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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.

DELAYED NAVAL CONSTRUCTION IN PRIVATE YARDS.

On perusal of the report of the Naval Bureau of Construction, recently made public, we note with much regret that the private yards have, as yet, done no work whatever upon six of the most important vessels of our navy, although the contracts for the same were let as long ago as last winter. The six vessels include the four battleships "Virginia," "Nebraska," "New Jersey," and "Rhode Island," each of 15,320 tons and 19 knots' speed, and the two armored cruisers "South Dakota" and "California," of 14,000 tons and 22 knots' speed. Moreover, one of the new battleships, "Georgia," of the same class as the "Virginia," let at the same time, is in practically the same condition, only 1 per cent of the work being done, while of the armored cruisers of the same class as the two mentioned above, the "Colorado" is only 7 per cent completed, the "Pennsylvania" 4 per cent, the "West Virginia" and the "Maryland" 1 per cent. The blame for this delay is certainly not to be laid at the door of the Construction Department, to whose credit it may be said that its work in the preparation of plans has always been far ahead in expeditiousness of the contractors who undertake to build the vessels. The record of naval construction in private yards during the past ten years has shown very clearly that the government work is regarded, at least in some of these yards, merely as a kind of stop-gap to fill in the slack times between the execution of private orders.

It is a notorious fact that warship construction in the United States drags out to a weary length, and that ships are delivered in some cases years behind the contract date for completion. It is neither expedient nor patriotic that this should be the case. How can the country be expected to vote the required appropriations for warship construction when the builders give practical evidence that these appropriations are made years in advance of the capacity of the private shipbuilding yards to complete the vessels? In the case of the ten important vessels referred to above, at the present rate of construction the types will have become not a little out of date before the ships can be set afloat.

This indifference on the part of the private shipbuilders to the interests of the country is a significant commentary upon the fact that the bitter opposition which has prevented the construction of warships in government yards has found its source and support chiefly in and around the shipbuilding centers. The shameful state of things shown in the Construction Department's report should prove to the country, once for all, that the desire of our naval constructors to have some of our warships built in the government yards is prompted by the very best motives. Whatever may have been the case in the '80's and early '90's, the most completely equipped of our navy yards, particularly the New York yard at Brooklyn, can now build just as cheaply and certainly as well as the best of the private yards, and there is no question that a decision of the government to give some of the future ships to the navy yards would put a stop to the inexcusable dilatoriness which, particularly of late years, has marked the construction of new ships for the United States navy.

THE AFTERMATH OF THE "AMERICA" CUP RACES.

The American public sympathizes with Sir Thomas Lipton, both in the natural disappointment which he must feel in having the coveted "America" cup slip through his grasp by such a narrow margin, and also in his sportsmanlike determination to leave his very capable boat on this side of the water for the purpose of sailing her next season against the best of our 90-footers. Although he does not carry away the cup, the owner of "Shamrock II." has at least the satisfaction of knowing that his handsome craft has pushed the American cup-defender as never any of her predecessors was pushed before; and he may also carry with him the assurance that the most excellent impression which he made on his first attempt of two seasons ago has been abundantly confirmed by the extremely pleasant spirit that has pervaded the present races, a spirit to which the Irish knight has contributed a most generous share.

It has too often been the case that the year succeeding a series of "America" cup races has been a very dull one in yachting circles; but, thanks to the decision of Sir Thomas to leave the "Shamrock" on this side of the water, there is every prospect that the season of 1902 will be the most exciting in the history of American yachting. With "Shamrock," "Columbia," "Constitution" and "Independence" fighting it out for the weather berth and the winning gun, not amid the flukes and chances of the three brief races of an international cup contest, but throughout the long four months of a yachting season, there will be witnessed a series of contests that will be worth going far to see.

A veteran skipper, who sailed three previous cup-defenders to victory, is credited with the remark that, although the owner of "Shamrock II." did not lift the cup, he has "set it rocking." He certainly has; and his statement that, failing a challenge from any other British yachtsman he will himself make another attempt, will be good news to his friends, among whom may safely be included the whole American public.

DETERIORATION OF THE BROOKLYN BRIDGE.

The report of the engineers appointed by District Attorney Philbin, after the recent partial collapse of the Brooklyn Bridge, to make a thorough survey of that structure and ascertain its present condition, has just been made public, and will be found in the current issues of the SUPPLEMENT. The shameful condition of neglect which was revealed by that accident, a full account of which was given in the SCIENTIFIC AMERICAN of August 3, 1901, fully justified the District Attorney in ordering an investigation. The conclusions of the report show that the neglect of the bridge, which was only accidentally discovered through the failure of certain details, is more or less general throughout the whole of this costly and magnificent structure.

