger. According to reports they are giving satisfactory results in speed and consumption.

SCIENCE AND ENGINEERING (By Prof. F. C. Lea, D.Sc., President of Section G—Engineering). "The Electrical Review," August 23rd, 1929; Report of Meeting of the British Association in South Africa.

It is not desired in this address to emphasise the intellectual or political influences of engineering, but rather to suggest: (1) the vital importance of scientific research to engineering, (2) that as in the remarkable engineering developments of the last century the scientific method has been the key to progress, even so it must be in the future, and (3) that there are many engineering problems of great interest and importance, not only to engineers, but to the general public, which can only be solved by supplementing experience by direct and indirect attack, using all the aids that mathematical and experimental science can give. It is also desired to suggest that all the arguments for a public interest in scientific research apply with particular force to the work of this section.

Engineering is much older than modern science. The engineer to-day has to guide him the accumulated experience of many thousands of years, and for a solution to many problems with which he is faced he has to fall back upon this accumulated experience and his intuitive ability. For this reason it is sometimes argued that engineering is an art, and that it owes little to science. The revival of experimental method leading to the wonderful conquests of physics and chemistry, and in the new attempts to co-ordinate the results of experience into a body of theory, assisted by the new mathematics, gave to engineering that impetus and assistance necessary for the achievement of the last century.

"Meanwhile, let no man look for much progress in the sciences, especially in the practical part of them—unless natural philosophy be carried on and applied to particular sciences and particular sciences be carried back to natural philosophy," wrote Francis Bacon in 1620. Twenty-four years after Bacon wrote these words Galileo died, and in the same year Sir Isaac Newton was born. From their joint labours, carried out without any desire for practical usefulness, came the principles of mechanics, without which much of the progress of the last three centuries would have been impossible.

A little more than sixty years after Watt built his first steam engine, Michael Faraday discovered that a magnet could be made to spin round a fixed wire through which a current of electricity was flowing, and a wire containing a current could be made to spin round a fixed magnet. Without these and other equally fundamental experiments the wonderful developments of the generation and transmission of power which have taken place during the last fifty years, as well as the application of electricity to almost every need of the engineer, would have been impossible.

It is true that Carnot and Clausius came after Watt to perfect thermo-dynamic theory, and the modern theories of electricity were not known when Siemens made his first dynamos, but experimental and mathematical science had shown the way to engineering developments of the greatest significance to the life of the world. Water-wheels were used to raise water 2,000 and more years ago, but in the seventeenth century water-wheels were little different from those described by Vitruvius in the first century before Christ, and had efficiences well below 50 per cent. In the latter part of the eighteenth century, organised experiments on the flow of fluids had been carried out, relative velocities, momentum, and kinetic energy were well understood. The next step was made by Pancelet in 1832, who enunciated the guiding principles underlying the design of vanes receiving moving fluids, and from that time progress has been so remarkable that to-day water turbines of more than 70,000 h.p., having efficiencies greater than 80 per cent., are being constructed, and millions of horse-power are being generated by water power. The brilliant achievements in the development of the steam turbine of Sir Charles Parsons and others following in his steps are to-day well-known. At the beginning of the nineteenth century there were probably 10,000 engines in England giving a total horse-power of about 200,000. To-day steam turbines, each capable of developing more than 200,000 h.p., have been or are being made for stations in various parts of the world. It seems very doubtful if this could have been possible except as a consequence of the work of Pancelet and two centuries of scientific experiment. The rapid developments of high-tension distributions of power have been made possible by research in the laboratory. Many attempts had been made to utilise the explosive force of gunpowder, hydrogen, and coal gas for power production before the modern 4-cycle internal combustion engine was developed, but without success, until it was recognised from thermo-dynamical considerations that compression is essential before ignition. The principles of geometrical and dynamical similarity based upon strict mathematical reasoning have been of the greatest service in the development of ships, aeroplanes, and airships. The work of Sorby on the micro-sections of rocks has led to micro-photography of metals, which has been of the greatest assistance to the metallurgist in the development and control of those metals which have played such a revolutionary part in modern engineering. Unfortunately, sufficient use is not made by engineers of this powerful aid to uniformity of product. Accurate pyrometry and uniform distributions of temperature in heating furnaces are essentials of success in many branches of engineering using alloys of steel and aluminium, cold-worked metals, and many other forms of materials.

The important steps that have been made in engineering during the last hundred years and that distinguish this century from all preceding ones, were made possible by fundamental discoveries of science, and it can safely be anticipated that no new epoch-making developments in the future will be possible unless they are preceded by new fundamental scientific discoveries. Sufficient energy can be transmitted across oceans by directed beams to allow of telephonic communication, but it seems improbable that wireless transmission will be possible for the large outputs of power-generating stations.

