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.

obstacle whatever to England constructing and sending to sea, not merely those great and swift, but delicate and fragile, Atlantic hotels in which the British navy was to embark and fight, for the want of something better, but also war-ships, — real war-ships, capable of bearing the once proud flag of England boldly into the waters of any enemy whatever.

BONE-CAVES IN WALES.

FROM a careful study of the bone-caves in Wales, Dr. Henry Hicks (*Proc. geologists' association*, vol. ix. No. 1) makes some very important conclusions in regard to the contents of the caverns. The evidence shows that the area of North Wales was subjected to very great physical changes during pleistocene times. In the earliest part of the period it was raised to a considerably greater elevation than it is at present, and depressed afterwards in interglacial times to a depth of at least two thousand feet, so that it became a mere cluster of islands. After that, the area gradually rose again, with slight oscillations of level, until it attained its present configuration. Deposits relating to all these changes are to be found either on the Welsh hills or in the valleys, especially in those surrounding the Vale of Clwyd. If an attempt is made to correlate the deposits in the caverns with the glacial drifts of the neighborhood, — the results of the changes referred to, — one would be inclined to look upon the lowest drift in the caverns, that consisting mainly of local materials, as belonging to an early part of the glacial period, i.e., before the great submergence. Possibly this material was introduced into the cavern when the river flowed in the valley at a much higher level than at present, as it has much the appearance of that usually brought down by river-action. As time went on, and the valley became deepened, so that the caverns were above the reach of the floods, they probably became the abodes of hyenas and other beasts of prey, or places where animals retired to die. During the epoch of great submergence, as soon as the caverns were on a level with the sea, they were probably filled with sand, and the animal remains became entombed in them. This sand is now found in the cavities of the bones, and occasionally cemented to them. In the period of upheaval which followed, as soon as the water was again on a level with the caverns, it washed out most of the sand, and carried in with it, instead, the muddy and other materials which had been deposited in the neighborhood by floating ice. By this means there was produced a general re-arrangement of the contents of the caverns. It was as the waters receded that the upper bowlder-clays were deposited both in the valleys and caverns. The abundance of bones in the caverns, and their very rare occurrence in the bowlder-clays of the valleys, prove almost conclusively that they must have been accumulated in the caves, and not washed in from the bowlder deposits near by. The proof furnished that the bones must have been buried in a marine sand before they were enclosed in the present cave-earth, is strong evidence that the animals occupied the cavern in very early glacial times. Whether man also lived in the area at so early a period, cannot at present be decided by any evidence, as the flint implement found with the bones in Cae Gwyn Cave might have been introduced at a later period. It is, however, interesting to know that it appeared to be associated with the reindeer remains, and that the type is supposed to characterize what is called in France the 'reindeer period.'

AN EDIBLE CLAM INTRODUCED ON THE ATLANTIC COAST.

AN interesting shipment of shell-fish has just been received at the Wood's Holl (Mass.) station of the U. S. fish-commission. It consists of nearly eight hundred living specimens of Tapes staminea from the shores of Puget Sound, in Washington Territory, where it is known as the 'little round clam.' It is not unlike the quahaug (Venus mercenaria) in general appearance, though differently ornamented, and not growing so large, and, as in the latter species, the valves fit closely together all around when the shell is closed. This clam is one of the most highly prized of the west-coast species, of which there are several used as food. It is marketed in large quantities in all of the principal towns, and would form a valuable addition to the food-products of the Atlantic coast, if it could be made to thrive here.

The shipment was made in one of the fish-commission cars, in charge of Mr. George H. H. Moore, and was obtained at Henderson's Bay, near Tacoma, Washington Territory, where the clams live on sandy and gravelly bottoms about the level of low tide. Between four thousand and five thousand specimens were secured, and first packed in wet sand, in the large stationary tanks on both sides of the car, filling a space about twenty-four feet long by two feet wide. The sand was moistened twice a day with sea-water at a temperature of about 56° F. During the first four days not over fifty of the clams died; but at the end of that time, as they were evidently not doing well, they were taken from the sand, and kept for a few hours in pure sea-water.

Then they were transferred to a bed of sand in which the shells were laid with the ventral margin uppermost, and covered with rock-weed which was kept constantly wet. During the next two days the mortality was very great, and it was thought best to try the salt water again. They were accordingly placed in tin cans of sea-water, in which they completed the rest of the journey, arriving at Wood's Holl, Friday, June 26, about seven days from the time of leaving Tacoma, where, however, they had been kept in the tanks two or three days before starting. On the last day of the trip, over seven hundred were lost, and the exact number received at Wood's Holl was seven hundred and sixty-eight. These were transferred to a suitable sandy beach, into which many began to burrow at once. It is impossible to predict how many of those brought over will recover