While it was due in part to neglect, we had hoped that the failure was precipitated merely by local conditions inherent in the design and construction of the bridge at the point of failure; and that on a general examination of the structure it would be found that although other parts of the bridge had been neglected no serious results had followed. The report before us, however, shows that, as far as inspection and upkeep are concerned, the whole main span, including the saddles on the towers, is in an unsatisfactory condition; and after perusing the careful findings of the engineers one is impressed with the fact that the Brooklyn Bridge, which, because of its size and importance, should have received the most minute and careful inspection, has actually been left in a state of neglect which would be unpardonable even in an out-of-the-way and little-used county bridge.

Of the two engineers who made the investigation, one is considered to be the most expert authority on long-span suspension bridges in the world. The examination consisted of a thorough inspection of every part of the main span, and a careful computation of the stresses to which the bridge is subjected under the increased dead and live loads which have been put upon it since it was first designed. As the result of this increased loading the engineers find that the present margin of safety is so reduced that the necessity for repairs is urgent, and they suggest means by which the safety can be largely increased without materially interfering with the traffic and at a comparatively small cost. They further state that the present methods of supervision, inspection and maintenance are very faulty, and are not such as will with any certainty maintain the bridge in a safe condition.

Referring to the accident of July 24, 1901, they state that transverse bending was the cause of the breaking of the suspender rods, part of this being due to the absence of lubrication in the trunnion-blocks, and part of it to the fact that there was no provision for the side-play resulting from the pressure of the wind. They consider that this wind pressure was the immediate cause of the fracture, and that the suspender rods broke transversely to the bridge. We do not agree with this decision, as our investigation, made on the spot while the broken suspender rods were being taken out, showed that the fracture of the rods was due to an alternate bending strain in a plane parallel with the stiffening trusses, this strain resulting from the unlubricated and rusted condition of the trunnion-blocks.

Next to the failure of the suspender rods and the shameful condition of neglect in which these parts were found, most serious evidences of neglect were found in no less important a portion of the bridge than the saddles supporting the cables on the tops of the towers. These saddles are placed on rollers to allow a certain amount of longitudinal movement of the cables as they adjust themselves to the varying stresses upon the bridge. Like the trunnion-blocks and the suspender rods, the saddle bearings should have been regularly lubricated and all dust and foreign substances removed. To learn from the report that these saddles have been so far neglected that the inspection "shows no efforts whatever in this direction, ridges of rust, paint, and dirt being found on the bed-plates along the outer rollers," will come as a shock to all engineers who appreciate the necessity of living up to the principles on which the bridge was designed. Other evidences of neglect are that many of the diagonal bars and sway rods have been allowed to wear by rubbing against each other, and many of the suspender ropes by rubbing against the floor of the promenade; that water and mud have been allowed to collect and remain in portions of the bottom chords, and road sweepings in the bottom of the floor beams around the suspender stirrups; while a number of the stirrup rods of the wire suspenders were found to be improperly adjusted. We are entirely in accord with the report when it says that "the method of inspection in vogue on this bridge is at direct variance with the methods in general use on good American railroads." The safety of the bridge demands that the present methods of inspection by mechanics should be changed at once to that which is generally recognized as best, namely, an inspection by engineers in person at frequent, stated intervals, the results being recorded on printed forms. With the bridge in its present condition, the engineers consider that some parts of it should be inspected daily, others weekly, and every part of it at least monthly.

The investigation of the actual stresses to which the bridge is subjected has been gone into at great length, and is of extreme interest. We can merely summarize a few of the important findings. With regard to the main cables, it was found that under the increased loading which has been placed upon the bridge the maximum stress imposed is 75,400 pounds to the square inch. If it be admitted that the stays take a certain part of the load, the stresses in the cables may be put at 71,000 pounds per square inch, or 18 per cent in excess of the permissible working stress of 60,000 pounds to the square inch, the 71,000 pounds, however, being increased by the wind pressures, but to what extent is not now known. The masonry of the towers is also greatly overstrained. The maximum pressure in the towers with the saddles, thanks to gross neglect, rusted to the foundation plates, is at least 39.6 tons per square foot, whereas the working stress of the masonry should not be more than 20 tons per square foot. The report suggests a means by which this pressure can be reduced to about 25 tons per square foot. The floor system, as was to be expected, is subjected to excessive stress. The intermediate floor beams of the railroad tracks should be subjected to only 14,000 pounds to the square inch, yet the actual stress is 27,000 pounds. The intermediate floor beams of the road are also subjected to 25,000 pounds, as against a lawful stress of 14,000 pounds to the square inch. The wooden stringers of the railroad tracks should have a stress of only 1,300 pounds, whereas the actual stress is 1,750 pounds to the square inch. The anchorages are estimated to be perfectly safe, their factor of safety against sliding being 2.45, whereas ordinary practice requires only a factor of safety of 2. It is estimated that the alterations and improvements to bring the bridge up to the desired standard of strength can be made for between $500,000 and $750,000.