Rutherford has shattered the nucleus of the atom. Dr. Krapitza, in the Cavendish Laboratory at Cambridge, has claimed to have reached temperatures of 1,000,000° C., and Eddington tells us that in the great power houses of the sun and the stars, where the temperatures are, it is estimated, as high as 40,000,000° C., the energy of the escaping electrons of the atoms is the source which for millions of years has made, and will make, it possible for the sun and stars to radiate energy without appreciable fall in temperature.

It may be impossible for atomic energy in large quantities to be obtained and controlled. Also it may be equally impossible to obtain energy by the synthetic building up of other elements from the fundamental element, hydrogen; but it seems certain that only by following the new ways opened by pure science can there be hope of success. As many years ago there came the new and wonderful discovery of voltaic electricity, while Galvani was making experiments with frogs, so in the future a biologist or chemist or physicist, working on some subject entirely remote from the production of energy, may make discoveries which the Watts and Faradays of the future may use to change the life of the world.

From the point of view, then, of developments in engineering, modern communities cannot afford to neglect the encouragement of scientific research, even in those subjects which at present may seem most remote from its activities. Upon almost every section of this association, engineering lays tribute, and in return engineering has given something at least to make possible much of the brilliant work associated with other sections. The precision of modern engineering made possible the manufacture and control of the great telescopes and other instruments upon the accuracy of which the possibility of testing the attraction, predicted by Einstein, of the light rays of the stars by the sun depends.

In his essay on James Watt, Frances Arago wrote in 1834: "There are two things to be considered in every machine; on the one hand the moving power, and on the other the arrangement, more or less complicated, of the moving parts," and, he might have added—the difficulty of materials suited to the new purpose.

Many years of labour experimenting with materials were necessary before the steam engine was at all perfect, and in every step that has been taken in the direction of higher pressures and higher temperatures, new materials and new processes have been necessary before success could be achieved.

Much has been done in the development of prime movers, but there is perhaps no movement in engineering to-day that is of greater interest than the attempts that are being made considerably to increase the efficiency of power production from coal and other fuels. The average overall thermodynamic efficiency of the public stations distributing electrical energy in Great Britain for the year ending March, 1928, was about 15 per cent. The best station had an efficiency of 21·3 per cent. Recently a power unit has been supplied from England to Chicago which on test gave an efficiency of 34 per cent.—a remarkable figure. Making allowance for boiler losses, efficiencies of from 25 to 35 per cent. ought to be possible, therefore, in the future, and if only suitable materials can be developed to meet the onerous conditions of temperature, corrosion, and erosion, higher efficiencies than 35 per cent. may be anticipated with steam plant. Still higher thermodynamic efficiencies may be expected, as well as the chemical riches of the coals preserved, if, as a result of research, solid fuel engines or gas turbines can be developed. At the temperature of from 400° F. (205° C.) to 600° F. (315° C.), at which boilers and super-heaters have until recently worked, mild steels have been found suitable. To realise higher efficiencies than at present, much higher temperatures will be required, and at contemplated temperatures of 1,000° F. (538° C.) and upwards carbon steels creep at low stresses. Below a certain stress, at a particular temperature, which I have ventured to call "The limiting creep stress," the creep ceases, or becomes so small, that it cannot be observed in a number of days. This limiting creep stress is evidently the important factor in the problem of high working temperatures. Experiments indicate that with alloy steels, limiting creep stresses much higher than those obtained from carbon steels may be expected, and that alloys of iron, nickel, chromium, with or without other alloyed elements, containing as much as 60 per cent. of nickel and chromium, have considerable strength at high temperatures, and also resist corrosion and erosion. There is still, however, a very large amount of research to be done in which the laboratory and the workshop must co-operate, as new workshop technique is required before these alloys can be used for specific purposes. More rapid progress could be made and a much bolder policy pursued, if the public organisations and the large power distributing companies and authorities accepted the responsibility of the provision of funds for research. In the Universities much fundamental work can be done if funds are available. The Department of Scientific and Industrial Research is assisting industry and the National Physical Laboratory to carry out researches on the physical properties of metals at high temperatures.

NAVIGATION BY WIRELESS.—The navigation of a ship from Finisterre to Liverpool through fog solely on wireless bearings is reported in a communication from the master of the motor vessel *Athelking*. The *Athelking* carried a Marconi direction finder, and, commenting upon the efficiency of coastal wireless beacon installations used in conjunction with the ship's direction finder, the captain states that he was able to take the usual four point bearings for some distance off in spite of the fog. The report again emphasises the valuable aid rendered to navigation by wireless beacon stations, two more of which have recently been completed by the Marconi Company for Trinity House. Installed at Cromer and Dungeness lighthouses, they will prove a very useful addition to the facilities available in the Channel and North Sea to ships equipped with wireless direction finders.

