Further tests showed that the effect was unlikely to be associated with fungal penetration through the injured roots but was probably caused by an induced resistance of the upper parts of the roots or of the lower stems. It was further noted that the metabolism of the injured plants had been greatly altered, inducing an accumulation of soluble carbohydrates in the aerial parts. It appeared likely that the effects of certain compounds lay in their effect on host resistance and not in systemic fungicidal action on the pathogen.

These observations emphasized the fact that the chemical treatment of plants in an attempt to obtain systemic fungicidal action might affect the host. Such effects might not necessarily be as drastic as those noted above but might, even so, play a part in any subsequent reduction in fungal invasion. The work also suggested ways in which host resistance may be further investigated.

In the lively discussion following these contributions, many speakers commented on the effect of external environmental conditions on the expression of systemic fungicidal action. These conditions presumably affected the power of the host to absorb and translocate the active compounds.

In summarizing the discussion, Prof. Wain recommended that the fundamental approach to studies on systemic fungitoxicity should not be overlooked. Such factors as the stability of compounds, their movement within the plant and the effects of systemically-acting compounds on normal plant biochemical processes should be made subjects for research. He awaited examples of control of plant diseases using systemic fungicides under field conditions.

R. W. Marsh

SCIENTIFIC INSTRUMENTS FOR RESEARCH AND INDUSTRY

PHYSICAL SOCIETY'S EXHIBITION, 1952

THE thirty-sixth annual exhibition of scientific instruments, organized by the Physical Society, was formally opened by the president of the Society, Prof. L. F. Bates, on Thursday, April 3. In his opening remarks he pointed out that the Council of the Physical Society regards this exhibition as one of the most important aspects of the work of the Society. Of its national importance there can now be no doubt; after thirty-six years (excluding the war years) of steady progress it has become increasingly popular, and is now regarded as an outstanding event of 'the scientific year'. At the time of writing, the death of Sir Stafford Cripps recalls the first post-war exhibition in 1946. That exhibition was opened by Sir Stafford Cripps, who was then president of the Board of Trade. In his concluding remarks, after paying tribute to the excellence and importance of the scientific instrument industry, he said: "It is essential that we should have and maintain in this country a pre-eminent scientific instrument manufacture both for our own use and to help to supply those many other countries who cannot themselves afford to set up such manufactures". The Council of the Physical Society, in organizing these splendid annual exhibitions, is doing much to encourage the development of a pre-eminent scientific instrument industry. The recent thirty-sixth exhibition upheld the standard set by its predecessors. It was held by kind permission of the College authorities in the large rooms of the Imperial College and of the Huxley Building, South Kensington. The exhibition was open for five days, from Thursday, April 3, to Tuesday, April 8 (excluding Sunday). The total turnstile figures indicated an attendance of more than 17,000 in the Main Building of the Imperial College and more than 9,000 in the Huxley Building. There can be no doubt that the extension of the exhibition to the Huxley Building has resulted in less over-crowding, and it would seem advisable now to consider a less-complicated system of issue of tickets than that hitherto found necessary.

As usual, an important feature of the exhibition were the discourses given by lecturers eminent in special branches of scientific research. On this occasion two special discourses were arranged: (1) "Engineering Supersonic Aerodynamics", by Mr. B. N. Wallis (of Vickers-Armstrong, Ltd.), and (2) "The Physical Basis of Colour Photography", by Mr. E. R. Davies (of Kodak, Ltd.). At short notice, a third discourse was given on "The Torpidity of Liquid Surfaces", by Dr. K. Hickman (of Rochester, New York).

