stroke double-acting engine, the former being less complicated than, and at least as efficient as, the latter. For still larger powers the two-stroke double-acting engine is considered to be the logical line of development. Experimental engines of this latter type are being tested, and it is to be expected that a reliable two-stroke double-acting engine will be produced. There are difficulties involved in applying the oil-engine to high-powered war vessels, and a warning is expressed against applying it indiscriminately or without full consideration of its suitability for the service.

The most important stresses to which the liners, pistons, and covers are subjected are those resulting from temperature, and the real safe continuous power rating of an internal combustion engine is therefore largely dependent upon the heat flow through the liners, etc. The maximum power which can safely be developed thus depends upon the working fluid temperatures, and in order to limit the latter without reducing the mean pressure, attention must be given to the efficiency of combustion and volumetric efficiency. The efficiency of combustion is mainly dependent upon the shape of the combustion space and the movement of the air within that space. A compact combustion space is desirable, as this enables a lower compression ratio to be adopted, and the hemispherical-cavity form is considered to be the best. Whether airless or blast injection is adopted, any movement of the air in the combustion space which causes the globules of fuel to collide with each other or with the walls of the combustion space is to be avoided.

If two engines develop the same mean pressure, that with the lower volumetric efficiency must necessarily be hotter. The crank case engine is a very simple type, but it has a low volumetric efficiency and is consequently a hot and low duty engine. The four-stroke engine has a higher volumetric efficiency than the two-stroke engine because of its more effective scavenging. The introduction of port scavenging simplified the two-stroke engine at the expense of volumetric efficiency, but recent improvements have largely counteracted this. In four-stroke engines the opposed piston type is considered to have nearly as high a volumetric efficiency as the single-piston engine. Heating the induction air has an adverse effect upon volumetric efficiency. Supercharging is receiving considerable attention, but its adoption will only be justifiable if it enables higher mean pressures to be attained without increasing cycle temperatures.

Direction Finding in Navigation.

IT is of great importance to aircraft to know exactly the direction in which they are travelling, and hence direction-finding equipment has been elaborated. This not only takes up much of the limited space available but is often also difficult to operate. The Air Ministry has recently developed a new method of direction finding in its design establishment at Biggin Hill. This was described on Jan. 4 to the Institution of Electrical Engineers by Messrs. T. H. Gill and N. F. S. Hecht.

The chief object of the method is to replace the direction-finding equipment on the aircraft by something very much smaller and easier to operate. A loop aerial is employed at the station, the energy radiated from the loop being a maximum in one direction and a minimum in another. The loop rotates about a vertical axis at a speed of one revolution per minute and sends out a continuous signal. This signal is interrupted when the line of minimum radiation is in the true north direction and a special Morse signal is transmitted at that moment. This enables the observer to start a chronograph. He can then find the interval between the north signal and the instant at which he is receiving minimum radiation. He thus obtains his bearing.

From the results obtained it was found that bearings could be determined with an accuracy at least equal to that obtained by any other radio method of direction finding. For the accuracy necessary for aerial navigation, this method gives a range of 200 miles.

The Air Ministry having found the 'rotating beacon' method of great use for aircraft, the Radio Research Board has made a series of experiments to find out if it would be equally useful for navigation. The results of these experiments were communicated to the Institution of Electrical Engineers by Messrs. R. L. Smith-Rose and S. R. Chapman at the same meeting.

The rotating-loop beacon was installed near Gosport and a calibration was carried out at fixed points in various directions up to a distance of 60 miles. It was found that the observed bearings were subject to a permanent deviation due to land effects. This permanent deviation was not greater than one or two degrees. At distances exceeding 60 miles, radio bearings got by this method were found to be subject to night effects similar to those obtained in radio direction finding. The errors were not serious, however, until the range exceeded 90 miles oversea. Even at great distances a fair accuracy can be obtained by taking the average value of a series of readings made in about ten or fifteen minutes. It was concluded that, up to 50 miles, the rotating beacon method gives accurate readings.

Compared with the ordinary direction-finder as used on board ship, this method has several advantages. It is independent of the steadiness of the ship, and also of the accuracy with which the ship's head is given by the compass reading at the instant of observation. No correction or compensation corresponding to the quadrantal error associated with the ship's direction-finder is necessary. It was proved, however, both theoretically and experimentally, that the limitation of the accuracy by night effects applies equally to both methods.

School Natural History.

THE annual report of the Marlborough College Natural History Society, the 75th in series, shows evidence of considerable vigour under the presidency of Mr. L. G. Peirson, who is clearly a naturalist of wide attainment. The area of work is defined as ten miles from the College as centre. All the various sections (Astronomy, Archæology, Ornithology, Botany, and Entomology) seem to have vigorous boy members with to each a master having the same hobby. This year the most notable record is that of 558 species and varieties of flowering plants —evidence of close raking, though the surrounding country is singularly varied with its forest and great downs, its chalk hills and lands of high cultivation, its water meadows and valleys of rocks. It is the only place where the Icterine Warbler has been