INSTITUTE NOTES.

TITANIC ENGINEERING STAFF MEMORIAL FUND.—Donations received from Messrs. E. L. Hunter, Member, 7s.; H. Melville, Member, £1 1s.; F. A. Trigg, Member, £1 1s.; J. W. Hall, Associate Member, 3s.; H. W. Bugg, Member, 8s. 6d. R. Carruthers, Member, 8s. 6d.; Cecil Hughes, Associate Member, 7s. 6d., are gratefully acknowledged with the thanks of the Committee.

BOOKS ADDED TO THE LIBRARY.

Presented by the Publishers.

"Hints on Oxygen Metal Cutting." Booklet No. 2. Published by the British Oxygen Co., Ltd., Edmonton, London, N.18. 6½in. x 4in. Pp. 64. Price 6d.

The issue of this little booklet is an intelligent gesture on the part of the British Oxygen Co., Ltd. It is well written and profusely illustrated, in fact a *vade mecum* for all those interested in the practical side of oxygen metal cutting.—A.J.

PURCHASED.—

"Regulations relating to the Examination of Masters and Mates in the Mercantile Marine." Published by H.M. Stationery Office, 1925 (reprinted 1929). Price 1/6.

"Report of the Committee appointed by the President of the Board of Trade to advise on Load Lines of Merchant Ships, and Special Load Lines for Steamers Carrying Timber Deck Cargoes and for Tankers." Published by H.M. Stationery Office, 1929. Price 2/-.

ELECTION OF MEMBERS.

The following were elected at Council Meeting on Monday, September 2nd, 1929:—

Members.

Cecil Godfrey Binks, 14, Caldy Road, Aintree, Liverpool.

James William Bruce, Harbour Works, Cochin, Malabar Coast, South India.

Edward Leslie Chounding, 52, Milroy Avenue, Kensington, Sydney, N.S.W.

Rene Cortes, Lieut.-Engr. Chilean Navy, Club Naval, Valparaiso, Chile.

John Mordey Dyer, 111, Fulwell Road, Sunderland.

George Willie Gunn, 3, Grinden Avenue, High Ford, Sunderland.

Harry Joseph Hetherington, 21, St. Mildred's Road, Lee, S.E.12.

Thomas Spensley Howes, Hall Engineering, Ltd., Vitre Street, Montreal, Canada.

Frederick Kemp Keer, Aldringham, near Leiston, Suffolk.

John McBride, 7, Morton Terrace, Greenock, Scotland.

Alexander McCallum, 4, Octavia Street, Port Glasgow.

John McInnes, Third Engr., S.S. *Barjora*, c/o McKinnon, McKenzie & Co., Ballard Estate, Bombay.

Henry Nicholls, 55, Willoughby Road, Wallasey, Cheshire.

Frederick Thomas Price, S.S. *Golconda*, c/o McKinnon, McKenzie & Co., Ltd., Strand Road, Calcutta, India.

Edgar Arthur Roberts, c/o The Armstrong Construction Co., Ltd., Royal Airship Base, Karachi, India.

Associate-Members.

Charles Davidson, 55, Bedford Place, Aberdeen.

Harry Marshall, Glenfield, Maidstone Road, Rochester.

Alfred James Pottinger, New Zealand Refrigerating Co., Timaru, N.Z.

John Verschueren, 26, Duthie Terrace, Mannofield, Aberdeen.

Associates.

Joseph Arthur Hackett, 126, De Grey Street, Hull.

John Macdonald, *c/o* Vacuum Oil Co., Port Said, Egypt.

Robert Napier Orren, 54, Little Heath, Old Charlton, S.E.7.

John Hodson Trickey, 8, Claremont Road, Highgate, N.6.

Graduate.

Thomas Whitehead, New Barn Farm, Hesketh Road, Rochdale, Lancashire.

Transferred from Associate-Member to Member.

Walter Clarence Baker, Burns, Philp and Co., Bridge Street, Sydney, N.S.W.

Harold Reginald Clayton, 6, Pelham Road, Wallasey, Cheshire.

Joseph Ellson, 159, Woods Moor Lane, Stockport, Cheshire.

Thomas Anthony Qualters, 274, Knowsley Road, Bootle, Liverpool.

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BOILER EXPLOSION REPORTS.

REPORT No. 2926. S.S. *City of Paris*.

This refers to an explosion from a boiler on the S.S. *City of Paris*. The enquiry was conducted by Mr. R. W. Gunston, Board of Trade Surveyor, Glasgow.

