

difficulty in generating higher pressure steam caused stagnation in marine engineering practice; until the substitution of steel for iron in boiler making, the advent of new types of furnaces, and improvements in the machinery used in boiler construction have enabled pressures as high as from 150 pounds to even 200 pounds to the square inch to be carried. The result has been that, for the two-cylinder compound engine, there have been substituted two types of engine, known respectively as the triple expansion engine and the quadruple expansion engine. The names are misleading, as even the ordinary compound engine expands its steam more than three or four times.

The growth of the science of marine engine design, which we have so briefly sketched out, may appear, to those who are not engineers, but little more than a record of increasing steam pressures. Undoubtedly a higher steam pressure has been the fundamental reason for these advances, but the carrying out of these successive changes in pressure has necessitated an entire reconstruction of marine engine practice; so that an engine working at 15 pounds pressure can hardly be said to belong to the same category as one working at 150 to 200 pounds pressure. Tooth-wheel gearing, which was first used with screw propellers, has long ago disappeared, side levers and trunks are no longer introduced, and the surface condenser has become a necessity. In the old days, with jet condensers, the boilers were fed entirely with salt water, now in the best marine practice the condensed steam is all returned to the boiler, excepting that which is unavoidably lost, and this quantity is made up by special distillers and condensers, the manufacture of which has introduced a new branch of marine engineering, as may be judged by several exhibits by different firms in the Exhibition. The practice of circulation of refrigerating water through the surface condenser by means of separate centrifugal pumping engines has also introduced a distinctive type of auxiliary marine engine, upon which several important firms have been chiefly employed. Indeed, the increase in auxiliary machinery has been as marked a feature in the recent progress of marine engineering as have been the changes in the main engines themselves. A battleship of the first class will carry between seventy and eighty separate engines, in addition to those used for driving the propellers. These include electric light engines, hydraulic machinery in connection with the working of heavy guns, steering engines, &c. As an instance of what is gained by the use of auxiliary machinery, an instance given by Mr. White may be quoted. On one occasion it took 78 men  $\frac{1}{2}$  minutes to put the helm of the *Minotaur* hard over. Steam gear was subsequently fitted, by the aid of which two men were able to do the same thing in 16 seconds.

We do not propose to give a list of the various objects exhibited, to which we have referred in penning these remarks. The official catalogue performs that function far more completely than we could hope to do. The collection at Chelsea is well selected and fairly complete, and there will be found there material for object-lessons in all we have advanced in this brief sketch. We may, however, with advantage, add a few figures as to money cost, which cannot fail to be of interest, and for which we are indebted to the Director of Naval Construction. The cost of a 100-gun line-of-battle ship at the beginning of the century was about £65,000 to £70,000, armament and stores being excluded. The corresponding outlay on the 110-gun sailing three-deckers of 1840 was about £110,000; and that of the 121-gun screw three-deckers of 1859 about £230,000, machinery included. The *Warrior*, completed in 1861, cost over £375,000; and the *Minotaur* class about £480,000. With the increase in size of the *Dreadnought*, and the introduction of hydraulic mechanism, came an increase of cost to £620,000; while the *Inflexible* cost no less than £810,000."

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The *Nile* and *Trafalgar*, complete with armament, would represent little less than a million sterling each. The cost of the armour-plating, propelling machinery, and hydraulic gun mountings alone, would have paid for five first-rates of Nelson's time. The sum paid for the armour alone on one of our latest battleships, such as the *Royal Sovereign*, would pay for the Natural History Museum at South Kensington; whilst even a first-class torpedo-boat costs as much to build and equip as a 40-gun frigate of Nelson's time.

#### A GEOLOGICAL EXCURSION IN AMERICA.

I BEG to call to your attention the following short account of a geological excursion planned for the benefit of foreign geologists who may attend the coming meeting of the International Geological Congress in this city in August next. It will afford an exceptionally favourable opportunity for European geologists to become personally familiar with the most important geological phenomena of the United States.

