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NEW YORK, SATURDAY, SEPTEMBER 12, 1903.

The editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

ANOTHER GREAT HYDRAULIC-ELECTRIC POWER PLANT.

No stronger evidence could be afforded of the great development which has taken place in the last few years of hydro-electric installations than the fact that a great 50,000-horse-power plant, such as is illustrated on the front page of this issue, should have been planned and built with such little ostentation that it has only recently, as it neared completion, attracted the attention which its size and importance demands. It seems but a few years ago that the world was filled with wonderment at the announcement that sufficient water was to be diverted from the Niagara River, to operate a series of large turbines, whose aggregate power should reach the then enormous figure of 50,000 horse power. The project was regarded with much curiosity, and there was no little foretelling of disastrous failure, while the day of its opening was regarded as one of the most momentous in the history of the industrial world. This event occurred less than a decade ago; yet, so great was the success of the venture, that its capacity has already been doubled, and another one of far greater size is under construction on the opposite shores of the river. So many similar installations of large aggregate horse power are either planned or under actual construction that the building of a 50,000-horse-power power house, like this one in the upper valley of the Hudson, seems to call for little more than a passing remark. The indications are that within a few generations there will not be a natural waterfall or rapids, except in the unsettled portions of the country, that will not resound with the hum of the turbine and the generator.

THE LAST OF A FAMOUS LINER.

Every one that is interested in the history of the transatlantic service (and who is not?) will learn with a measure of regret that the famous White Star liner "Britannic" is now engaged upon her last voyage, preparatory to being sent to the bone-yard to be broken up. This historic vessel will long be remembered as having ushered in the era of the high-speed, luxuriously furnished transatlantic liner with which we are familiar to-day; for the very latest vessels are merely a development in size, speed, and comfort of certain features which were first embodied in this ship. She is further remarkable because of the unusual endurance of her engines and boilers, which present an instance of continuous service that, as far as we know, is without a parallel in the history of the mercantile marine. It is not generally known that the engines and boilers with which she is now making her last voyage across the Atlantic are the same that were put into the boat by the Harland & Wolf firm when she was launched in 1874, or nearly thirty years ago.

To the "Britannic" belongs the credit of being the first boat to reduce the time between Queeenstown and Sandy Hook to less than eight days, her record for the easterly passage being seven days and sixteen hours. The "Germanic," a sister ship to "Britannic," which was launched shortly after her, is still in the Atlantic service; but she has been re-engined and re-boilered, and thoroughly brought up to date. The older boat, however, has been steadily breasting the storm and stress of the transatlantic passage for twenty-nine years with her original engines and boilers, and she has the remarkable record of never having missed a day in all that time through accident or breakdown. She has remained continually at work except for two or three weeks in each year, when she was taken off the route and overhauled for the season's work. In the twenty-five years from 1874 to 1899 she made 260 round trips between New York and Liverpool, crossing the Atlantic more than 500 times and traveling over 1,800,000 miles, or sufficient to make the circuit of the earth over seventy times. During her long period of service she has carried without accident over 200,000 passengers.

IS YACHT DESIGNING AN EXACT SCIENCE?

The present series of international races has been full of surprises and to no one more than to the two eminent designers of the competing yachts. For it is certain that saving and except for the fact that "Reliance" has done what she was designed to do in successfully defending the cup, each of the great 90-foot sloops has shown, in actual sailing, qualities that were never intended nor expected, and has conspicuously failed to develop other qualities that were specially aimed at in their design. "Reliance," as we announced several months ago when that boat was undergoing her early trials, was designed to secure exceptional speed when reaching, and, indeed, on any point of sailing with started sheets. This quality was expected to make her perfectly sure of winning the triangular race; and in view of the fact that the leeward leg of the windward and leeward races off Sandy Hook is almost invariably turned by a shift of the wind into a reach, it was calculated that being fast under spinnaker and exceptionally fast on a reach, she would be certain to gain on the leeward leg everything that she might lose by her less speedy performance when beating out to the weather mark. It was estimated that, with her great overhang and full waterlines, the most unfavorable conditions for "Reliance" would occur when sheets were hard aboard, and she was heading into a short and broken sea. As a matter of fact this estimate of the boat turned out to be entirely at fault; for she was unable to beat "Constitution" on a reach, while in windward work she proved to be a most consistent and remarkable performer. Even in the much-dreaded combination of light winds and lumpy seas, she has proved to be a simply phenomenal craft, being, indeed, so swift under these conditions as to stand in a class absolutely by herself. Thus has theory proved itself to be once more entirely at sea, and on no point so much as on the failure of "Reliance" to develop any remarkable speed when reaching in a whole-sail breeze. Anyone looking at her lines would expect that the easy diagonals, the great length of her water line, and the small displacement in proportion to the enormous rig, would enable her to reel off a speed of at least 13½ to 14 knots an hour. Yet, as a matter of fact her highest recorded speed in reaching on a measured 10-mile leg is only 12.6 knots per hour. How this discrepancy is to be explained, nobody, not even Mr. Herreshoff himself, can tell.