The boiler is a single-ended return tube marine boiler, 16ft. 7ins. in diameter by 12ft. 7ins. long. It is fitted with four corrugated furnaces, each with its own combustion chamber. The mountings include two glass water gauges at the front end and two safety valves adjusted to blow off at 225 pounds per square inch. The water gauges are of the hollow-column type, each end of which is connected to the shell by means of a pipe and cock.

The boiler was about seven years old, and was made by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne.

No repairs have been made beyond keeping the mountings in good working order.

The crown of the starboard wing furnace of the forward starboard boiler was deflected downwards 16 inches. The back tube plate attached to this furnace was buckled in about 2ins., fracturing two of the lower and two of the upper stay tubes, thus allowing the contents of the boiler to escape. The tubes in this tube plate were compressed oval, the chamber crown being down about 2ins. The port wing tube plate was buckled about half-inch between the furnace and the lower tubes. The tubes in this plate were also compressed oval, the chamber crown being down about $\frac{3}{4}$-inch.

The explosion was due to shortage of water. This vessel is employed on regular trading between Glasgow, Liverpool and Indian ports. It is fitted with five single-ended marine type boilers in one boiler room. They are coal-fired and are fitted with closed ash pit forced draught.

On 1st January, 1928, the vessel called at Marseilles on the way home from India, and while in this port the forward starboard boiler was used for auxiliary purposes. On 3rd January, 1928, the vessel left Marseilles for Plymouth. The first move of the engines was at 6.30 a.m., and all clear, full speed ahead at 7.20 a.m.

At 11 a.m. steam and water commenced coming from the smoke box of the forward starboard boiler. It was at first thought that a superheater element had failed. The boiler was therefore isolated, the safety valves eased and the fires drawn. Subsequent examination showed the boiler was damaged as already described, and that the superheater elements were intact.

The two forward boilers face aft, and their feed check valves are fitted on the back ends of these boilers. The main and auxiliary check valves and a master shut-off valve are in one chest. In order to get at these valves one has to go down a narrow dark space at the side of the boiler and then climb a short vertical ladder to a grating which runs along the back of the boiler at about half height. As they are thus rather inaccessible, intermediate feed control valves have been inserted into the main and auxiliary feed pipes to these boilers. These intermediate valves are placed near the front of the boilers, and can be worked from the stokehold platform by means of extension handles.

While the vessel was in Marseilles the forward starboard boiler was used for auxiliary purposes, and was fed through the auxiliary check valve. It is thought that the main check valve was shut, and that it was not re-opened when the boilers were put back on the main feed supply, preparatory to leaving Marseilles. The engineers on watch would then endeavour to regulate the feed to this boiler by the intermediate valve, without realising that the check valve was shut.

Why the shortage of water was not discovered by the engineers on watch has not been ascertained, but the evidence that the water had been allowed to sink to about level with the crowns of the wing furnaces is (1) the damage already reported; (2) the interiors of all the other combustion chambers had a thin coating of soot below this level, but above it the soot had been burnt off and riveted seams were open, so that a feeler could be inserted; (3) under a water pressure test applied subsequent to repairs the smoke tubes in the centre boxes were tight below this level, and slack in the tube plates above it, and (4) the explosion occurred about four hours after leaving Marseilles. Normally this boiler would evaporate about 27 tons of water in four hours, but if it had received no feed water in that time, the amount evaporated would be rather less on account of loss of heating surface. It is computed it would require about 20 tons of water to raise the level from three inches below the wing furnace crowns to the working level.

It has been suggested that the explosion might have been caused by oil on the heating surfaces, and in this connection it is notable that the auxiliary machinery of this vessel was given rather more than one quart of internal lubricating oil per day. The exhaust from these auxiliaries went into a surface feed heater, and the drainage from this heater did not go through the feed water filter before being returned to the boilers. There was, however, no sign of grease inside the boiler, either on the shell or on the heating surfaces. Specimens of scale and sediment taken from the furnace crown and tube plates respectively have been analysed and showed no trace of free oil, but there were traces of carbon which may have been the residue of burnt oil. Other boilers in the vessel have also been examined, and appeared quite free from grease.

There is agreement in the evidence of the engineers that when the vessel left Marseilles the water was showing from $\frac{3}{4}$ to $\frac{7}{8}$ glass in all boilers. The evidence is also that both water gauges are always kept in use. There is no evidence that any of the gauge cocks had been left shut, or partly so. When the vessel arrived in Glasgow the water gauges of this boiler were completely dismantled in my presence. All passages were found perfectly clear and the cock handles had not been bent, so as to give a false indication as to whether they were open or not. The heating surfaces were clean, and corroborate the Chief Engineer's statement that the boiler was cleaned in Bombay.

Observations of Mr. A. E. Laslett, Engineer Surveyor-in-Chief.

Overheating and consequent collapse of furnaces has sometimes been attributed to oil deposited on the water side of the plate, but the nature of the damage sustained in this case and its extent indicates that the explosion was due to shortage of water.

