about 480 revolutions per minute. With the Diesel engines, of 1000 h.p., the remarkably low consumption of 0·37 lb. of oil per shaft h.p. was obtained.

In the concluding paper of the meeting Messrs. Reid and Mavor made out an excellent case for electrical propulsion in conjunction with Diesel engines in the type of large canal barge or freighter used to such an extent on the great inland waterways of North America. The efficiency of such a vessel depends very largely on the ease and rapidity with which it can be manœuvred, reversed, accelerated, and backed, during its frequent passages through the locks on these waterways, and this puts the direct-coupled Diesel engine, under present conditions, out of court.

THE NATIONAL PHYSICAL LABORATORY

OPENING OF NEW BUILDING.

THE new building at the National Physical Laboratory, Teddington, was opened by the Right Hon. A. J. Balfour on the day of the annual visitation, Thursday, June 26. The opening ceremony was held in the structure designed for the new wind-channel for aëronautical work. A large and distinguished company foregathered, including Sir Archibald Geikie, who presided, Colonel Seely (Secretary of State for War), Lord Rayleigh, Lord Allerton, Lord Welby, Viscount Esher, Lord Montagu of Beaulieu, Sir Oliver Lodge, Sir Wm. Crookes, Sir Wm. Ramsay, Sir John Brunner, Sir Albert Spicer, and Dr. R. T. Glazebrook (director of the laboratory).

The chairman, in his opening remarks, referred to the amazing growth of the laboratory and the place it had taken as one of the most important national institutions in this country.

Dr. Glazebrook dwelt on the noble liberality of the friends who had so splendidly supported the laboratory in the past, and Lord Rayleigh emphasised the fact that funds were still needed for equipment purposes. Lord Rayleigh went on to express the hope that in the future larger funds would be available to enable greater attention to be paid to research in pure science, as well as to work calculated to further the immediate ends of industry.

Mr. Balfour gave an interesting and thoughtful address dealing largely with the national advantages of the study of pure science. In the course of his address he remarked:—

Measuring is the very life-blood of physical science. It lies at the root of almost all great discoveries and their application to practice. It is impossible not to acknowledge the benefit which mankind has received by the command which science has given us; and measurements and testing are absolutely essential to science. The great features of a national laboratory are its impartiality, its ability to bring an adequate staff and adequate machinery to bear on problems, and the standard of perfection which it sets for instruments and which serves as an ideal for manufacturers to work to. The advantages to industry are beyond all doubt and beyond all question.

But the successes of the future of industry depend on the abstract of purely scientific investigations of the present, and it is to the labours of the man of science working for purely scientific ends, and without any thought of the application of his doctrines to the practical needs of mankind, that mankind will be most indebted as time goes on. The general public does not realise that it is to the results of pure science that we have owed in the past, and shall owe more and more in the future, all great advances in industrial knowledge and practice. Still less does it realise that the man of science who is working continuously towards that end is only half a man of science, and is not likely to do his scientific work nearly so well as if he were simply and solely occupied in advancing that branch of knowledge with which he is connected.

When these important truths have sunk into the public mind, we may see, as a reflection of that new conviction, a different attitude adopted by those who have to settle what expenditure should be presented to Parliament for its sanction, and the attitude which Parliament itself may take in the face of such suggestions. The growth of this great institution during its very few years' existence justifies us in looking forward to a great and glorious future for it. The thanks of the public are due to the brilliant and hard-working staff of the laboratory who, under no small difficulties, are the real authors of the triumph which we are met to celebrate.

After the opening ceremony, an inspection was made of the new building, and visitors wandered at will through the various departments of the laboratory, in which a series of interesting demonstrations had been arranged.

The new building marks the completion of a scheme for the erection of laboratories for metallurgy and optics, and of a building for administration purposes. The late Sir Julius Wernher made himself responsible for the funds for the metallurgical laboratories, and for the rest, the Treasury, the 1851 Commissioners, and some of the City Companies have made generous contributions.

One of the main objects for which the new laboratories have been erected was to enable the testing work, until recently carried out at Kew Observatory, to be transferred to Teddington. Kew Observatory is in future to devote itself purely to meteorological objects—it is now, in fact, the central observatory of the Meteorological Office—while the testing of instruments of all kinds will be undertaken exclusively at Teddington.

The new building provides accommodation for the administration and optics departments, together with workshop and packing rooms. The optics wing is designed to accommodate the optical testing work hitherto carried out at Kew and in a suite of rooms at Bushy House. The latter rooms are now occupied by the thermometer-testing observers from Kew, while the remainder of the Kew test-work has been housed in the metrology department.

The new building, of which we show an illustration, is a three-storey structure built of purple Surrey bricks with red brick facings. The architecture is of the Queen Anne period, and the structure bears a general resemblance in style to Bushy House, alongside which it stands, and which, it will be recalled, formerly housed the whole of the work of the laboratory. The new building impresses one as being generously lighted and very substantially built, and reflects great credit on the architect, Mr. W. D. Caröe, and on the clerk of the works, Mr. R. Allen Jane.

