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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 Queenstown 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

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