being 10 inches, 15 inches, and 28 inches in diameter respectively, all of 2 feet stroke. The high pressure cylinder is placed inverted over the intermediate one, the same piston rod serving for both, and there being space between for packing glands, etc. The cover of the intermediate cylinder is made in halves, so that its piston can be drawn without removing the high pressure cylinder. The crank shaft and screw shaft are forged from Lowmoor scrap, the diameter of journals being 5¾ inches. The surface condenser has 350 square feet of tube surface, the tubes are three quarter inch external diameter, packed with Marshall's patent rings. The air pump is 10½ inches in diameter by 12 inches stroke, and is single-acting; the circulating pump is 6 inches diameter by 12 inches

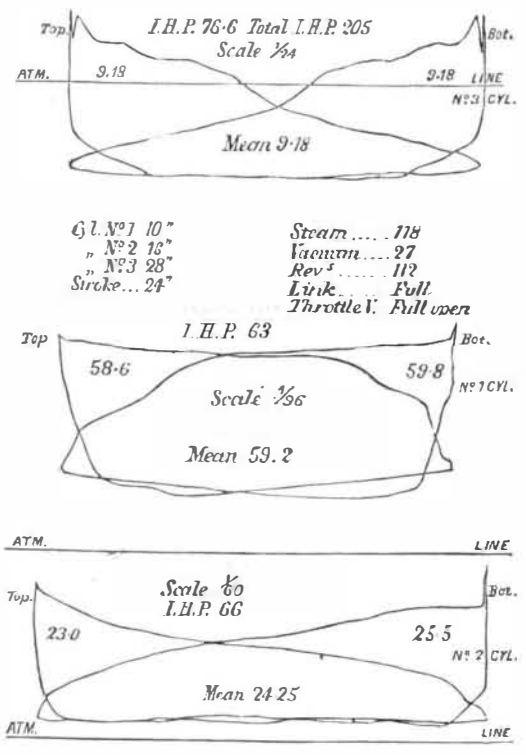

Fig. 2.—DIAGRAMS FROM THE ENGINES OF THE ISA.

stroke, and double acting. There are two feed pumps 1⅞ inch in diameter by 12 inches stroke, and one bilge pump 2⅜ inches in diameter by 12 inches stroke. The propeller has two blades and is of gun metal, polished all over; it is 8 feet 6 inches diameter and 12 feet 3 inches pitch. Steam is supplied by one boiler 8 feet 9 inches diameter by 8 feet 6 inches long, with two furnaces 33 inches in diameter, and 106 return tubes of 2¾ inches external diameter. The shell plates are one inch thick with double butt straps, treble riveted; the boiler was proved by hydraulic pressure to 250 lb. per square inch, and with steam to 150 lb. The working pressure is 120 lb. The accompanying diagrams were taken during a run out to sea, the speed of the yacht being about 12 knots.—*Engineering.*

The Suez Canal.

Mr. Farman, United States consul-general at Cairo, Egypt, furnishes the Department of State with an interesting article on the Suez Canal. His facts are derived from authentic sources. A few of them are selected of remarkable interest. The entire cost of the canal was 472,921,799 francs, or $92,273,907. The stock of the company consists of 400,000 shares, at 500 francs each. These shares have sold as low as 100 francs each. At the opening of the canal they had advanced to only 300 francs. They are now quoted at 717 francs, and are probably worth more. The British government paid about 568 francs. The number of shares bought, in 1875, by Lord Beaconsfield at this price was 176,602. This great purchase, aside from its political and commercial advantages, thus affords a clear profit of 25,000,000 francs at present prices. The balance of the stock is held by a large number of persons, mostly in France. The revenues of the canal have increased from 5,000,000 francs in 1870 to over 30,000,000 francs in 1877. The expenses, including interest, sinking fund, and lands, have been a little over 17,000,000 francs per year. While the revenues steadily increase, the expenses are decreasing or stationary. Deducting the amount paid for interest and the sinking fund, the actual expenses are about 5,000,000 francs annually. The cost of cleaning the canal and its accessories is only about 2,000,000 francs per annum. The small comparative cost of maintaining the canal arises from the fact that there are no locks or lateral embankments to be broken. Except the ordinary cleaning, there is little to be done. Vessels drawing twenty-five feet of water or less pass through the canal. The saving of distance to the British ships going to India is nearly 5,000 miles. Two thirds of all the vessels passing through the canal carry the English flag.

Monsieur Ferdinand Lesseps, who has been at the head of the enterprise since its beginning in 1854, expresses the opinion that the Panama canal must be constructed without locks to be successful or remunerative.

MATHEWS' BOILER ATTACHMENT.