Great care has been bestowed on the fireproof qualities of the building; the floors and stairs are of ferro-concrete throughout, and generous provision has been made for fire hydrants. This feature is, of course, doubly important in a building one of the functions of which is to house important records.

The ventilation is controlled by a large fan on the roof, communicating by ducts to extractors in the ceilings of the different rooms. Fresh air is admitted through louvres behind steam-heated radiators provided with suitable baffle plates.

The corridors throughout are covered with Dolo-

ment patent flooring; the woodwork is chiefly oak, the effect of which is altogether admirable.

To take the central block of the new building first. Opening on to a large central hall on the ground floor are the accountant's offices and strong-room, reception-rooms for visitors, and a telephone exchange room; on the first floor are the director's room and the secretarial offices; on the second floor, *inter alia*, the "White Library," a publications room, and a lecture theatre. The library is being furnished by the Drapers' Company in memory of the late Sir William White, to whose good-will and energy the laboratory owes a great deal. A brass memorial tablet records that "The Worshipful Company of Drapers of the City of London, mindful of the last wishes of Sir William Henry White, K.C.B., F.R.S., gave to the Laboratory the bookshelves in this library." The fittings are being carried out in old oak, and the library, with its panelled walls, recesses, and gallery, brings to mind some of the college libraries at the older universities.

It is anticipated that the new lecture-room will afford facilities for meetings of scientific societies, for many of which an annual visit to the laboratory has become a recognised function. It is hoped also that

New building of the National Physical Laboratory.

opportunity will be afforded to the members of the staff of hearing distinguished visitors at a fortnightly or monthly colloquium.

The central block is isolated from the north and south wings by fireproof doors.

On the ground floor of the optics division are two large semicircular arch-shaped tables made of cast-iron. One of these is vertical and the other horizontal. They are used to test the accuracy of graduation of theodolite circles and sextant arcs. One face of each table is machined, and to it are bolted at definite angles collimators pointing to the centre of the semicircle. The tables rest on isolated masses of concrete weighing some 20 tons; and to avoid troubles due to seasonal and extraneous temperature changes, the tables and supports are hollow throughout, and are kept at uniform temperature by circulating water through them. In the same room is a tilting table with standard wedges for testing clinometers. The photometer and spectacle-lens benches are mounted in an adjoining room, along one end of which is a movable partition which can be removed when extra long-focus process lenses are being tested.

A rapid and convenient system of light-tight blinds is a noteworthy feature of the fittings. The testing of microscopes is conducted in an adjoining room.

On the first floor, a group of rooms is allotted for testing terrestrial telescopes. One of these can be completely darkened for the purpose of examining the parallelism of the axes of binoculars, or the illumination of cross wires. Test objects and scales of various forms, and at distances up to 400 yards, have been erected.

A long ferro-concrete balcony (which, by the way, was cast in one mould complete) extends along the outside of the first floor. This will enable open-air tests to be made on instruments.

On the second floor, the equipment for examining photographic lenses is grouped in adjoining rooms. Here are, for example, the Hunter apparatus for obtaining a numerical estimate of definition; the Beck bench for measuring focal length, astigmatism, curvature of field, &c. The testing of photographic shutters is carried out here, by the use of vibration galvanometers tuned to resonance with electrically-driven tuning-forks or vibrating bars.

Next is the room devoted to spectroscopy, and in particular to the examination of refractometers and spectrophotometers. A feature of the room is a large roller shutter by means of which the room can be readily divided into two. The shutter is provided with suitable apertures, to fit the various instruments under test, and will be brought into use when it is important that the eyes of the observer should not be exposed to bright lights during the test.

The remainder of the rooms are given up to the general photographic work of the laboratory. There is an unusually well-designed and ventilated suite of dark-rooms with light-trapped doors and the like. Other rooms are specially designed and illuminated for photographing apparatus and diagrams.

The roof of the building is flat and asphalte-covered, and on it at one end is arranged an observatory. This is to be fitted with a telescope with an equatorial mounting, and a dome. The telescope is designed so that object-glasses sent for test can be mounted as in actual use.

The north wing contains the packing-rooms and the associated clerical offices, together with store-rooms and wood and metal workshops. Arrangements have been made here for the engraving of instruments with the familiar NPL mark—outward and visible sign that an instrument has passed its tests. Copious provision was necessary for dealing with the packing and unpacking of cases containing instruments, the handling of which under the old arrangements was fast becoming a problem owing to the volume of stuff which had to be dealt with. There is a large Waygood lift, to which leads a sunk track for wide rubber-wheeled trolleys. Thus these latter can be run on the lift, and so to the various corridors and rooms. There is a second lift to the workshops. In this block, a common-room for the laboratory boys has been provided.

The foregoing description will perhaps give an idea of the admirable manner in which the new building has been designed for its work.