I venture, therefore, in their interest, to request that you publish some notice of it in your widely circulated periodical, with a request that those who desire to take part in it will kindly advise me as early as possible, in order that arrangements may be thoroughly perfected beforehand. A single train will carry 75 to 100 persons comfortably. If more join, the party will be arranged in two trains. Arrangements will have to be made beforehand at the various stopping places along the road for the reception of the party, and you can therefore readily understand the importance of knowing as early as possible how many are to be accommodated.

S. F. EMMONS, Secretary.

Washington, D.C., May 30.

For the close of the fifth session of the International Congress of Geologists, which is to be held at Washington, D.C., from August 26 to September 2, a grand geological excursion has been organized, which presents unusual attractions and facilities for the European geologists who attend the Congress, and who wish to see some of the geological wonders which have become familiar to them through the memoirs of American geologists. The excursionists will start from Washington, on September 3, on a special train of Pullman vestibuled cars, which will constitute a moving hotel, being provided with sleeping and toilet accommodations for both ladies and gentlemen, restaurant cars, smoking, reading, and bath rooms, and barber's shop, and so arranged that travellers can pass freely at all times from car to car through covered passages. It will accompany the party wherever the rails are laid in the regions visited, the hours being arranged so that all the most interesting portions of the route will be passed over in the daytime, and stops may be made wherever any object of special interest to the travellers presents itself. American geologists who have made special studies of the different regions visited will accompany the train, and explain their geological structure upon the ground. The main route laid out is over 6000 miles (nearly 10,000 kilometres) in length, and extends over  $38^{\circ}$  of longitude and  $12^{\circ}$  of latitude. It is planned to occupy 25 days, and the cost per person will be 265 dollars (1325 francs), which will cover all necessary expenses, of whatever kind, during the trip.

The following are the principal objects of geological interest which will be seen by those who make the excursion:—

Going westward, the Appalachian Mountains are first crossed, and an opportunity will be had to see the closely appressed Paleozoic rocks which constitute their typical structure. The prairie region of Indiana and Illinois, at the southern end of Lake Michigan, its ancient outlet

into the Mississippi River, will be seen on the second day, and the Kettle moraines of the ancient Glacial sheet will be visited under the guidance of Prof. Chamberlin. On the third day the twin cities of Minneapolis and St. Paul, centres of the great wheat-growing region of the north-west, will be visited, and glacialists will have an opportunity to see one of the time gauges of the Glacial period, at the Falls of St. Anthony, on the Mississippi River.

During the fourth day the Great Plains of Dakota will be crossed, and toward its close the characteristic Bad-land topography of the Upper Missouri region will be seen. On the morning of the fifth day the travellers will leave the train at the entrance to the Yellowstone Park, and during the following week will be transported by stages through the Park region, stopping at rustic hotels established near points of special interest. The various geyser basins, the hot lakes and mud volcanoes, the obsidian cliffs, the falls and cañon of the Yellowstone River, the Yellowstone Lake, and other objects of interest, will be successively visited under the guidance of Messrs. Arnold Hague and Jos. P. Iddings.

On the twelfth day the railroad journey will be resumed, and, after crossing the crest of the Rocky Mountains in Montana, a stop of several hours will be made at the famous mining town of Butte, whose mines produced, during 1890, over 26 million dollars worth of copper, silver, and gold.

The morning of the thirteenth day will find the travellers on the edge of the great lava plains of the Snake River. Those especially interested in volcanic phenomena will have an opportunity here of making a side trip across these plains to Shoshone Falls, where the Snake river makes a single leap of over 200 feet, and cuts a narrow gorge 600 feet deep in the andesitic and basaltic lavas. The main party meanwhile will proceed southward into Utah, viewing the desert mountain ranges, the shore-lines of ancient Lake Bonneville, and skirting the shores of its present relic, the Great Salt Lake, will reach Salt Lake City, the Mormon capital, in the afternoon. A halt of three days will be made in Salt Lake City, which will give the travellers an opportunity of seeing the Mormons, the desert scenery around Salt Lake (with bath in the lake), and the magnificent Wahsatch Mountains. The Pleistocene phenomena will be explained by Mr. G. K. Gilbert, and the mountain structure and mining geology by Mr. S. F. Emmons.

