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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.

## OUR VAST RAILROAD SYSTEM.

The era of extraordinary prosperity now being enjoyed by the United States is reflected in the stupendous railway system which has contributed so largely to that prosperity. We have in this country, as recorded in the latest available figures, a total single-track railway mileage of 218,101 miles. This is an increase of 4,196 miles over the year preceding. The aggregate length of mileage, including sidings and tracks of all kinds, is 306,796 miles, which is owned by no less than 2,167 railway corporations. The equipment includes 48,357 locomotives, an increase during the year of 1,614; while the total number of cars is 1,842,871, an increase of 44,310 during the year.

It is gratifying to note that the work of the Interstate Commerce Commission in enforcing the use of train brakes and automatic couplers has been so successful, that out of an aggregate number of 1,891,228 locomotives and cars, 1,641,395 are fitted with train brakes, and 1,871,590 have automatic couplers. To operate the railroads requires the services of 1,382,196 employees; and the total amount of wages and salaries paid out during the year was \$839,944,680. The par value of the amount of railway capital outstanding is nearly thirteen billion dollars, and of the total capital stock 37.16 per cent paid no dividends. Of the balance of the stock 9.72 per cent paid from 1 to 4 per cent; 14.77 per cent from 4 to 5 per cent; 10.74 per cent from 5 to 6 per cent; 8.79 per cent paid from 6 to 7 per cent, and 11.68 per cent paid 7 to 8 per cent.

The number of passengers carried by the railways was 738,834,667, an increase of over 23 million during the year. The number of tons of freight carried was 1,428 millions, an increase during the year of nearly 118 million tons. The gross earnings were for the first time over two billion dollars, while the operating expenses were \$1,390,000,000.

In the annual reports made to the Interstate Commerce Commission, carriers are expected to include all casualties to passengers, employees, trespassers, and other persons; and the totals as compiled by the Commission show that the total number of casualties to persons on railways for the year ending June 30, 1905, was 95,711, which was made up of 9,703 persons killed and 86,008 injured. Among the employees 1,990 trainmen were killed and 29,862 injured; 136 switch tenders, watchmen, etc., were killed and 838 injured; while of other employees, 1,235 were killed and 36,097 injured. The risk due to the work of coupling and uncoupling cars accounts for 230 lives and 3,543 injuries. The number of passengers killed in the same year was 537, and the number injured was 10,457. In addition to these figures we find that no less than 4,865 people were killed and 5,251 were injured while trespassing on railway property; while of persons other than employees, 4,569 were killed and nearly as many injured by being struck by trains, locomotives, or cars. In applying the test of risk in proportion to numbers, we find that one passenger was killed for every 1,375,856 carried, and one injured for every 70,655 carried. When we apply the same test to the employees, the results are exceedingly discouraging and positively tragic, for we find that one out of every 133 trainmen, that is, engineers, firemen, conductors, and other trainmen employed, is killed and that out of every 9 employed one is injured.

## A BRILLIANT NAVY YARD SUCCESS.

It is now some half dozen years or more since Francis P. Bowles, the late Chief Constructor of the United States Navy, made the startling proposition that it would be advisable for the government to undertake the construction of some of its warships at the leading navy yards. The proposal was bitterly opposed, ostensibly on the grounds that some of our early, government-built warships had proved to be exceedingly costly; that they had taken a long while to construct; and that they had not proved to be altogether satisfactory in service. Mr. Bowles re-

plied that those ships were built at a time when the navy yards were smitten with the blight of political interference; that the yards had now been emancipated from politics; and that they were in a thoroughly efficient condition, and were fully competent to build warships expeditiously and, within the limits of the shorter hours and higher wages paid, to build them economically.

The SCIENTIFIC AMERICAN, after a careful investigation of conditions, reached the conclusion that the suggestion to build some ships at the navy yards was an excellent one, the arguments offered in favor of the policy being unanswerable. At that time the private contractors who had warships on hand were showing a deplorable lack of regard for the nation's interests, by allowing work on the war vessels to drag along in any old fashion, and it was largely in the hope that the stimulus afforded by the construction of government vessels in government yards would prompt the private shipyards to live up to the spirit and letter of their contracts, that the proposal was put forward. But over and above this consideration was another and not less important, namely, that if such a navy yard as that at Brooklyn were occupied in the construction of a warship, it would be necessary to keep a large and skilled force of mechanics constantly at work, and there would not be that continual fluctuation in the number of men employed, which had been one of the severest drawbacks to efficient work when the yard was engaged merely upon repairs and refitting. Under the old regime, the work of the yard consisted almost entirely in the refitting of the fleet twice a year, in June and November. A large number of extra hands had to be temporarily taken on, only to be discharged again when the fleet sailed for its summer or winter cruise. Frequently, it proved to be difficult to gather a sufficient force of the kind required, and it took some little time to break the men in thoroughly to work which, to many of them, was of a novel character. It was urged that if a warship were on the stocks it would be possible to keep a force of large proportions permanently in the yard, and that when the fleet came in for refitting, these men could be transferred from construction to repair work, and returned to construction work when the fleet left the yard.

It is a matter of history that Congress was led to see the wisdom of the course proposed, and that when the 16,000-ton "Connecticut" and "Louisiana" were authorized, it was decreed that one of the ships should be built at a government yard. It is also a matter of history that the "Connecticut," which was laid down at the Brooklyn navy yard, has been built in the record time of three years and nine months, and that the pace she set was followed by the private yard which was building the sister ship, both of these vessels being completed at practically the same time. This time should be compared with the time taken in the construction of earlier battleships, of only two-thirds the size, which had taken from five to six years to build.