Turning now to the challenger, it was evident to every one who is acquainted with the elementary principles of yacht designing that her best work should be done in light winds, when the relatively small area of wetted surface which always goes with a full model of large displacement, such as she shows, would tell in her favor. The boat was evidently built for the Sandy Hook courses where light and moderate winds prevail at the time of the year when the races take place. It was natural to expect that in the stronger winds, when the speed passed the point at which the fuller body and relatively larger displacement of the English boat would tend to set up wave-making, the chances of "Shamrock" holding "Reliance" would diminish, and that the stronger the wind, the less would be her liklihood of taking the race. Here again theory has been totally upset, for in the contests that have been held the "Shamrock" has shown to the best advantage when the winds were strongest, and as the strength of the wind diminished, so the margin by which she has been beaten has steadily increased. In the triangular race sailed in a good breeze of 10 to 15 knots strength, when, theoretically, "Reliance" should have dropped her steadily with every mile that was sailed, particularly on the 20 miles of reaching, she proved so far the equal of our boat that, on corrected time, if we omit the 19 seconds handicap at the start, she was only beaten by one minute. On the other hand, in an attempted race in which there was that very roll of the sea and light wind which was supposed to embody the ideal conditions for "Shamrock," she was beaten by the same boat 20 minutes in a 15-mile leg to windward.

It is because of these strange anomalies that the yachting world is drawing on its thinking cap, in the endeavor to find just exactly where it stands; for there is no denying that these two boats, in which are embodied the wisdom and skill of the two leading naval architects of the day, have persistently done the things that nautically they ought not to have done, and have left undone the things that nautically they should have done!

The moral of all this is that in spite of our boasted advancement in the art of yacht design we have as yet by no means reached the ideal boat; and we shall not have done so until some one discovers how to combine with the remarkable beating and running qualities of "Reliance," the ability to reel off 13 to 14 knots an hour when reaching in a whole-sail breeze.

LIMITS OF ELECTRIC TRACTION WITH DIRECT CURRENT.

Systems of electric traction differ widely as to the power that may be delivered to a car, the distance from a generating station at which a car may be operated, and the rate of acceleration that a car may attain. With continuous-current dynamos supplying car motors at pressures of about 500 volts, a limit to the power that may be delivered through a single trolley contact is soon reached.

A car with a motor equipment of 200 horse power, such as is not uncommon for interurban service, draws 350 amperes from the trolley wire when loaded to full rated capacity, if the motors have an efficiency of about 85 per cent and their voltage is 500. At starting and on heavy grades the amperes taken by such a car may go up to 1,000 without serious heating at the trolley, but it is doubtful whether this current could be collected constantly without trouble. Coming to a large electric locomotive or heavy train requiring 2,000 horse power at normal rating, the regular current with voltage and motor efficiency as before, would be 3,500 amperes, which might rise to 10,000 or 15,000 amperes for short periods. Such currents are entirely beyond the capacity of any single trolley or contact shoe. A number of trolleys might be employed with a heavy train or locomotive, but such complication would soon reach a limit. The limitations as to radius of operation of the 500-volt continuous-current traction system may be well illustrated by an example. If a car requiring 200 brake horse power on the wheels, or a delivery of 350 amperes and 500 volts at its motors, is operated ten miles from the station with a drop of 50 volts in its feeder wire, this wire must have an area of 400,000 circular mils. Ten miles of such wire with weatherproof insulation weigh 80,000 pounds, and at 15 cents per pound have a value of $12,000. This sum represents an investment of $60 per horse power capacity of the feeder wire, or about three times the cost of dynamos per like unit of capacity. Assuming that only 50 volts drop will occur in the rails as a return circuit when the drop in the trolley feeder is 50 volts, the total loss of pressure between dynamo and car motors is 100 volts, so that the dynamo must deliver current at 600 volts in the assumed case. This drop of 100 volts on the line and rails corresponds to a loss of 16.66 per cent. For exceptional loads, as when the car is climbing a steep grade, the percentage of loss in feeder wire and rails will increase directly with the amperes flowing to the car. Thus, when the car motors take 1,050 amperes, the fall of pressure in the rails and feeder together will be 300 volts, and one half of the energy delivered at 600 volts by the dynamo will be lost in the transmission. If more than one car is supplied by this feeder, the percentage of loss in it will increase directly with the number of the cars. The torque exerted by the car motors increases approximately with the amperes they receive, but their speed drops with the terminal voltage; hence, though the motors carry a heavy overload, the cars cannot maintain normal speed because of the loss of pressure in line and rails.