Whatever action may be taken upon this report, there is one lesson that should be immediately laid to heart by the people of the city, namely, that the bridge has been shamefully and willfully neglected, and that if the process of deterioration is not to continue they must see to it that the care of the structure is committed to those who are technically qualified to exercise a conscientious and systematic inspection of the kind suggested by the report.

THE LATEST TRANSATLANTIC RECORD BREAKER.

In all the history of the transatlantic steamship, there has been nothing quite so remarkable as the consistency with which the Vulcan Works at Stettin, Germany, have produced in each transatlantic steamer that leaves that yard a vessel that is appreciably faster than its predecessor. Some three years ago this firm built for the North German Lloyd Company the "Kaiser Wilhelm der Grosse," 649 feet in length and of 30,000 horse power, the largest and fastest ocean steamer of her time. She made the quickest maiden trip on record, and steadily added to her speed until, last year, she covered the eastward passage at an average speed of 22.8 knots per hour. She was followed in 1900 by the "Deutschland" of the Hamburg-American Company. This magnificent ship was an enlarged "Kaiser Wilhelm der Grosse," her length being 686 feet and her contract horse power 33,000. She also broke the record on her maiden trip to the eastward, the time being five days, sixteen hours and fifteen

minutes. On every successive trip the "Deutschland" showed an improvement in her speed, and after six months' service she covered the distance between Sandy Hook and Plymouth in five days, seven hours and thirty-eight minutes, at an average speed of 23.36 knots per hour, the engines showing an average indicated horse power for the whole trip of just under 37,000. This year the North German Lloyd Company have added to their fleet the "Kronprinz Wilhelm," which, in size and horse power, holds a middle position between the "Kaiser Wilhelm der Grosse" and the "Deutschland." She is 663 feet 4 inches in length and her horse power is 33,000. On the return trip of her maiden voyage, she gave promise of soon breaking all records for speed on the Atlantic, the route being covered in five days, nine hours and forty-eight minutes, or in several hours less time than the maiden trip of the "Deutschland." The best day's run of 540 knots was made at an average speed of 23.3 knots per hour.

A curious fact, not generally known, regarding vessels built by the Vulcan Works for the two great German companies is that while the Hamburg-American engineers are in favor of forced draft, the engineers of the North German Lloyd are strongly opposed to it. Forced draft is conducive to a high indicated horse power and a superior showing in efficiency; but while this fact is admitted by the North German Lloyd people, they claim that the decreased fuel consumption, (the "Deutschland" consuming only 1.3 pounds per horse power hour), is more than offset by the great wear and tear upon the boilers, the more frequent repairs, and the decreased life. The contest between the "Deutschland" and "Kronprinz" for the much-coveted record will be watched with great interest during the two years which will intervene before the giant vessel which is now building at Stettin for the North German Lloyd Company is completed and put in service. It is expected that the new vessel, which will be the longest and fastest in the world, will make its maiden voyage in May, 1903.

THE DEVELOPMENT OF THE BITUMINOUS COAL INDUSTRY.

BY WILLIAM GILBERT IRWIN.

There are no more interesting recitals in the annals of trade than that of the development of the fuel industries, for commerce and industry are very largely dependent upon the fuel supply. For many years the chief source of the world's fuel supply has consisted of those hydrocarbon compounds found in nature and known as coal. Scientists have long disputed over their origin, while in the meantime modern industry has adapted them to its varied requirements, and as a result has brought about achievements scarcely dreamed of a century ago. In the diversified fields of industry from which the capitalist reaps his millions and the workman toils for the necessities of life the coal trade has played a most important part. In its development we see the mightiest struggles of genius, the boldest strokes of business stratagem, the most gigantic projects involving the expenditure of enormous capital, and the organization of great armies of employés. The coal trade has constantly undergone an evolution involving a struggle for "the survival of the fittest," whether that of inventive genius, mechanical superiority, labor or capital.

