bore the concomitant privations and physical exertion it required.

The first general assembly for 1885, of the Geographical society of Paris, took place on the 24th of April. The president, Mr. de Lesseps, gave a brief address, in which he touched upon the much greater sensitiveness to occurrences in little-known lands, which the extension of telegraphs and means of transportation has brought about among the more civilized nations; and the growing importance, from all points of view, of geographical instruction in schools, universities, and even in the reading-matter furnished the general public by the daily and periodical press.

Dr. Ballay, in an address on the new possessions of France in Africa, sums up by saying, that while the Ogowé can never be rendered navigable, it can at least be made useful for *bateaux*. Its basin is naturally fertile, and rich in resources. On the other hand, the country extending from this basin to the Kongo is generally sterile. Ivory is about the only product. There is little to hope for from this region; but it is the beginning of the practicable route for reaching the trade of the upper river, which has inhabitants of intelligence and thrift. The natural products of all this region, such as rubber, ivory, etc., may be expected to become rapidly exhausted. It should therefore be provided that artificial cultivation, new industries and crops, should be introduced and directed by the whites. In this way a permanent trade will arise, and commerce be permanently benefited.

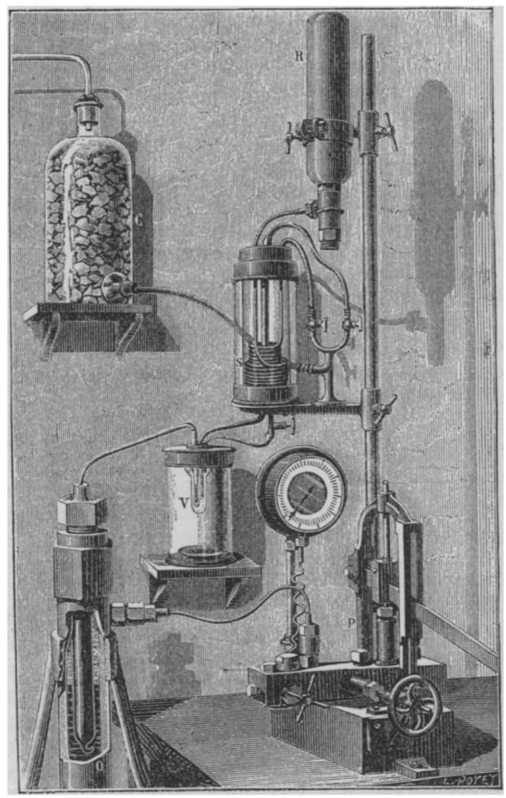
From Iceland, under date of March 21, we learn that the shocks of earthquake which had devastated the vicinity of Husavik, North province, began Nov. 2, 1884, and continued at short intervals, but less energetically, until the 25th of last January. On this day stables were thrown down, springs burst from the ground in new places, and small elevations were visible in a formerly level sandy plain. It is singular that on every historical occasion when earthquakes have been felt in Spain, Iceland has simultaneously suffered: this may be due, however, to the prevalence of earthquakes in Iceland at all times.

The Corwin has returned from Bering Sea to San Francisco for some repairs. She reports the sea ice unusually far south in April and May in that sea. No whales had yet been taken.

THE LIQUEFACTION OF OXYGEN.[1]

LIQUID ethylene, the use of which I have already explained to the Académie des sciences, furnishes, when boiled in the open air, a cold sufficient to cause oxygen, if compressed and reduced to this temperature, to present, when the pressure is diminished, a hard boiling appearance, which continues for an appreciable time. By evaporating the ethylene by the air-pump, the temperature is sufficiently lowered to reduce the oxygen to a liquid state. I have endeavored to avoid the inconvenience and complication which result from working in a vacuum, and to this end have already suggested the use of liquid methane, by means of which the liquefaction of oxygen and nitrogen may be easily brought about.

I thought, however, that, notwithstanding these advantages, ethylene, which is so easily prepared and handled, ought to be preferred to methane; and, by means of ethylene boiled in open jars, I have succeeded



CAILLETET'S APPARATUS FOR THE LIQUEFACTION OF OXYGEN.

in reducing the temperature sufficiently to cause the complete liquefaction of oxygen. The process I use is very simple, and consists in evaporating the ethylene by forcing into it a current of air or of hydrogen at a very low temperature. In my apparatus, the steel receiver *R*, which contains the liquid ethylene, is attached to a copper worm three or four millimetres in diameter, closed by a screw-tap arranged in a glass jar, *S*. On turning into this jar some chloride of methyl, the temperature falls to $-25°$; but if we blow into this air which we have dried by passing it through a flask, *C*, containing chloride of calcium, we soon have a cold of $-70°$. The ethylene thus cooled condenses, and fills the worm. When the tap is opened at the base of the jar *S*, the ethylene flows

[1] Condensed from *La Nature*, May 16.

under a slight pressure, and without apparent loss, into the glass gauge *V*, set, as shown in the figure, in a jar containing pumice-stone saturated with sulphuric acid, to absorb the water-vapor. It is indispensable to work in absolutely dry air; for otherwise the moisture of the air will condense in the form of an icy film on the walls of the gauge, which will become perfectly opaque.