When under normal full load, the car in question receives 350 amperes at 500 volts, or 175 kilowatts. When an overload causes the current to rise to 1,050 amperes, the pressure at the motors drops to 300 volts and they receive 315 kilowatts, or 1.8 times the power delivered to them at normal full load. As the generating station was assumed to operate continuously at 600 volts, it appears that when the output from this station is multiplied by three, the rate of energy delivery to motors increases only 80 per cent. In other words, the proportion of the entire energy output absorbed by the line and track rises with the ampere flow, and an absolute limit is thus put on the power that may be delivered to the car motors. As one-half of the energy sent out by the power station is lost in the line and rails with a current of 1,050 amperes, any further increase of current will actually decrease the power delivered to the car motors, though it will increase their torque. Thus if the station delivers 1,400 amperes at 600 volts to the particular feeder and track under consideration, the motors on the car will receive this current at 200 volts, representing only 280 kilowatts.

In the matter of motor torque, the continuous-current system of electric traction presents its strongest point. The unequalled capacity for increase of torque possessed by the series-wound continuous-current motors has carried street cars up all sorts of grades with all sorts of loads and placed electric traction in the secure position which it occupies to-day. Furthermore, this capacity for increase of torque makes it possible with the continuous-current motor to obtain rates of car acceleration that can be equaled with no other machine of the same normal rating.

The torque of a continuous-current motor depends on the strength of the magnetic field in its air gaps and on the amperes flowing through its armature coils. If the magnetic field remains constant, the armature torque increases directly with its current, and if the field strength goes up also, the torque increases faster

than the current. But the armature current distorts the magnetic field in the air gap and tends to cause destructive sparking at the commutator, this tendency being greater the larger the current in the armature coils. Where great increase of torque over the normal rating must be had, the continuous-current series motor offers this unique property, that the increase of current which gives the armature greater torque further strengthens this torque by adding to magnetic density in the air gap, and this addition reduces cross magnetization and the tendency to destructive sparking at the brushes. A. D. A.

THE AGREEMENT BETWEEN THE BRITISH GOVERNMENT AND THE CUNARD AND MORGAN COMBINE MERCANTILE FLEETS.

BY OUR LONDON CORRESPONDENT.

The British government has published the terms of its agreements arranged respectively with the Cunard Steamship Company and the Morgan Combine concerning the British vessels which were incorporated in the trust. The government comprises the three branches—the Admiralty, the Board of Trade, and the Postal Department. With regard to the Cunard Company, the government assumes practical control. The financial assistance comprises a loan of $13,000,000 or less under certain circumstances, at a yearly interest of 2¾ per cent, an annual payment of $450,000, and the increase of the postal subsidy from $310,000 to $340,000 a year. The Cunard Company, on the other hand, in answer to this assistance, will build two new vessels of from 24 to 26 knots hourly speed, suitable for use as armed cruisers, and will place the entire Cunard fleet at the disposal of the government whenever required; will improve the mail service, and will guarantee that the company remain purely British both concerning its control and the shareholders. That is to say, no one but a British subject may be an official or have any share interest in the concern. The agreement is to remain in vogue for twenty years from the time the second new vessel departs on her maiden voyage.

Many important clauses are inserted in the agreement, to enable the government to control both the company and its vessels. The most important of these are broadly as follows:

The plans and specifications of the new vessels to be approved by the British Admiralty, who may make reasonable modifications in the designs to suit their especial requirements.

The ships are to be held at the disposal of the government for either purchase or hire. The purchase price is to be the market value of the vessel plus a 10 per cent bonus as compensation for loss or compulsory sale. Depreciation is to be set down at 6 per cent per annum upon the actual cost price of the steamship.

The payment for the hire of a vessel is to vary with its speed. In war time the Admiralty will provide the crew, but when the vessels are requisitioned for naval purposes during peace time the government is to have the option of the crews and will pay them for their services. The rate of payment will vary from $6.25 without crew and $7.50 with crew, for vessels of above 22 knots speed to $4.37 without crew and $5 with crew for vessels of between 14 and 17 knots speed, these rates being per ton per month. The company, on their part, are not to increase unduly freight or other charges and must not give undue preference against British subjects.