In our last issue we gave an illustration and description of this simple apparatus. The address of Mr. F. C. Mathews, given at the close of the article, is incorrect. It should be 337 and 339 Canal street, New York.

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(Illustrated articles are marked with an asterisk.)

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THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 172,

For the Week ending April 19, 1879.

Price 10 cents. For sale by all newsdealers.

THE WORLD'S FAIR OF 1883 AT NEW YORK.

That the hundredth anniversary of the acknowledgment of the Independence of the American colonies by the mother country in 1783, will be signalized by a grand world's fair in this city, may be accepted as morally certain.

The occasion will be one demanding especial recognition; and in this industrial age there is no way by which the great events of a nation's history may be celebrated so appropriately or so profitably as by a national or international exhibition of the arts and sciences. From idle pageantry and noise and mock engagements at arms, national celebrations have risen to the higher level of useful exhibitions of industrial achievements, progress in the higher walks of civilization, national resources, and the thousand inducements which commerce offers for the closer interweaving of nations in the arts of peace and mutual helpfulness.

Neither the educational nor the industrial nor the commercial benefits which flow from such exhibitions need be argued now. That lesson was sufficiently learned three years ago, and the coming census will show that Philadelphia alone has reaped a sufficient harvest from the Centennial Exhibition to more than repay the cost of it, had the burden fallen upon that city alone. And not only Philadelphia, but the whole country, even to the smallest hamlet or farmhouse or wayside workshop, however remote from the great centers of trade or manufacture, is to-day enjoying a real and growing prosperity, in which may be traced the influence of that exhibition, either in creating new industries and finding new markets, or in improving, stimulating, and widening the old. And whatever good was accomplished in 1876 will be easily confirmed and surpassed by the exhibition of 1883. The former demonstrated not merely the profitableness, but the possibility of a successful world's fair on this continent; and not only will our own people take a more lively interest in the next one, but millions of our American neighbors, who were but feebly represented, or not represented at all, at Philadelphia, will have the strongest possible incentive to come forward in 1883. The one took place during a period of profound industrial and commercial depression; the other will reap the advantage of the rising tide of what promises to be a period of national prosperity such as the world has never yet seen. The projectors of the Philadelphia Exhibition were met with almost universal doubt and incredulity; and it was not until the show was open that the majority of our people became convinced of its probable success. The vast majority of our West Indian and South American neighbors were not reached by or represented in it at all. Mexico was meagerly represented; Central America not at all. With the exception of the British Islands of Jamaica and Nassau, the West Indies were unrepresented. Brazil was well represented, and Chili slightly; all the other rising States of South America, so rich in raw material, so promising as markets for our manufactured goods, took no part at the Centennial. In organizing the exhibition of 1883, no such obstacles and deficiencies will be encountered. Our productive industries, and those of all the rest of the world, now know for a certainty that representation will pay, and that a failure to be represented will be the reverse of profitable. This will make it possible to secure at once a wider range and a higher grade of exhibits. And the experience gained at Philadelphia should secure also a more critical and judicious selection and arrangement of materials.

It may be said that it is too soon to repeat what was, despite its shortcomings, so admirably done at Philadelphia. True, but not too soon to hold another exhibition which, without repeating what was done in 1876, shall supplement, extend, and crown the work begun there for securing the supremacy of our country in the development of the peaceful arts and sciences. To represent simply the progress of the world between 1876 and 1883, excluding everything exhibited at Philadelphia which cannot show an improvement upon what was shown there, will suffice to make the coming exhibition as wide in scope, as rich in material, and even more valuable and instructive as an exhibition than the Centennial Exhibition was. And the success of American exhibitors, there and since, at Paris, will compel our foreign rivals to send the best they have.

We may be sure that whatever New York undertakes will not be second rate in magnitude nor deficient in thoroughness of execution. The assured character of the gentlemen engaged upon the new project gives good reason to anticipate a successful exhibition. It certainly will not fail through any lack of broad views, practical ability, or administrative capacity.

THE WORCESTER FREE INSTITUTE OF INDUSTRIAL SCIENCE.

The Free Institute of Industrial Science at Worcester, Mass., has now been in operation just ten years. It has graduated eight classes; and the list of the residences and occupations of its graduates shows them to be, almost without exception, engaged in honorable and lucrative occupations. Very naturally the great majority of them are connected with important productive industries. The directors believe that by combining practical work with theoretical study, the student's entrance upon professional life is an expansion of his school life, and not an abrupt transition to a new mode of life, and the results seem to justify the belief.

Practice, in this school, is subjected to three conditions: First, that it shall be a necessary part of each week's work; secondly, that it shall be judiciously distributed; and thirdly,