the iron used in the link exceeds that used for the *Great Eastern* by ¾ in., being 3⅜ in. in thickness at the smallest part. Each link is about 22¼ in. long, and together with the crude cast-steel stud, weighs about 160 lbs. The total length of the main cable is about 2000 ft. and the total weight about 100 tons. The joining and anchor shackles represent a weight of 500 lbs. and 840 lbs rsspectively. The chain is forged throughout. This particular cable was made for Messrs. Swan, Hunter, and Wigham Richardson, and this firm gave instructions for three of the links used in the cable to be tested at Lloyd's Testing House. Three links were accordingly severed and sent to the proving-house at Netherton, Staffordshire, the testing machine installed there being one of the most powerful in the country and licensed by the Board of Trade Department for the testing of chains and anchors of the largest dimensons. The test was carried out before Mr Peskett, the naval architect to the Cunard Company. The sample was at first submitted to the proof strain established by the British Admiralty, which is of 189.8 tons. The result of the trial was nothing beyond a total elongation of the three links by almost ¼ in. The statutory breaking strain of 265.7 tons was next applied, but the chain successfully withstood. the test, a further elongation of about ⅝ in. for the three links resulting. An attempt was then made to test the links to destruction, and notwithstanding the fact that the maximum capacity of the testing machine was applied, representing 350 tons—the actual tension applied was over 370 tons—the machine failed to break the links. They were then carefully examined but no sign of fracture or defect could be discovered although the strain applied was about 90 per cent. in excess of the breaking strain imposed by the British Admiralty and is the greatest tensile strain that has ever been applied to a chain cable, the only result was an elongation of the three links by 6 in. above the length before submission to the tests.

Such is the latest word in British steamship construction. The eyes of the world will be upon the *Lusitania*, the first of the sisters launched, when she sets out on her first Atlantic voyage

GAS ENGINES FOR SHIP PROPULSION.

Mr. J. E. Thornycroft recently read, before the Institution of Naval Architects, a paper entitled "Gas Engines for Ship Propulsion." He said that the majority of small gas engines worked on the "Otto" cycle, which had the advantage of requiring no special gas or air pumps, and that this was the only type of engine that had been as yet tried for marine work. The gas producer, which was generally used for moderate powers worked on what was known as the "suction" principle—*i.e.*, instead of the gas being generated by the combustion of fuel, by air and steam being forced through it under pressure, it was generated by the air being drawn through the producer, the whole of the apparatus working somewhat below atmospheric pressure The advantage of this system was that neither a steam boiler working under pressure, nor a gas container for holding the gas was required ; and the further very important advantage for marine work is that there was no danger from a leakage of gas from the producer—if leakage occurred, it was from the atmosphere into the producer itself.

The producers for moderate powers were usually worked with anthracite coal, and where vessels were to be used on fixed routes, and the same class of fuel could be obtained, anthracite or coke would be found to be the most suitable for moderate powers, it being too difficult to make a satisfactory small plant to work with bituminous coal

After the gas leaves the producer, it must first be cooled, and, as there would always be a certain amount of impurity, even when anthracite was used, it had to be thoroughly cleaned. This was usually done by passing the gas through a series of vessels, where it was "scrubbed" by its passage through layers of coke over which water was running. The large space occupied by the ordinary coke scrubbers prohibited their use for marine work, and to meet this difficulty Herr Capitaine had arranged his plant to clean the gas after it had been cooled, by the introduction of a very fine spray of water, which mixed with the small particles of dust and other impurities in the gas, and formed a sort of fog ; the gas in this stage was passed into a centrifugal apparatus, having a peripheral speed of 160ft. a second, which threw out the moisture and impurities, leaving a clean dry gas to be drawn out by the engine. The composition of this gas might be taken to be as follows. Carbon dioxide, 6 per cent. ; carbon monoxide, 25 per cent.,; CH_4 methane, 1 per cent., hydrogen, 14 per cent. ; nitrogen, 54 per cent

It would be realised that the size of the producer for a given power was comparatively small when it was known that the area of the firegrate necessary was only 0 05 square foot per h p, whereas the average amount for an ordinary natural-draught steam boiler, burning 15lb coal per square foot grate area, would be 0 2 square foot per h p.

In Messrs. Dowson's arrangement of suction producer designed for anthracite coal, which the majority of smaller suction producers resembled, a fire-brick lined steel casing was fitted with firebars and a closed ashpit, and in the upper part of the casing a conical hopper was placed, with the usual valves for opening and closing to admit fresh charges of fuel The gases came off the fuel at the base of the conical hopper, and passed through a stream generating pipe or vessel, and then away to the cooler and scrubber. The producer was fitted with an outer casing, in which the air was heated and mixed with the steam on its way to the ashpit. In the "Duff-Whitfield" producer, arranged for working with bituminous fuel, the tarry products which were evaporated from the new coal were caused to pass through the hottest part of the fire, and so were consumed before the gas passed away to the cooler. The "Boutillier" producer was arranged for working with bituminous fuel, in which the fuel was supplied by an undertype stoker to the hottest part of the fire, so that the tar was at once decomposed, and could not pass away with the gas. The principle upon which this producer worked seemed to be one of the best adapted for marine work. The "Jan" producer consisted of a series of producers which were arranged to work in sequence, the gases of one which had been newly charged passing through another which had been at work some time so that there were always some of the producers supplying tarry gas, the tar being consumed by one of the other producers in the later stages of the series. The heat efficiency, as given by Messrs. Dowson for their suction plant, was 90 per cent As the result of a great many tests, the late Mr. Bryan Donkin gave the average heat efficiency of steam boilers at 66 7 per cent.

