The National Physical Laboratory, Teddington.

INSPECTION BY THE GENERAL BOARD.

ON Tuesday, June 26, the General Board of the National Physical Laboratory made its annual inspection of the laboratory. As is customary on this occasion, a large number of members of scientific and technical institutions, government departments, and industrial organisations were invited to be present. The visitors were received by Sir Ernest Rutherford, president of the Royal Society and chairman of the General Board; Sir Richard Glazebrook, chairman of the Executive Committee; and the Director, Sir Joseph Petavel.

The activities of the laboratory were well illustrated by an extensive programme of exhibits.

In the Duplex Tunnel a demonstration of wing flutter on a full scale light aeroplane wing was given. The critical speeds at which flutter occurs have been determined in the tunnel and compared with those calculated from the measured elastic and inertia constants of the wing with the help of aerodynamic data derived by the study of a model wing.

In one of the seven-foot wind tunnels tests were in progress on one of a series of symmetrical Joukowsky aerofoils to obtain data on profile drag at high Reynolds numbers. The aerofoil was supported between two stream-lined projections fixed to the tunnel walls and surrounding the supports, the latter being carried through the walls and linked outside to the roof balances by a suitable system of levers. By keeping the gap between the aerofoil and the projections as small as possible, three-dimensional flow at the wing tips was minimised. Measurements were made of the total force on, and the pressure distribution along, the centre section of the aerofoil, with the latter in the position of zero lift. Of interest also was a one-fifth scale model of a new projected variable density wind tunnel by the use of which it is expected that measurements on models of aircraft will be rendered more directly comparable with similar measurements on full scale machines. The tunnel is of the return flow type. To measure the lift or drag, a special form of balance has been devised, in which the balance arm carries a coil forming the movable element of a Kelvin balance. By previous calibration the relation between the current through the coil and the force on the balance arm can be determined. The position of the balance arm is indicated electrically by means of a bridge arrangement, the arms of which consist of two small electromagnets spaced on opposite sides of the balance arm and two windings on the iron core of a moving coil relay. Any movement of the balance arm disturbs the equilibrium of the bridge and produces a deflection of the relay.

In the Engineering Department apparatus for the study of phenomena accompanying fatigue in crystals of aluminium and iron was shown. Large single crystals of either metal can be subjected to reversed direct and torsional stresses, to single blow tensile impacts, and to slow cycles of repeated tensile loading. X-ray analysis permits the positions of the crystal planes with respect to the axis of loading to be determined, and X-ray spectrographic and photomicrographic examinations at frequent intervals during the tests allow the inclinations and nature of the slip bands to be determined.

Another exhibit of interest was apparatus installed for the purpose of determining the efficiency of motor-car transmission gearing. The gear box can float freely and the efficiency is determined by measuring the reaction of the gear box to the motion of the gear train. Apparatus for conducting tests on gear wheels, in which small errors in radial alinement and in pitch of teeth are purposely introduced, was also shown, together with some of the gear wheels examined. In most of these failure had taken place by fracture of a tooth or of teeth near the root and not by abrasion.

Included in the exhibits of the Metrology Department was a new secondary standard barometer designed to give an accuracy between those of the primary and the working standards. To determine the barometric pressure measurement is made, by means of a specially designed micrometer, of the distance between two contacts. One of these consists of a fine platinum wire sealed in the top of the barometer tube and dipping in the upper surface of the mercury column. The other forms the lower end of the micrometer stem and dips into the lower surface of the mercury column. Contact with the mercury is indicated electrically, and the mercury levels can be adjusted by means of a stainless steel plunger supported in an auxiliary tube.

Apparatus for measuring the friction between pivots and jewels was also demonstrated. By means of this apparatus relations between the frictional torque and the load can be determined in terms of the radii of curvature and the elastic constants of the pivot and the jewel.

In order to facilitate the rapid melting of small charges of metals and alloys, a valve-operated high frequency furnace has been installed in the Metallurgy Department. Two thermionic valves, each capable of dissipating two and a half kilowatts at the anode, are employed, and are connected to the A.C. supply in such a way as to permit both halves of the A.C. wave to be utilised. The furnace was being used in connexion with experimental work to remove oxygen from electro-deposited chromium, in which it is found in the form of an insoluble oxide. Removal of the oxygen is effected by maintaining fragments of the metal at about 1400° C. or 1500° C. in the furnace, and at the same time passing over them a rapid stream of purified hydrogen which is circulated in a closed system containing the metal and a purifying train.

A new type of carbon resistor furnace developed in the Department was also on view. The action of the furnace depends on the contact resistance between a number of carbon pellets contained in a refractory and nearly air-tight sheath. The temperatures attainable are limited only by the power of the sheath to withstand the heat developed, and it is found that the pellets remain unchanged for a considerable period of time even when maintained at temperatures approaching 1500° C.

In the Physics Department an investigation was in progress to determine the heat of combustion of carbon monoxide at atmospheric pressure. Oxygen and carbon monoxide are fed from separate cylinders into a special burner fitted in a vacuum walled vessel furnished with flow tubes for the continuous circulation of water. The temperature rise of the water is measured by means of a pair of differential resistance thermometers. The calorimeter is calibrated by replacing the flame by a resistance coil in which a measured amount of electrical energy is dissipated as heat and carried over the cooling tubes by means of a stream of oxygen.

Apparatus for the determination of the thermal conductivity of furnace materials was also on view. The material under test rests on a metal plate heated from beneath by a number of electrical resistors, and on its upper surface is mounted a flow calorimeter

with guard ring. The rise in temperature of the water is measured by means of differential resistance thermometers and the temperatures of the upper and lower faces of the specimen are determined by means of a number of suitably disposed thermocouples.