Under ordinary conditions in a ship with a moderate number of boilers, when there is no abnormal loss of feed, it soon becomes evident from the rising water level in the remaining boilers that the feed to a particular boilers is insufficient, but from the statements of the engineers on this occasion there were apparently no signs of loss of feed water, nor was there marked difference in the water levels shown by the water gauges on the various boilers. In these circumstances the shortage of water is inexplicable.

The general arrangement of the machinery in this ship is no doubt satisfactory, but it is advisable that essential boiler mountings, such as feed check valves, blow down cocks, etc.. should be placed in positions which are easily accessible, so that their setting can be readily seen, and can be adjusted as required. It is probable that if in this case the feed valves had been so arranged, the engineer in charge would have noticed that the check valve on the boiler which was damaged had not been opened.

REPORT NO. 2,960. S.S. *Gladiator*.
O.N. 135567.

Explosion from cast iron steam stop valve on S.S. *Gladiator*. Investigated by Mr. J. M. Binmore, B.T. Surveyor, Glasgow.

The explosion occurred at about 8 a.m. on 24th October, 1928, when the vessel was lying in the Queen's Dock, Glasgow.

Two firemen, Charles McCartney and John Robert Wynne, members of the ship's crew, were so badly scalded that both died of their injuries within 24 hours of the accident.

The stop valve was of the globe type, the chest being made of cast iron 15/16th inch in thickness, and of the following general dimensions:—Bore, inlet and outlet, 5 inches diameter; flanges, $10\frac{3}{8}$ inches diameter, $1\frac{3}{8}$ inches thick; length overall, $19\frac{3}{4}$ inches

The brass valve seat fitted to the central division plate was $5\frac{1}{4}$ inches bore and 5/16th inch thick. The brass spindle for operating the valve was $1\frac{3}{8}$ inches diameter and screwed six threads per inch. The cover was made of cast iron, $11\frac{1}{2}$ inches diameter, $1\frac{1}{8}$ inches thick, and was secured to the chest by 9 studs $\frac{3}{4}$ inch diameter.

The explosion was of a violent nature. The chest of the valve fractured longitudinally on both sides above the diaphragm and circumferentially inside each flange, the upper portion with the valve and spindle attached being blown away. In addition, the central diaphragm was split over its entire length, and the longitudinal fracture of the chest extended on one side through the outlet flange. No other material damage was done, but the bulk of the steam contained in the starboard and centre boilers escaped through the orifice into the stokehold.

The failure of the stop valve was due to water hammer action.

The steamship *Gladiator*, formerly named *Saint Quentin*, was built in 1914 by Messrs. William Hamilton and Co., Ltd., Port Glasgow, the machinery being made and installed by Messrs. David Rowan and Co., Ltd., Glasgow. Three cylindrical multitubular boilers, each having three furnaces, were fitted, and the working pressure was 180 lbs. per square inch. The steam pipes were all of 5in. bore, 5/16th inch thick, and made of wrought iron. The valves and junction piece were made of cast iron of substantial thickness, and well ribbed where necessary. The intermediate globe type stop valves were inserted in each branch to meet the requirements of the original owners. Drainage of all pipes was provided for by small valves fitted to the outlet side of each main boiler stop valve, but these could only drain the respective branch pipes when the intermediate stop valves were open. No drain was fitted to the engine stop valve, but heating up of the range could be done by using the impulse valve to cause a flow of steam.

The vessel was purchased by her present owners in March, 1918, and no renewals, repairs or alterations have been made to the main steam pipes or valves since that date, except that the three drain valves were renewed between the 13th and 16th October, 1928. The Chief Engineer had served at sea for 22 years and held his present position for about 12 months. He stated that he had always exercised great care to see that the range was drained before the main boiler stop valves were opened and it was at his request that the drain valves were recently renewed. That great care was exercised in this respect is borne out by the evidence of the other engineers.

The vessel left Liverpool on 17th October last and arrived at Glasgow the following day. When the use of the main engines was no longer necessary the main boiler stop valves on the three boilers, and the intermediate stop valves attached to them, were closed. The port and starboard boiler fire were then allowed to die out, and steam was maintained on the centre boiler for cargo working and general purposes.

At midnight, 22nd-23rd October, the fires in the starboard boiler were again lighted. At 8 a.m. the intermediate stop valves on both the centre and starboard branch steam pipes were opened and the centre main boiler stop valve was eased slightly to warm the range of pipes. At 9 a.m. these two boilers were under equal steam pressure and the engineers proceeded to couple them by means of the main steam pipes. The centre main stop valve was first closed and then the drain valves on it and the starboard main stop valve were opened. When clear of water the two main valves were gradually opened to their full amount and the drains closed. From then onwards up to the time of the explosion no alteration was made in the condition of any of the stop valves or drains, and no sign of any defect had been observed.