In its adaptation to the uses of modern economic industry anthracite coal preceded bituminous, but of recent years the latter fuel and its products has had a much wider use in the iron and steel and allied industries, and present conditions foreshadow a continuance and even a rapid increase of this lead. The original area of the anthracite coal fields in this country did not exceed 500 square miles, and embraced the great field in Eastern Pennsylvania and the comparatively unimportant fields in Massachusetts, Rhode Island, Colorado, and New Mexico, while the bituminous fields already partially exploited in this country exceed 200,000 square miles, which shows conclusively that the latter coal is to form the fuel of the future.

Anthracite coal was first discovered in this country in Rhode Island in 1768, and in 1791 this fuel was discovered near Mauch Chunk, in Eastern Pennsylvania. The first discovery of coal in America was that of a bituminous vein near the present site of Ottawa, Ill., mentioned by Father Hennepin in 1679. The first coal mine opened in this country was a bituminous mine near Jamestown, first worked in the latter part of the seventeenth century. It is not the purpose of this article to trace these fuel industries through the period of their early development, but rather to trace the growth of the bituminous coal trade and the benefits which it has conferred upon modern industry.

The development of the bituminous coal industry up to 1850 was confined to the eastern part of the country. Then, as now, Pennsylvania held the lead, with Virginia, Illinois, Maryland, and Ohio making up the residuum of the output. The soft coal production in 1850 was, in round numbers, 10,000,000 tons. As yet the railway development of the country had not really been begun, and the iron and steel industries had not yet emerged from that period when charcoal formed the principal fuel. The coal trade then depended upon the rivers for transportation to the markets. In the development of the soft coal fields of Western Pennsylvania we can divide the industry into a number of epochs in accordance with the development of transportation facilities. The latter days of the seventeenth century witnessed the opening of small mines for local consumption; this was followed by the days of keel-boating down the Ohio and the Mississippi; about 1817 the flatboating epoch began; in the early forties the development of the slackwater systems on the upper Ohio streams ushered in the days of steamboating as applied to the coal-carrying traffic; in the meantime the coking industry was undergoing its infantile vicissitudes; then came the iron way of the railroad; lastly, the introduction of modern mining appliances and advanced mine engineering practice marks the highest point in the history of this great fuel industry.

Coming down to 1870 we find nineteen States and Territories producing soft coal, and in that year the output was 17,000,000 tons; ten years later twenty-five States and Territories were producing 43,000,000 tons; by 1890 the number of bituminous coal producing States had increased to twenty-eight, and the aggregate output for that year was 111,000,000 tons. During the past ten years the industry has been developed in no new States, but many new fields have been exploited in the already soft coal producing States, as will be seen from the fact that the output for 1900 was, in round numbers, 208,000,000 tons. While, in part, the marvelous increase in the soft coal output for the past ten years has been due to the development of new fields this is not entirely the case. During this period the introduction of the mining machine, the application of electricity and compressed air to mining operations, steel tipples and automatic tipple appliances, and the advancement of mining engineering, have had much to do with the development of the industry, as have the stimulating influences of the great industrial revival which this country has experienced during that time.

The Western Pennsylvania field, better known as the Pittsburg coal field, has during all these years maintained its lead with comparative ease, the production for 1900 being, in round numbers, 78,000,000 tons. Of the other principal coal States Illinois follows with 25,000,000 tons; West Virginia, 22,000,000; Ohio, 17,000,000; Alabama, 8,000,000; Indiana, 6,000,000; Kentucky and Iowa, each 5,000,000; Kansas, a little over 4,000,000.

According to geology the bituminous coal fields of our country are classed in seven groups. The Triassic field embraces the Richmond basin in Virginia, and the Deep River and Dan River areas in North Carolina. The maximum output of this field was reached many years ago, and its present annual production does not exceed 50,000 tons. While not the largest in area, the Appalachian field far exceeds all other fields in importance, its annual production being about two-thirds of the entire bituminous output of the country. It embraces Central and Western Pennsylvania, Southeastern Ohio, Western Maryland, West Virginia, Eastern Kentucky and Tennessee, Northwestern Georgia, and Northern Alabama. It contains the well-known Connellsville coking field, the Clearfield and Pittsburg gas and steaming coal seams, and the Monongahela field in Pennsylvania; the Blossburg and Cumberland fields in Maryland; the Pocahontas and New River fields in Western Virginia; the Fairmount, Flat Top, Kanawha, Georges Creek, Elk Garden and other important fields in West Virginia; the Massilon and Hocking fields in Ohio; the Jellico field in Kentucky and Tennessee; and the Birmingham field in Alabama. The central field, including the coal areas in Indiana and Illinois, and Western Kentucky, has a considerable area and a large production, as will be seen from the production of States given above. The Western field embraces the States of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Texas and Indian Territory. In extent it is the largest field in the country, and in production it ranks third. The Rocky Mountain field includes the coal areas in Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, and Wyoming. This field is rapidly increasing in importance. In 1887 the production of the field was about three and one-half million tons. Within three years the annual output was doubled and the production for 1900 was, in round numbers, 14,000,000 tons. While California and Oregon produce small quantities of coal their combined annual output does not exceed 200,000 tons. The Washington field is being rapidly developed, and the output of the State has increased from 1,263,689 tons in 1890 to 2,418,834 tons in 1900.