In connexion with an investigation on cold storage, a vertical closed-circuit air channel has been developed to investigate the laws governing the transfer of heat between the air stream and pipes through which brine is flowing. The speed of the air is controlled and arrangements are being made to use single pipes or batteries of pipes in which a shielding effect comes into play. It is hoped to obtain the conditions governing the maximum transfer of heat with the minimum resistance to air flow. It will be possible to use either dry or moist air in the channel, and in the latter case to investigate the problems of hoar frost deposited on pipes. The presence of hoar frost seriously impairs the transference of heat from the air to the pipe.

A method of determining the acoustical absorbing powers of various materials by means of stationary waves was demonstrated in the Sound Division. One end of a smooth cylindrical tube is closed by a steel disc to which the material is cemented, the other end being open and facing a loud speaker producing a pure note of known pitch. Stationary waves are formed in the pipe and the relative intensities of the maxima and minima for various materials depend on their absorbing power. Measurements of their intensities are effected by means of an exploring microphone.

A recent addition to the Radiology Division consists of a constant voltage generator for X-ray tubes. A transformer, the secondary voltage of which is 100,000, is employed. Full wave rectification is obtained by means of four hot-cathode rectifying valves, and smoothing is effected by suitably disposed condensers and chokes. Power is drawn in at each half cycle, and the transformer is not subjected to any unidirectional magnetic field.

An important addition to the equipment of the Electrotechnics Department consists of new precision current transformers cored with 'permalloy.' By means of this alloy of nickel and iron, which has very high permeability and very small hysteresis loss at very low flux densities, it is possible to obtain currents in the secondary closely proportional to and nearly 180° out of phase with the current in the primary. This is of considerable importance in measurements of power in circuits carrying heavy alternating currents.

A new standard water-cooled tubular resistance capable of carrying 7500 amperes has also been constructed. In the design of this, the aim has been to make the resistance so far as possible independent of the method of connexion to the external circuit, so as not to interfere with the streamline flow of current.

In the High Voltage Building was to be seen the new power equipment for single, two and three-phase high voltage work up to 1,000,000 volts, together with apparatus developed for this work. Mention may be made of a new shielded parallel-plate air condenser of zero phase angle. Three plates are used, the centre one being the high voltage plate and the two outer ones being earthed. To avoid corona effects, the edges of the plates are curved, the degree of curvature being so adjusted that the potential gradient round the edges is not greatly in excess of that between the plates.

Among the exhibits in the Electric Standards Division was a screened bridge for the measurements of inductance, capacitance, and effective resistance at radio-frequencies. It is essentially a Schering bridge, consisting of two equal resistance arms and two capacity arms, one of the latter being the unit under test. The bridge is balanced by means of variable condensers shunting each resistance arm. The complete apparatus consists of the bridge proper, a local source of radio-frequency supply to the bridge, a screened detector and amplifier, and a local screened oscillator to heterodyne the oscillations from the bridge.

Of interest also was apparatus for the study of the vibrations of quartz oscillators. Interference patterns are obtained when monochromatic light is reflected from the flat polished surface of the crystal after previous transmission through an optical flat. Any vibration of the crystal leads to blurring, except at the nodes, where the appearance of the interference bands remains unaltered.

The Wireless Division exhibited a new portable self-contained transmitter for use with wireless direction finders. It is operated by a 12-volt battery, the anode voltage of 300 volts being supplied by a generator operated by the battery. An Eccles two-valve circuit with interchangeable coils for wave-lengths from 30 metres upwards is used. A portable mast, adapted for mounting on a motor-car, completes the equipment. A small laboratory short-wave transmitter for wave-lengths of 5 metres and upwards has been developed for the study of wave propagation. In this oscillator two valves are arranged on the 'push-pull' principle with variable capacity coupling between the anode and grid coils.

The efficiency of light wells in building blocks is a matter of considerable importance in illuminating engineering, and a model light well has been constructed in the Photometry Division to permit such determinations to be made. The breadth and depth of the well are fixed, and seven different-sized sky openings can be provided by adjusting the sizes of the other two walls. A number of selected points are taken in the middle vertical line of one of these walls, and at each point the ratio of the illumination on the wall to that falling on the sky opening of the well is determined. By this means wells of different size and using paint of varying reflection factor can be directly compared. An artificial sky is provided in order to approximate to actual conditions, and the well is fitted with a matt black floor.

Mention should also be made of a precision illumination photometer of the Macbeth type. This embodies the usual Lummer-Brodhun photometer head, and is fitted with internal screens between the head and the comparison window to minimise the effect of stray light from the tube walls. The comparison lamp is enclosed in a small whitened chamber equipped with a window, in order to eliminate errors due to internal reflection in the comparison lamp bulb. The instrument operates on the inverse square principle, and its constant can be varied by the insertion of stops in front of the translucent window. Precise control of the comparison lamp current, an important item, is provided by including the lamp in a Wheatstone bridge circuit, of which it forms one arm.

In the William Froude Tank a self-propelled model of a merchant ship was run at intervals through a series of regular waves. The model, which was electrically driven, was fitted with self-recording mechanism, by means of which the propeller thrust, torque, revolutions, and time were automatically determined, while in the main carriage generally used for towing models, the pitching and rolling of the vessel could be recorded by means of a lever system operating suitable recording mechanism, once the speeds of the model and the carriage had been synchronised. The work forms part of a research on the influence of waves on the resistance and propulsion of ships.