The "Connecticut" has thus amply fulfilled the promise made as to speed of construction; and there is no question that the stimulus thus afforded will be permanent. It was realized at the outset that, because of the fact that navy yard employees work shorter hours and receive higher pay than those at private yards, the vessel must, of necessity, cost more than if she were built by contract. The difference was estimated at ten per cent, an amount which is more than repaid in the military advantages of having on hand at all times an efficient force of men. Although the final estimate of the cost of the two vessels has not yet been made up, enough is known to guarantee the statement that the "Connecticut" has cost less than was estimated, that is to say, that she has been built well within the ten per cent excess that was anticipated.

We have noticed that in certain quarters there is evidence of a desire to disparage the work done at the navy yard, and assert that the "Connecticut" has cost more than was anticipated and has taken very much longer to complete. Therefore we now wish to state the facts as recorded in the government official reports of the two vessels, which have already appeared in the public press. Last April, when the "Connecticut" was slightly ahead of the "Louisiana," both ships being between 97 and 98 per cent completed, the appropriation had been all expended, and work was stopped on the "Connecticut" for the reason that the ordinance, which was being supplied to both ships by the government, was lacking. For this reason, from April to July, nothing whatever was done on the "Connecticut." In order, however, to save demurrage charges in the case of the contract-built ship, the government decided to accept the "Louisiana" in her incomplete condition. Consequently, although in the government report for July the "Connecticut" is given as only 97.41 per cent completed, the "Louisiana," having been accepted, is given as 100 per cent completed; but at the foot of the report is a note to this effect: "The percentage of completion refers to contract work, which in the case of the 'Louisiana' has been modified so that

the installation of the battery is to be completed by the government." When the belated 7-inch battery was delivered to the "Connecticut" in the summer, the work incidental to mounting the battery was pushed to completion, and the ship recently went into commission. It is well known to government officials that, in regard to minor fittings and general finishing up, the "Connecticut" is as a matter of fact in a slightly more advanced condition than the sister ship. Not so much because we advocated strongly the construction of one or two warships at the navy yards, as because we have the interests of the navy most sincerely at heart, we take the present opportunity of presenting the true facts of the case to the public, with the hope that, at least as regards our two leading yards, the policy of government construction will be continued.

The argument has lately been advanced by those who are opposed to government construction, that the navy has grown to such a size that there are sufficient ships at the navy yard at all times to keep a large force permanently employed. While it is true that the permanent force is larger, it is also true that the fluctuation in the force is much greater than it ever was before. Therefore, the arguments in favor of having at all times a large job of new construction on hand are stronger than at any previous time in the history of the navy. Proof of this is shown by a comparison of the number of ships in the yard for repairs on June 14 of this year with the number in the yard on October 1. In June the Atlantic fleet was at the Brooklyn navy yard for extensive repairs and refitting. Work was being done on five battleships, the "Indiana," "Massachusetts," "Maine," "Alabama," and "Illinois," while work would have been going on upon the "Connecticut" had the supply of 7-inch guns been available. Repairs and refitting were being done also on five of our largest armored cruisers, the "West Virginia," "Charleston," "Colorado," "Pennsylvania," and "Maryland," and also upon four auxiliary vessels, the "Portsmouth," "Culgoa," "Celtic," and "Celt," and last upon the submarine "Plunger."

From sixteen vessels at the yard in June the number had fallen to five on October 1, namely, the battleships "Connecticut" and "Massachusetts," the yacht "Mayflower," and the auxiliaries "Culgoa" and "Aberdeen." Such fluctuating conditions as these involve a variation in the total force of the yard from a maximum of 6,000 at the time that the "Connecticut" was under construction, to a total of from 3,000 to as low as 500 when, as in October, there is no warship on the stocks and but little work is being done on the vessels that are there.

The above comparison is sufficient proof, surely, that the construction of at least one ship at our leading yard is eminently desirable; for not only does the employment of a permanent force lead to great economy and efficiency in the work done, but it puts the yard in the best possible condition to meet the sudden emergency, which will always arise during a war scare, or upon the actual outbreak of hostilities.

## THE SHAPE OF THE SUN.

That there is a variation in the figure of the sun has long been suspected. Observations apparently confirming this variation have been recently published by Ambronn embodying heliometer measures made with the Göttingen heliometer during 1890-1902. Schur determined a series of measures of the solar diameter throughout the whole of a sun-spot cycle of eleven years or thereabout, and, to obviate errors as far as possible, two complete and independent series of observations were made by himself and Ambronn. In their discussion Ambronn found the mean solar diameter for the whole series; then the residual for each observation by subtracting the mean. From these residuals he obtained the mean residual for each year, and thus the yearly variation in diameter. The table of these variations shows a periodicity with a time of between six and eight years.

C. L. Poor, in an article appearing in the *Astrophysical Journal*, considers that this method could not lead to the detection of any changes in the diameters, and rediscusses the whole series of values. He detects a decided periodicity, the polar diameter being larger in 1890-91, while the equatorial diameter was greatest during 1892, 1893, and 1894. The exact length of the period is uncertain, but it appears to be nearly the same as the sun-spot period. The amplitude of the variation is 0.2 sec., the difference between the largest positive and negative values being about 0.5 sec. These heliometer measures thus corroborate the conclusions previously determined from Rutherford's photographs, but the amplitude of the variation is much less in the case of the visual observations.

Since 1878 to the present time nearly every year has seen a continued and steady decline in the amount of rainfall in Ecuador. No exact statistics are obtainable, but there is little reason to doubt that the decline within the period cited is upward of 30 per cent.