It is then only necessary to evaporate the ethylene by means of a rapid current of air or of hydrogen cooled in a second worm, placed in the jar of chloride of methyl, *S*, to cause the oxygen compressed in the glass tube attached to the upper part of the reservoir *O* to be resolved into a colorless, transparent liquid separated from the gas above it by a perfectly clear meniscus. By working the pump *P*, the water acts on the mercury in the receiver *O*, and forces it into the gauge which contains the oxygen. The gas thus compressed liquefies in the branch of the tube in the gauge *V*. This tube dips into the ethylene at a temperature of — 125°. The mass of liquefied oxygen, which is as limpid as ether, is figured in black in the figure in order that it may be visible. By means of a hydrogen thermometer, I have measured the temperature of the ethylene, which in one of my experiments I found to be — 123°. I am in hope, that, by cooling the current of hydrogen more carefully, the temperature may be still further reduced. The copper worms in which the air and ethylene circulate are dipped into the chloride of methyl, which is rapidly evaporated by a current of air previously cooled. In conclusion, by evaporating liquid ethyl by a current of air or hydrogen much reduced in temperature, its temperature may be reduced below the critical point of oxygen, which in this way liquefies in the clearest form. This experiment is so simple and easy to perform, that it may enter into the regular course in a laboratory.

L. CAILLETET.

THE FORM OF SHIPS.[1]

IN the course of his address, the lecturer briefly explained the great development which the science of fluid resistance had undergone of late years, largely owing to the labors of Stokes, Rankine, and others, but more largely still to those admirable investigations which had been carried out, under the patronage of the admiralty, by the late Dr. William Froude, and subsequently by his son, Mr. R. E. Froude. He likewise explained the very great effect which those investigations had produced in the royal navy, owing to the judicious and prompt adoption of Froude's results by the admiralty constructors. Stress was laid, throughout the lecture, upon the importance of adjusting the form and proportions of ships, not only to the loads which they have to carry, but likewise to the weight of the materials entering into their structure. It was a common error to judge of the merits of steamships by the relations which exist between their displacement, steam-power, and speed, as expressed by formulae of various kinds. Approximations to the theoretical form of least resistance were sought by some naval designers, and all considerable departures from that form were regarded as objectionable. The lecturer, on the contrary, pointed out that no such theoretical form was any true or proper guide for a naval designer, since every change in the average weight of the hull necessitated a corresponding change in the form and proportions of the ship; and the great merit of a designer often was, that he adopted forms differing widely from the abstract forms of the schools, and presenting a very inferior appearance when put into what are known as 'constants of performance.' This was illustrated by examples derived partly from actual ships, and partly from calculations made for the purpose. Two actual war-ships were compared, one attaining the high figure of 213 marks when examined by the received formulae, and the other gaining but 172 marks ; yet, in the lecturer's view, the latter was far the better ship, because she performed precisely the same service as the other, being inferior in no respect, and yet had cost less than the other by £114,000, and expended no more steam-power in attaining an equal speed. The lecturer remarked, that he should probably have regarded the abstract 'form of least resistance' with more respect but for the circumstance that the designing of armored vessels, in which he was much engaged, was "a branch of naval construction of much too concrete and ponderous a character to admit of any dalliance with abstract or fancy forms." He went on to express his regret, that owing largely to the restrictions which granite docks imposed upon naval constructors, and to the absence of iron floating docks capable of receiving ships of any form, and owing to other causes likewise, the construction of armored ships — by which he meant ships which had a sufficient volume protected above the water to keep them afloat and upright while the armor remained intact — had been abandoned, and the first place upon the sea had been offered to any nation which had the courage and the will to assume it. In his opinion, this was a purely voluntary abandonment, and was not the result of any scientific or economic necessity. He admitted that great changes in forms and proportions were very desirable in our great line of battleships : for example, a great increase of breadth was necessary in order to economize the side-armor, and to keep the ram and torpedo at ample distance from the boilers and magazines, which should be protected by an inner citadel, so to speak, well removed from the outer one. But, so far was true science from presenting obstacles to these and other important changes, it actually invited these very changes; and increase of beam in particular had been shown by Froude to facilitate the attainment of practical invulnerability combined with very high speed. Size and cost were among the bugbears of our naval administration: by the true engineer they were always regarded as secondary to great and noble objects, among which objects he included the naval pre-eminence of England. At any rate, there was no engineering

[1] From a lecture before the Institution of civil engineers by Sir EDWARD REED.