In the "Capitaine' producer the gas was of a comparatively slow-burning nature, and might be described as poor gas, to distinguish it from town gas, and some of the other gases generated by pressure producers which had a larger proportion of hydrogen, such as water gas There was an advantage in this slow-burning gas, as it enabled the engine to work with a high compression, thus giving a larger range of expansion, and consequently, a high economy

The one great disadvantage of the internal combustion engine was the necessity of setting the engine in motion before it would run automatically. For powers less than 200 h.p it was preferable to employ a reversing gear, keeping the engine always running in the same direction, or to use a reversing propeller. Compressed air was being employed for starting up large engines, and when once the engine was fitted in this way the valve gear for running the engine in either direction did not amount to very much. For moderate powers, a single-acting engine with a trunk piston was found most convenient, as the piston did not require to be water-cooled, until one as much as about 2ft. in diameter was employed. A single cylinder of 20in. diameter and 2ft. stroke, running at 120 revolutions per minute, would give about 100 h p., taking the average working pressure at about 80, which was less than the figure often obtained For large powers fitted to vessels where steam capstans and steering gear were fitted, it was thought that the best plan would be to employ an auxiliary boiler, which could be heated by the gas when the whole plant was at work, and could be used independently to drive the various auxiliary and starting engines when the producer was not alight.

Professor Capper had stated that the theoretical maximum thermal efficiency of the steam engine was only 30 per cent., and only from 5 per cent to 20 per cent. of the heat generated was ever turned into useful work. In the case of the gas engine, the theoretical efficiency was about 80 per cent., and in practice 25 per cent. to 30 per cent. of heat developed in the cylinder was turned into useful work. For vessels fitted with small-powered compound-condensing engines of less than 100 h.p. the fuel consumption would be from 2lb to 3lb. per 1 h.p. For gas plants of this power the fuel consumption would be less than 1lb per 1 h.p ; but for larger powers of not less than 500 h.p. the economy would not be quite so marked.

The official report of the "reliability" trials in the Solent last summer showed that the Emil Capitaine of 16 tons displacement, ran at an average speed of ten miles per hour for ten hours, on a consumption of 412lbs. of anthracite coal. This consumption also included the fuel which was consumed by the producer during the previous 12 hours, when it was not in active operation, but simply smouldering and keeping itself alight, the producer having been filled the night before the trial. The amount of fuel consumed in this way was very little, but should be taken into account when making a consumption trial. For the purpose of comparison, tests were made on November 8, 1904, with the Gastug No. 1 and Elfriede, a steam tug of very nearly the same dimensions and power. The Gastug No. 1 was 44ft. 3in. long by 10ft. 6in. beam, and was fitted with one of the four-cylinder 70 h.p. suction gas plants. The Elfriede was 47ft. long by 12ft. beam, and was fitted with a triple-expansion steam engine developing 75 h p

At the towing meter the Gastug No. 1 attained a maximum pull of 2,140lbs., and the Elfriede a maximum of 2,020lb. A run from Hamburg to Kiel and back was made by these two boats, during very stormy weather, at a maintained speed of 8½ knots. The consumption of fuel was measured for a period of ten hours, and was as follows —For the Gastug No. 1, 530lbs. German anthracite ; for the Elfriede, 1,820lbs. steam coal. This shows an economy of 1 to 3.44 in favour of the gas plant.

To demonstrate the possibility of using gas plants for large powers, Messrs. William Beardmore and Co., who are joint owners with the author's firm of the British Capitaine patents, are constructing sets of engines of 500 and 1,000 h.p, to run at a speed of about 130 revolutions per minute.

There were many instances of gas engines running for stationary purposes for long periods on town gas without a stop of any sort ; and it appeared that there were several engines of 250 to 400 h p per cylinder running regularly every week from Monday morning to Saturday afternoon without a stop. The Premier Gas Engine Company gave an instance of an engine which had made a run of 51 days without a stop, the previous run being 49 days without a stop of any kind.

The King and an Inventor.

DISCOVERER OF MAUVE RECEIVES A KNIGHTHOOD.

The King has been graciously pleased to confer the honour of knighthood upon Mr. Edwin Thomas Ann, J P, Mayor of Derby, and Dr. William Henry Perkin, F R S.

Dr. Perkin was the discoverer of the dye-stuff "mauve," by which the foundation was laid of the coal-tar colour industry, and an official communication from the Prime Minister's residence states that at the international celebration of the coal-tar colour jubilee on July 26 Dr. Perkin received presentations and addresses from English and foreign societies

The story of Dr. Perkin's discovery is an interesting one. While acting as assistant in the research laboratory of the Royal College of Chemistry under Professor Hofmann in 1856, Dr Perkin attempted in his own laboratory to effect the synthesis of quinine with a view to preparing it artificially. In this he failed, but to study the products actually formed he selected a substance, aniline, which could be prepared from benzine, a constituent of coal-tar.

The aniline was treated with an oxidising agent, when a black precipitate was obtained which was found to contain a brilliant colouring matter since known as aniline purple, or mauve. Further investigation showed that the colouring matter had the properties of a dye. Dr. Perkin took out a patent, and in 1857, with his father and brother, set up works at Greenford Green, near Harrow In 1874 Dr. Perkin retired from business and devoted himself to scientific investigations.