The discourse by Mr. B. N. Wallis on "Engineering Supersonic Aerodynamics" was given on Friday evening, April 4. Mr. Wallis said that since the end of the Second World War and following the rapid development of jet propulsion, the principal interest in aerodynamics has moved from the study of fluid motion at subsonic speeds to that at supersonic speeds. In what might be called its subsonic era the anatomy of the aeroplane could be treated as substantially two-dimensional, and the problems of three-dimensional flow were of relatively minor interest. Supersonic aircraft, on the other hand, must comprise an essentially three-dimensional, as well as a two-dimensional, element in their anatomy. So great may the drag of a three-dimensional body become that three-dimensional supersonic flow is correspondingly important. Moreover, some rearrangement of the wing – body combination is necessary if an overwhelming penalty in interference drag is to be avoided. If complete freedom of anatomical arrangement be assumed, wing – body combinations can be suggested the drag of which might be less than the sum of the drags of the components taken separately. 'All-wing' and 'Delta' aircraft illustrate attempts to attain this benefit. The necessity for low drag, however, focuses attention on flow in the boundary layer. The opinion commonly held that this must be turbulent at the high Reynolds' numbers involved is based on practical rather than theoretical reasons. If the conditions known to be necessary for stable laminar flow are present, there is the possibility that it will be maintained at least over a large part of the surfaces involved. Can any anatomical arrangement be devised for the now essential association of body and wings whereby the two sets of conditions, that is, those for favourable interference drag and those for minimum frictional drag, are satisfied simultaneously?

Mr. E. R. Davies gave his discourse on "The Physical Basis of Colour Photography" on Monday evening, April 7. He pointed out that most colours can be matched visually by some additive mixture of a beam of red light, a beam of green light and a beam of blue light; this has long been known, and was used by Maxwell in 1861 to make the first colour photograph. All modern processes of colour photography depend on the same principle, the subtractive

method of forming colours with various concentrations of cyan, magenta and yellow dyes being merely a convenient way of controlling and mixing the red, green and blue components. Even when applied in its simplest form, however, this principle is incapable of reproducing colours with their correct hues, saturations and lightnesses, and in practicable processes the errors can be considerable. Despite the inherent errors, many modern processes of colour photography produce highly satisfactory results. This is largely because colour is, to the observer, not a physical quantity but a sensation, and many subjective effects are operative both when the original and the reproduction are viewed.

The discourse on "The Torpidity of Liquid Surfaces" was given by Dr. K. Hickman on the evening of April 3. Dr. Hickman, an expert on high-vacuum physics, happened to be in Great Britain during the period of the exhibition and was invited to give this lecture. Experiments with the high-vacuum short-path still suggest that liquids in the common state of purity are covered with a film of contaminating molecules which retard evaporation. The 'accommodation' or evaporation coefficient is thus less than unity. When such liquids are ejected from a nozzle, their surfaces remain clean for the first tenth of a second and the coefficients become unity. When they are evaporated in a pot still, the contaminating layer may divide abruptly into two parts, a torpid and a working area. This effect is most pronounced in the range of vapour pressures 30–300 microns. It is almost exactly analogous to steam pushing aside the skin of a milk pudding in the oven. The working area has an evaporation coefficient of 0·5–0·9, while the torpid area has a coefficient 0·25 to as low as 0·001. At lower temperatures, before the surface has become schizoid, the 'torpidity' is uniformly distributed over the surface, where it is compressed or stretched by every movement of the liquid. Emission of vapour, and composition of vapour from a gross mixture, vary rapidly, increasing with tension and diminishing with compression. This is a universal property of liquids occurring, for example, with the common plasticizers and glycerine at elevated temperatures and with butanol at − 30° C. Not until the surface has been rendered purer than ever before, as by weeks of continuous redistillation, with overflowing of the surface, does the relatively stagnant liquid lose these properties and attain an evaporation coefficient of unity.

A list of the hundred and fifty exhibitors with details of the demonstrations and exhibits is to be found in the "Handbook of Scientific Instruments and Apparatus 1952" published by the Physical Society*. The handbook is a well-printed volume lavishly illustrated by half-tone reproductions, and is essential to all workers concerned with the progress, use and development of scientific instruments. The exhibitors included not only industrial firms but also government research establishments and university laboratories, while the exhibits ranged over the whole field of physical instruments and materials used in their construction.