On the sixteenth day the railroad journey will be continued across the Wahsatch Mountains into the plateau region of the Colorado River, crossing that stream in the afternoon, and obtaining views of great monoclinal scarps, and groups of laccolitic mountains in the distance.

On the seventeenth day the Rocky Mountain region of Colorado will be entered, through its finest cañon gorges, affording wonderful geological sections. Halts of a few hours each will be made at Glenwood Springs and at the famous mining town of Leadville, which has produced over 150 million dollars worth of silver and lead.

On the eighteenth day the train will descend the great mountain valley of the Arkansas River, between mountain peaks over 14,000 feet high, and through cañon gorges 3000 feet deep, debouching upon the plains through the Royal Gorge at Cañon City, where a remarkable geological section in the "Hogback" ridges will be visited. A short stop will be made at Pueblo, a great centre of smelting works; and Manitou Springs, in a sheltered nook under Pike's Peak, will be reached in the evening.

The nineteenth day will be spent at Manitou Springs, the vicinity of which abounds in objects of geological and mineralogical interest, and those who wish may make the ascent of Pike's Peak (14,200 feet) by rail.

The twentieth day will be spent at Denver, the capital of Colorado, a beautiful city of 130,000 inhabitants,

having a view of the whole eastern front of the Rocky Mountains. For those who desire it, a further excursion of ten days or more will be organized under the guidance of J. W. Powell and C. E. Dutton, to the Great Cañons of the Colorado River in Arizona, which they have so fully described in their writings. More detailed visits to the mining districts of Colorado will be directed by S. F. Emmons for those who wish to remain over for that purpose. Those who remain over will receive tickets securing them passage to New York by regular trains when they are ready to start.

The special train will leave Denver on the evening of September 21, crossing the Great Plains of Kansas and Nebraska and the Mississippi Valley, and reaching Chicago on the evening of the 23rd. A day will be given to Chicago, and thence the train will skirt the Great Lakes, Michigan, Huron, and Erie, crossing a portion of Canada, and reaching Niagara Falls on the morning of September 25. Leaving there in the evening, the travellers will descend the beautiful valley of the Hudson River early the following morning, and reach New York before noon of September 26.

#### NOTES.

THE Delegates of the University Press have informed Prof. Sylvester that they will be prepared to bear the expense of publishing in quarto a complete edition of his mathematical works. We understand that a memorial recommending this course was addressed to the Delegates of the Press, numerously signed by leading mathematicians of the two English Universities, and by eminent members of the French Academy of Sciences.

GEOLOGISTS on this side of the Atlantic will learn with deep regret that Captain Dutton, whose admirable memoirs in the Reports and Monographs of the U.S. Geological Survey are so widely known and valued, has been ordered to take up military duty in Texas—a wide pastoral region where his genius as a geological explorer will find no scope for exercise. As a member of the Corps of Engineers, he has of course always been liable to be taken away to mere routine service of this kind, for which any ordinary officer of his grade would be sufficient. But the authorities have hitherto appreciated his remarkable powers, and have allowed them free exercise, much to their own credit and greatly for the benefit of science. Whether a new martinet has resolved to apply the rigid rules of the service we do not know. But surely there ought to be public spirit enough in the United States to put such pressure on the Engineer Department as will make it reconsider its arrangements. It has only one Captain Dutton, and should be proud of him and make the most of him.

THE Council of the Royal Meteorological Society has decided to arrange for a general dinner, open to all Fellows and their friends, to be held in commemoration of the entrance of the Society on its new premises. The dinner will take place at the Holborn Restaurant on Tuesday, July 7, at 6.30 p.m.

THE Committee appointed by the Hebdomadal Council, Oxford, to consider in what way the University could assist in the establishment of agricultural education, with a special view to the needs of the County Councils, have now submitted their report. By agricultural education the Committee understand instruction in the sciences, or the branches of science, specially applicable to agriculture, employing the latter term with the larger meaning which must have been present to the mind of Dr. Sibthorp when he designated the professorship founded by him the professorship of "Rural Economy." Used in this sense agriculture becomes not merely the science of the cultivation of the soil, but includes the knowledge of its constitution and properties, of its vegetable products, and of the structure, habits, and uses of the domestic animals that are