At about 3 to 4.15 p.m. the vessel was moved to a coaling berth in the Queen's Dock, the main engine being in use. It was then anticipated that coaling would be completed at 7 a.m. the following day and the vessel then be moved to a loading berth. In consequence of this the Chief Engineer gave orders that steam should be left on the main range, as he considered this procedure to be more safe than closing down and having to open up again in the morning and reheat it. The 4th engineer was on watch throughout the night whilst coaling operations were in progress, and he stated that the vessel was listed in varying amounts to port during the whole time up to his relief at 7 a.m. on the 24th. The 2nd engineer was informed, at about this time, that the main engines would not be needed until 11 a.m. and in consequence there was no necessity of then using steam from the main range for heating them.

At about 8 a.m. the vessel was noted to heel rather rapidly a few degrees to starboard, and this movement is presumed to have caused condensed water to flow from the port branch steam pipe into the centre and/or the starboard one. A considerable portion of the colder port steam pipe was thus exposed to an inrush of steam, which set up water hammer action of a most severe nature, and caused the explosion. The steam pressure on the boilers at the time of the accident was about 175 lbs. per square inch. Four men, the donkeyman and three firemen, were employed in the stokehold at the time, and the former and one fireman escaped by passing between the boilers and through the door into the engine room. The other two firemen climbed the stokehold ladder and reached the deck, but, unfortunately, were so terribly scalded whilst mounting the stokehold casing that they died from their injuries.

The severity of the shock sustained by the valve which failed was evident from the nature of the factures, the valve being of heavy scantling, uniform in thickness and of sound metal.

It has been decided that the intermediate stop valves will be changed to the higher ends of the branch pipes. In these positions they will still serve as a second stop valve to isolate any boiler not in use and will at the same time prevent accumulation of condensed water in the branch pipes.

Observations of Mr. A. E. Laslett, Engineer Surveyor-in-Chief

The introduction of intermediate stop valves between the boiler stop valves and the respective branch steam pipes, which was apparently effected at the request of the original owners of the vessel, afforded adequate means for isolating any of the boilers not in use, but as these valves were not furnished with drain fittings it was not possible, when the valves were used for the purpose for which they were intended, to avoid the possibility of water accumulating in the pipes, with consequent risk of water hammer action. That the risk was a very serious one was borne out in a most regrettable manner by this explosion, which caused the deaths of two men. If the intermediate stop valves had been fitted originally at the junction piece at the after ends of the branch steam pipes, as now decided upon by the present owners, and if suitable drain fittings had been provided, the isolation of the boilers would have been safeguarded and, with due care in the manipulation of the valves and drain fittings, the risk of water hammer action eliminated.

REPORT No. 2961. Steam Trawler *Charles Boyes*.

O.N. 143886.

Explosion from blow down pipe on Steam Trawler *Charles Boyes*. The investigation was conducted by Mr. S. A. Watson, B.T. Surveyor, Belfast.

The pipe was made of solid drawn copper and was $2\frac{1}{4}$ ins. in external diameter; the thickness originally was 12 Imperial Standard Gauge.

It was connected by means of flanges, $6\frac{1}{2}$ inches in diameter, to the boiler blow down valve, and to a switch cock; the distance between these points of attachment was 3ft. 6ins. The pipe was bent in a vertical plane to suit the different positions of the blow down valve and switch cock.

The machinery was installed in 1918 by Messrs. Amos and Smith, Ltd., Hull, and the pipe in question was supplied to them by Messrs. William Broady and Son, Coppersmiths, Hull, but the latter firm cannot definitely state who were the makers of the pipe.

The present manager states that the vessel has been under his control since 1919, and that no repairs have been made to the pipe, and, therefore, it is probably correct to state that the pipe was about 10 years old at the time of the explosion.

Whilst the boiler was being blown down, to reduce density, the blow down pipe ruptured between the blow down valve and the switch cock, forming an opening about $7\frac{3}{4}$ inches in length, and about $1\frac{1}{4}$ inches at its greatest width, through which the contents of the boiler escaped. The ship's side cock being open at the time, a certain amount of sea water entered the vessel through the opening in the pipe.

The pipe, whenever the boiler was blown down, was subjected to the scouring action of the solid matter contained in the ejected boiler water and, in course of time, had become so thin at the place of rupture that it was unable to withstand the pressure to which it was subjected.