The aggregate of the world's output of all kinds of coal for last year was about 800,000,000 tons. The production of bituminous coal in this country was more than one-fourth of the world's mineral fuel production. It exceeded that of Great Britain; was one-fourth greater than that of Germany; five times the production of Austria-Hungary; six times that of France; fourteen times that of Russia, and fifty times the production of Canada. All kinds of mineral fuel produced by Continental Europe last year exceeded our bituminous production by a little more than one-fourth. More than a third of a million men are employed in the bituminous coal mines of our country, while a like number are engaged in its shipment, in the manufacture of coke, fuel gas and other accessories of the industry, and in the other labor required in handling the product from the mines to the markets. The office forces of the concerns engaged in the industry aggregate thousands, and there are superintendents, foremen, fire bosses, engineers, electricians and thousands of other skilled laborers dependent upon the soft coal industry. The industry has stimulated the construction of thousands of miles of railway, and the great trunk lines of the country are reaping rich revenues from the bituminous coal carrying trade. The sum total of the capital invested in this great fuel industry makes another interesting recital.

The economic methods of coal mining and fuel operations already adopted in the Old World have been made necessary, because of the depleted condition of the coal fields there. So far as concerns the bituminous coal industry, there is no danger of an early depletion of the fields of this country; but this does not mean that we are not adopting the more economic measures in every department of the industry. Allowing for the variation of the bituminous coal measures of this country, which run from a little less than four feet to eight or nine feet in thickness, it would not be far out of the way to estimate a production of 10,000 tons to the acre, which would give our entire bituminous coal area a producing capacity of 1,280,000,000,000 tons. At the present rate of mining the depletion of this area would require something like 6,000 years. However, it must be remembered that thousands of acres of barren territory are embraced within this coal area, the mining operations extending over the past sixty or seventy years have been quite extensive and thousands of acres of coal have already been rendered unminable, and future operations will make it impossible to mine much of the coal. However, it will be seen that so far as concerns the bituminous coal supply this country has nothing to fear as to the future.

Already American bituminous coal is playing an important part in the export trade, and is being received with favor in Europe in competition with the Welsh product. Our exportation of bituminous coal has grown from 1,138,681 tons in 1890 to 5,411,329 tons in 1900. It has been only a few years ago that American coal was practically unknown in the European markets, while during the past year our soft coal was exported to eleven countries of Europe to the aggregate amount of over a quarter of a million tons. The scarcity of the Welsh product caused by the Boer war gave an impetus to the market for our soft coal in Europe, and it seems to have found a permanent market there. Last year our soft coal was exported to fifty countries, and American coke was sent to twenty-two foreign countries, the total exportation of this soft coal product being about 400,000 tons. Pennsylvania, West Virgina and Maryland bituminous coal figures most largely in the export trade owing to the advantageous location of the fields of these States with respect to the great Atlantic ports.

Mile Automobile Track Record Lowered.

The fastest time ever made on a track by horse, bicycle or any machine was made on Thursday, October 10, at Empire City Park, N. Y., by M. Henri Fournier and his guest, Mr. William K. Vanderbilt, Jr. The total time for the six miles was 6 minutes 47 seconds. The fastest mile, which was the third, was done in 1 minute 6 4-5 seconds. The rules require that two persons be in the motor vehicle in a record-making endurance test. Some idea of the enormous speed which was developed can be gained when it is stated that the distance was traveled on the track in faster average time than is made by the Empire State Express. M. Fournier used the same machine with which he won the Paris-Berlin race last summer, and he broke his own records by nearly six seconds. The best former world's track record was 1 minute 13¼ seconds, which was made in September at Fort Erie by M. Fournier himself.

It is anticipated that when the Solent tunnel, connecting the mainland of the south coast of England with the Isle of Wight, is completed it will have a great influence upon the transatlantic shipping traffic. A pier is to be built at Yarmouth, near which the tunnel will emerge on the island, and the North German steamers will be able to discharge their mails, passengers, and cargo at this point, instead of proceeding up to Southampton. Owing to the great care that has to be exercised in traveling up this waterway to the port, and thence down Spithead, a considerable amount of time is wasted. By stopping at Yarmouth a great economy in this direction will be effected.