formulæ since brought forward give a more accurate measurement. It is, of course, not fitted for use with racing motors, in which everything in design is sacrificed to piston speed, high mean pressure, and a sufficient endurance to last through a few races. For an engine having 4-inch cylinders the Royal Automobile Club formula gives a rating of 25·6 horse-power, which is about the brake horse-power that a normal engine of this size would yield when driven at a normal speed. Racing motors of this size have, however, given almost, if not quite, 100 horse-power, and even if it were possible to do so it is a question whether it is worth while to search out a formula which would embrace such divergent practice and conditions of operation. The Royal Automobile Club formula corresponds to combining a piston speed of 1000 feet per sec. with a mean pressure of 67·2 lb. per square inch. Before it can be revised a complete series of careful experiments on engines of sizes ranging from 2 inches to 10 inches should be carried out.

In the succeeding article the writer proposes to discuss details of the recent mechanical improvement of the internal-combustion engine in relation to the theoretical investigations already discussed.

H. E. WIMPERIS.

CONFERENCE OF ENGINEERS AND SHIPBUILDERS AT GLASGOW.

A JOINT summer meeting of the members of the Institution of Engineers and Shipbuilders in Scotland and of the North-east Coast Institution of Engineers and Shipbuilders was held in Glasgow on August 4, 5, and 6. It is of interest to note that, although a large number of works and shipbuilding yards was thrown open to visitors, no works in which Admiralty work is under construction were included. This arises from the firms concerned paying respect to the wishes of the Admiralty that as much secrecy as possible should be observed regarding the details and progress of Government work. Wednesday and Thursday mornings were reserved for the reading and discussion of papers, of which we give brief extracts.

Sir Andrew Noble contributed some notes on the history of propellants. Perhaps the easiest way of showing the striking difference between the old gunpowders and some of the modern propellants is to quote two tables given by the author. As both the units of heat and the quantity of gas vary considerably, depending on the pressure under which the propellant is exploded, the author has taken the transformation approximately at the pressures at which the propellants are generally used in guns.

Older Propellants.

	Pebble	R.L.G.	F.G.	Mining powder	Spanish powder
Volumes of gas	278	274	263	360	234
Units of heat	721	726	738	517	767
Comparative energy	200,438	198,924	194 094	186,120	179,478

Modern Propellants.

	Cordite, Mark I.	Italian ballistite	M.D. cordite	Norwegian 167	Nitro-cellulose	Norwegian 165
Volumes of gas ...	875·5	810·5	913·5	899·9	934·0	909·9
Units of heat ...	1246·0	1305·0	1030·0	1005·5	924·0	935·5
Comparative energy	1,090,873	1,057,703	940,905	904,850	863,016	851,212

It will be seen from the tables that the comparative energies of the modern explosives are more than four times as great as those of the older propellants.

As regards the serious question of erosion, in the case of very large guns it is important to remember that, while the surface of the bore subject to the more violent erosion increases approximately as the calibre or a little more, the charge of the propellant required to give to similar projectiles the same maximum velocity increases as the cube of the calibre. Consequently, unless special arrangements as to the projectile are made, or other means adopted, the life of the largest guns before re-lining must be short when compared with that of smaller guns. Attention should be given to the best method of reducing erosion when very large charges are used, either by lowering the temperature of explosion or possibly by introducing some cooling agent with the charge.

The author has tested the capacity for erosion of several explosives, and has found these to vary considerably, but all give similar results with varied charges. Thus the erosion due to one three-quarter charge was less than that of a full charge, but two three-quarter charges gave more erosion than one full charge. Two half charges gave less, but three half charges gave more, erosion than one full charge. These experiments controvert the statement which has been made frequently that the erosion due to four three-quarter charges, as also that due to sixteen half charges, are equivalent to the erosion due to one full charge.

A paper on the trials and performances of the S.S. *Otaki*, by Engineer-Commander W. McK. Wisnom, R.N., is of interest in view of this vessel being the first merchant vessel fitted with a combination of reciprocating and turbine machinery. The *Otaki* was built by Messrs. Denny, of Dumbarton, and delivered in November, 1908. She has since completed a voyage to New Zealand and back, and is virtually a sister ship to the twin-screw vessels *Orari* and *Opawa*, fitted with reciprocating engines and constructed by the same builders. All three vessels belong to the New Zealand Shipping Company.

The only important differences in the vessels consist in an increase in length of the *Otaki* of 4 feet 6 inches to make up for the loss in cargo capacity due to three shaft tunnels instead of two, and also the modified design of the stern and stern post in the same ship. The boiler installations in the three vessels are identical. The engines of the *Otaki* consist of two sets of ordinary triple-expansion reciprocating engines driving wing propellers, and a low-pressure turbine driving a central propeller. In ordinary ahead working the reciprocating engines exhaust into the turbine, and change valves are fitted so that the reciprocating engines can also exhaust direct to the condensers.

At the trials on the measured mile at Skelmorlie the *Orari* attained a mean speed of 14·6 knots; the *Otaki*, under the same conditions, attained a mean speed of more than 15 knots for a total water consumption per hour of 6 per cent. less than that of the *Orari*. The total water consumption per hour in the *Otaki* at 14·6 knots was 17 per cent. less than in the *Orari* at the same speed.

On the run from the Clyde to Liverpool, with the vessel partly loaded, on November 21 and 22, 1908, at about half power, the coal consumption was about 1·387 lb. per horse-power per hour for all purposes. Scotch coal was used, having a heating value of about 7500 centigrade units.

As regards the performance of the *Otaki* on service, the coal consumption on the voyage from Liverpool to Teneriffe was 11 per cent. less than the mean for the sister vessels *Orari* and *Opawa* under similar conditions and at practically the same speed. For the round voyage, at the same speed, the coal consumption of the *Otaki* is about 8 per cent. less than that of her sister ships. The engines of the *Otaki* made a non-stop run from Teneriffe to New Zealand, a distance of 11,669 miles as logged, which is probably the longest continuous run yet made by a marine turbine. The turbine worked perfectly satisfactorily throughout the whole round voyage.

The New Zealand Shipping Company is to be congratulated in allowing this experiment to be made, and also for its courtesy in rendering available the very full information contained in the paper regarding the performances of their vessels.

PAPERS ON REPTILES AND FISHES.

A NEW species of leathery, or leather-back, turtle from the Miocene of Maryland is described by Mr. W. Palmer in No. 1669 of the Proceedings of the U.S. National Museum under the name of *Psephophorus calvertensis*, this being the first representative of the genus, which was previously known from the Tertiaries of Europe and Egypt, hitherto recorded from American deposits. It is, however, pointed out that certain dermal armour from the Zeuglodont Limestone of North America, figured by Müller in his work on Zeuglodon, probably belongs to the same genus.

In No. 1681 of the same publication Dr. L. Stejneger gives the name *Mesopeltis longifrenis* to a snake from