The vessel was a steam trawler, one of a type which was built in large numbers for war purposes, and after the termination of hostilities was acquired by the present owner. The construction was that usually employed and presented no unusual features. The machinery consisted of one set of triple expansion engines, and one boiler fitted with three plain furnaces; the working pressure was 180 lbs. per square inch, with natural draught. The usual mountings were fitted to the boiler, and included a blow down valve, to which one end of the blow down pipe was attached by a flange; the other end of the pipe was also secured by a flange to a switch cock. This cock was connected by pipes to the ship's side blow down cock and to a suction valve on the donkey pump; by suitable manipulation of the switch cock, the boiler blow down pipe could either be put into communication with the donkey pump or the ship's side cock, or, alternatively, the ship's side cock could be used as a sea inlet for the donkey pump. The wheel handle of the boiler blow down cock was below the platform, and it was necessary to lift a portion of the platform to obtain access to the handle when blowing down the boiler.

The vessel left Milford on the 29th August last for a fishing trip. At about 11 a.m. on the 8th September the chief engine-man commenced to blow down the boiler; after opening the ship's side cock and placing the plug of the switch cock in the correct position, he opened the boiler blow down valve three turns. The valve had only been open for a few seconds when the explosion occurred. Owing to the escaping heated water, it was impossible to approach the vicinity of the valve to shut it, and the engine room had to be evacuated. After about half an hour's interval the firemen entered the stokehold and drew the fires. The chief engineman made several attempts to close the blow down valve, but was not successful until, he estimates, about two and a half hours after the explosion, when he succeeded in closing both the boiler blow down valve and the ship's side cock. By this time the sea water, which had entered through the open ship's side cock, and the ejected boiler water had accumulated in the machinery space until its surface was about 10 inches over the engine room platform, despite the efforts of the crew with the deck pump and baling with buckets. The useful work accomplished by the pump was very little owing to the continual choking of the suction pipe.

After the blow down valve had been closed the chief engineman did not raise steam again as he was doubtful as to whether the boiler had been injured by shortness of water. At 3 p.m. the skipper asked his managers by wireless for instructions, and at 6 p.m. received permission for the trawler *Joseph Barratt*, which had been standing by since shortly after the explosion, to tow the vessel to Milford; this was accomplished by 4 a.m. on the day following.

As before mentioned, the scouring action of the solids contained in the ejected boiler water was responsible for the unsuspected weakness of the pipe, and this explosion draws attention to the necessity of inspection and maintenance of these pipes. The managers are having the blow down pipes on their other vessels examined, and renewing them where necessary. The blow down valve spindles are being extended to enable the valves to be manipulated from above the platform. The boiler had not suffered any damage by overheating due to shortness of water.

Observations of Mr. A. E Laslett, Engineer Surveyor-in-Chief

Blow down connections on boilers require careful inspection from time to time. This explosion was primarily due to the unsuspected wastage of the blow down pipe; but blow down valves on boilers under steam require to be opened very gradually to prevent excessive shock to the blow down pipes, which must otherwise occur. The arrangement of the control handle fitted below the stokehold platform was an inconvenient one and, in this case, made it difficult to close the boiler valve after the pipe failed.

REPORT NO. 2979. S.S. *Alness*.

O.N. 140864.

This refers to the explosion from the main steam pipe on the starboard boiler of S.S. *Alness*, and the inquiry was conducted by Mr. E. F. Moroney, Board of Trade Surveyor, Cardiff.

The pipe was made of solid drawn copper, 5 inches bore and $\frac{1}{4}$ inch thick, fitted with gunmetal flanges $10\frac{7}{8}$ inches diameter, 1 inch thick, having eight steel bolts $\frac{7}{8}$ inch diameter on a pitch circle $8\frac{1}{2}$ inches diameter. A copper sleeve 4 inches long by $\frac{1}{4}$ inch thick was fitted around the pipe at each end behind the flanges and the sleeves were embedded in the brazing metal which secured the flanges to the pipe. The pipe was in one piece about 10ft. $4\frac{1}{2}$ins. long with one right angle bend between the steam stop valve on the starboard boiler and the junction piece on the main engine steam regulating valve.

The pipe was one of the original main steam pipes supplied by the builders of the engines, Messrs. Blair and Co., Ltd., Stockton-on-Tees, who obtained the material from the Birmingham Battery and Metal Co., Ltd., in July, 1920.

The main steam pipes were taken off and annealed by the Barry Graving Dock Co., Ltd., in February, 1928. No other repairs are recorded.

The explosion was very slight and consisted of a small leakage of steam noticeable at the collar around the neck of the flange near the starboard boiler steam stop valve.

A fine circumferential crack about 3 inches long developed in the pipe, below the sleeve, and was caused by fatigue due to vibration of the main engines over a number of years.

The *Alness* is a cargo vessel of 3,683 tons gross, built by the Ropner Ship Building Co., Stockton-on-Tees, and engined by Messrs. Blair and Co., Ltd., Stockton-on-Tees, in 1920.