The company must not sell or dispose of any vessel of over 17 knots speed, without the sanction of the government. All the ships' officers, except the engineers, are to belong to either the naval reserve or the naval fleet reserve, and not less than one-half of the crew must belong to either of these two branches of the service. In the event of the new vessels failing to attain the minimum guaranteed sea speed of 24½ knots in moderate weather, but not falling below the minimum of 23½ knots, then the amount of the annual subsidy is to be decided by arbitration.

With regard to the mail service, the subsidy for which has been augmented to $340,000 per annum, the service is to be accelerated and improved, and the new vessels are to be included. This payment is also to cover the transit of parcel mails up to a limit of 100 tons' measurement in either direction per week. Any failure in the mail service will result in the infliction of fines and penalties.

The government's control also comprises two nominees, who have the power to give votes equivalent to one-quarter of the number of votes possessed by the company's shareholders. In more explicit words the government holds one-quarter of the concern. Any person other than a British subject who acquires a share is to be forced to dispose of it within three days, failing which the share will be compulsorily sold at the market value to a British subject.

The amount of the subsidy to be paid every year has been deduced by careful investigation. The committee appointed by the Parliament for this inquiry reported that a sum of $552,500 would be necessary to indemnify a company for the financial loss they would sustain by running a 24-knot vessel in time of peace, which sum would have to be increased to $745,000 for a 25-knot boat. On this basis the increase between these two figures would amount to $1,297,500 for two vessels each of 24½ knots. This payment, however, has been compromised by reducing the rate of interest upon the loan of $13,000,000 from the normal outside market rate of 5 per cent to 2¾ per cent.

In the case of the Morgan combine, the agreement is also extended over a period of twenty years, but the government stipulates that in any postal, military, or naval services wherein it may require the utility of the vessels of any of the British steamship companies merged into the combine, they are to be treated precisely the same as other British shipping concerns. One exception, however, is made, and that is the construction of ships of "uncommercial speed" which the government may specially require to be constructed and which are principally intended for war purposes.

The combine undertakes that a majority of the directors of the British companies shall be British subjects; no vessel is to be transferred to a foreign registry without the consent of the British Board of Trade; the ships are to carry the same quota of officers and crew of British subjects as the government stipulates upon other British vessels engaged in the same trade; the government is to have the option of purchasing or hiring any vessel on arranged terms; and one-half of the tonnage at least added to the combine in successive triennial periods from September, 1902, when the agreement was signed, is to be British. With respect to the last clause, reservation is made concerning the ships of "uncommercial speed" and vessels purchased from other than British or American sources which have been running for not less than two years. In the case of any dispute arising between the two parties, the matter is to be referred to the British Lord Chancellor, who is to be the arbitrator, and whose decision either concerning law or fact is to be regarded as final.

From these two agreements it will be recognized that the British government has concluded a fairly powerful bargain, and while it practically acquires the Cunard Company, no antagonism is displayed to the mercantile combine.

MORE INFORMATION ABOUT THE PRIZE FOR A DUST-ARRESTING RESPIRATOR.

The council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a prize of a gold medal, or twenty pounds, for the best dust-arresting respirator for use in dusty processes, and in dangerous trades.

The council are well aware that for many years past the necessity for such an apparatus has been recognized. As far back as 1822 the society awarded its gold medal to Mr. J. H. Abraham, of Sheffield, for a magnetic guard to protect persons employed in dry grinding. The apparatus described in the society's "Transactions" (vol. xl., 1822, p. 135) includes a respirator to cover the mouth and nose. This respirator was fitted with magnets, for the purpose of arresting the fine particles of steel thrown off in the process of pointing needles, and in other processes of dry grinding. Although the invention was greatly appreciated at the time, it appears never to have come into practical use, the main objection to it having been, it is believed, raised by the workpeople themselves, who feared that the lessened risk attached to their employment would lower their wages. Similar considerations have, it appears, stood in the way of the introduction of various appliances intended to limit the risks associated with all trades in which the workpeople breathe a dusty atmosphere. The council, however, think that such considerations are likely to have less weight at the present time, and they hope that the offer of a prize may draw the attention of inventors to the matter, so that it may result in the production of some suitable piece of apparatus, despite the difficulties with which the solution of the problem is surrounded.

The apparatus will be required to fulfill the following conditions:

(1) It must be light and simple in construction.