Steam for the main engines is generated in two single-ended marine type boilers, working at 180 lbs. pressure per square inch. The nature of the trade in which the vessel was engaged called for a considerable amount of travelling in ballast condition. No undue vibration was felt at the main engines, as the balance was well maintained, and the bedplate holding down bolts were properly attended to. Only very shortly before the accident happened, among other work which was being carried out, all the holding down bolts had been overhauled at the works of Messrs. Workman Clark and Co., Belfast.

The vessel was proceeding in ballast trim on a voyage from Barry Dock across the Atlantic, when it was noticed that steam was issuing from the periphery of the sleeve around the neck of the steam pipe near the stop valve on the starboard boiler. The extent of the flaw could not be seen on account of the sleeve and it was considered advisable to put into Queenstown for repairs. A new pipe was made and fitted by the Queenstown Dry Dock Company, allowance being made for an expansion bend to the full extent of the material available, and since then no further trouble has been experienced.

Observations of Mr. A. E. Laslett, Engineer Surveyor-in-Chief.

The sleeves which were fitted to the ends of the pipe were apparently intended to afford additional strength at the parts subjected to the greatest stresses, but it is doubtful whether this method of re-enforcement is effective and the sleeves have the disadvantage of preventing local external examination of the pipe being made. The pipe which failed might with advantage have been arranged with a greater degree of flexibility and it is noted that the new pipe has been improved in this respect.

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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 September, 1929:—

NAME.	GRADE.	PORT OF EXAMINATION.
Lynch, William G.	1.C.M.E.	Cardiff
Barclay, Alexander McC. ...	1.C.M.E.	London
Gummer, Ernest G.	1.C.M.E.	,,
Young, Arthur	1.C.M.E.	,,
Jones, Hugh	2.C.	Dublin
Archibald, John S.	1.C.	Glasgow
Edmond, Alexander B.	1.C.	,,
Gillespie, William	1.C.	,,
Hughes, Ernest C. E.	1.C.	,,
Lockhead, Robert M.	1.C.	,,
McIntyre, John B. A.	1.C.	,,
Vipond, Alexander H.	1.C.	,,
McFie, William M.	2.C.	,,
Scott, Alexander V. F.	2.C.	,,
Symington, Gilbert S.	2.C.	,,
Brims, Donald	1.C.M.	,,
Menzies, William G.	2.C.M.	,,
Milligan, David G.	1.C.M.E.	,,
Burman, Sidney	1.C.	Hull
Ingram, Robert A.	1.C.	,,
Magee, Kenneth C.	1.C.	,,
Stephenson, Alfred	2.C.	,,

For week ended 7th September, 1929—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Black, Charles H.	1.C.	Liverpool
Cooper, James G.	1.C.	,,
Jones, William P.	1.C.	,,
Manser, Leonard	1.C.	,,
Rhind, John L. S.	1.C.	,,
Taylor, Thomas W.	1.C.	,,
Crosby, Charles C. A.	2.C.	,,
Esmarch, Raymond	2.C.	,,
Huxley, Charles S.	2.C.	,,
Jackson, Percival C.	2.C.	,,
Massey, Joel	2.C.	,,
Balmforth, Brian	1.C.M.	,,
Yeadon, Cyril	2.C.M.	,,
Harrold, George	1.C.M.E.	,,
Souchotte, Ernest F.	1.C.M.E.	,,
Godfrey, John W.	1.C.	London
Usher, Frank R.	1.C.	,,
Lack, William G. S.	1.C.	,,
Froud, Albert F.	1.C.	,,
Conning, James	1.C.	,,
Ward, William F.	1.C.	,,
Ross, Bertie E.	2.C.	,,
Plunket, Philip	2.C.	,,
Love, Richard G.	2.C.	,,
Liddell, Thomas W.	2.C.	,,
Brown, William V.	2.C.	,,
Topley, Ava F. S. V.	2.C.	,,
Bickerton, John M. D.	1.C.	North Shields
Nicholson, Charles R.	1.C.	,,
Tate, Arthur	1.C.	,,
Hardy, Lionel	2.C.	,,
Crowthers, Arthur	2.C.	,,
Embleton, John	1.C.M.	,,
Phillips, John	1.C.M.E.	North Shields
Muckle, William P.	1.C.M.E.	,,
Mitchell, John H. R.	1.C.M.E.	,,
Gray, John L.	1.C.M.E.	,,
French, Harry	1.C.M.E.	,,
Sayers, Herbert J.	2.C.	Sunderland
Hammond, Albert	2.C.	,,
Gray, Kenneth C.	2.C.	,,
Gillespie, William R.	2.C.	,,
Bell, Sydney	2.C.	,,
Wilson, Henry	1.C.M.	,,