(2) It should be inexpensive, so as to admit of frequent renewal of the filtering medium or of the respirator as a whole; or alternatively it should be of such construction that it can be readily cleaned.

(3) It should allow no air to enter by the nostrils or mouth except through the filtering medium.

(4) It should not permit expired air to be rebreathed.

(5) The filtering medium, though it should be effective in arresting dust particles, should not offer such resistance as to impede respiration when worn for some hours under the actual conditions of work.

(6) It is desirable that it should be as little unsightly as possible.

It should be noted that the prize is offered for a respirator intended merely to arrest dust, and not for a chemical respirator designed to arrest poisonous fumes. The applications of such chemical respirators are more limited, and there are special requirements connected with them. The council have, therefore, preferred to limit the range of their present offer to the simpler and more important cases of dust, either dust of all kinds or of some special character, e. g., iron or steel.

Inventors intending to compete should send in specimens of their inventions not later than December 31, 1903, to the secretary of the Society of Arts, John Street, Adelphia, London, W.C. Such specimens must be accompanied by full descriptions, and in cases in which the apparatus has been put into actual use, the experience of such use should be given.

Competitors intending to patent their inventions should be careful to obtain protection, as the council of the society cannot undertake any responsibility as regards the secrecy of the whole, or of any part, of an invention submitted to them.

The prize will be awarded on the report of judges appointed by the council.

The competition is not limited to British subjects.

The council reserve to themselves the right of withholding the prize, of extending the time for sending in, or of awarding a smaller prize or smaller prizes.

SCIENCE NOTES.

Science is nothing but trained and organized common sense, differing from the latter only as a veteran may differ from a raw recruit; and its methods differ from those of common sense only so far as the guardsman's cut and thrust differ from the manner in which a savage wields his club.—Engineering Record.

Calcite, when perfectly transparent and free from flaws, has great value for optical purposes. The locality which has yielded the largest quantity of fine calcite crystals is near Eskifjördhr, Iceland, and for this reason crystals of good quality are commonly termed Iceland spar.—Engineering and Mining Journal.

The latest addition to the German language is the word "knusperchen," meaning a little thing that can be nibbled. This is the word that has just taken the prize offered by some German educational society for the best translation of the noun "cake."

Phosphorus dissolves slowly in most of its solvents. Sometimes frequent agitation for weeks is required before saturation is effected. C. Stich (Pharm. Zeit.) has determined its solubility in the following liquids, the weights given being the weights of phorphorus in 100 grammes of saturated solution: Almond oil, 1.25; oleic acid, 1.06; liquid paraffin, 1.45; water, 1.0003; acetic acid, 96 per cent, 0.105.

The general public, we fear, is not acquainted with the dangers arising from arsenic coloring matter in wall paper. A recent death in Palmer, Mass., is directly attributed, by the medical authorities, to this cause. The trouble which resulted so disastrously made its appearance a year and a half ago in what seemed to be nervous dyspepsia. Two months of travel abroad seemed to greatly improve the patient, but on returning home he soon grew worse again. On account of certain conflicting symptoms which could not be readily accounted for, a specialist was called in and gave it as his opinion that there was arsenic poisoning in the system. An investigation was then made which resulted in the discovery of arsenic colors in the wall paper of the sitting room. This room had been papered shortly previous to the appearance of the first symptoms. The wall paper was at once removed, but the disease had by this time progressed so far that it was impossible to save the life of the unfortunate victim.

Andrews (Chicago Medical Recorder) mentions the usefulness of the tuning-fork in the diagnosis of fractures, especially of the long bones. The test is made by placing the bell of a stethoscope over the bone near the supposed fracture, where the soft tissues are as thin as possible, and the handle of a tuning-fork as close to the bone as possible beyond the supposed seat of fracture. The sound will be transmitted through the shaft of the bone to the stethoscope and through the stethoscope to the ears of the examiner. When the bone is intact, if the test is properly made, the sound of the fork will be heard with great distinctness; but if there is a lack of continuity, the sound will either not be heard at all or will be heard very faintly. By comparing the intensity of the sound on the suspected side with the sound heard under similar conditions on the normal side, the question of continuity of bone can be determined. The test for fractures is based upon the fact that bone is an excellent conductor of sound waves, while the soft tissue of the body conducts sound waves very poorly. The bell of the stethoscope should fit tightly to the skin and when comparing the sound and injured sides the instruments should be placed in the same relative positions. The sound waves will be transmitted through a fracture if the two ends are crowded together; also through a joint, especially if the articular surfaces are forced together.