Even a quick and cursory tour of the exhibition gave the impression that the exhibits this year had attained a very high standard of quality. This impression was confirmed later by a more detailed inspection of some of the exhibits. The following 'miscellaneous' remarks refer to a number of such exhibits selected almost at random.

Remarkably high speeds of rotation can be obtained by the use of a doubly tapered rod, rotating about a short axis. The ideal profile is that of a Gauss curve. Examples shown included a blade-ended rotor for generating fast molecular beams in low-pressure gases and a cup-ended rotor for carrying radioactive sources, used for Doppler-effect experiments with gamma-rays. These rotors are constructed in 75-ton alloy steel. Driven electromagnetically in a rough vacuum by a simple method which was demonstrated at low speed, they will reach speeds of about 10^5 cm./sec. (2,200 m.p.h.) before bursting. Apparatus was shown for measuring the particle size of powdered materials in the sub-sieve range using a light-transmission photo-cell method and a standard comparison cell. The particle size and hence the specific surface can be calculated from Stokes's equation for the rate of settlement. Another form of 'sedimentometer' determined the particle size in a sediment by direct weighing with a torsion balance. In the field of vacuum physics a good display of vacuum pumps and vacuum gauges, with many useful applications, were on view. The efficiency and quality of cathodic sputtering were shown to be greatly improved in a magnetic field. In another sputtering unit the normal process for depositing thin metallic films was employed for etching metallurgical specimens since the sputtering occurs preferentially from the grain boundaries.

The electrostrictive and piezoelectric properties of barium titanate (ceramic) are now receiving considerable attention; it is being used in acoustic 'pick-ups' and resonators. In addition to industrial exhibits of this material, the National Physical Laboratory showed it in use for transmitter–receiver probes at 1, 2·5 and 5 Mc./sec. Important metals and alloys for various purposes were exhibited by a number of firms. Zirconium metal can now be obtained on a commercial scale in the form of sheet, rod, wire and tube—this development is of considerable use in the chemical industry, where corrosion resistance to acids or alkalis is very important. Other metals and alloys exhibited included tantalum, molybdenum and tungsten, various electrical resistance alloys, aluminium-clad iron and magnetic alloys. In the latter connexion, a high vanadium–cobalt–iron alloy is being developed which has a high retentivity and coercivity, while being malleable and capable of being pressed either hot or cold.

In the field of acoustics, a low-power ultrasonic apparatus was demonstrated which was designed specially for educational purposes, operating at two frequencies, 1 or 5 Mc./sec. A wave analyser, designed primarily for the analysis of complex vibration waveforms such as those produced by ship turbines and propeller shafts, was shown to be nevertheless suitable for the harmonic analysis of any type of electrical wave-form within the frequency range of 19 c./sec. to 21 kc./sec. and gives an octave discrimination of better than 70 db. A number of types of supersonic flaw detectors for location of internal discontinuities in solids or liquids were on view. The importance of this form of non-destructive testing was exemplified in the National Physical Laboratory exhibit which provided a 'standard' for flaw detection. This consists of a steel block with accurately drilled holes permitting the assessment of behaviour and calibration of flaw detectors.

* "Handbook of Scientific Instruments and Apparatus 1952." As shown at the 36th Physical Society Exhibition. Pp. xi+244+A.76. (Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, 1952.) 6*s.*; by post, 7*s.* 3*d.*

An interesting and extremely useful application of electro-thermal processes is the development of flexible flat heating elements embodied in sheets of heat-resisting rubber, the whole being vulcanized. These heaters are designed for temperatures up to 200° C. Heating tapes have also been designed for electrically heating all types of pipes, columns, valves, vessels, tanks and similar containers difficult to heat by other means. These tapes consist of metal fabric bands separated and insulated by glass fabric bands, and are available for loadings up to 2 watts/cm.^{2} and temperatures up to 550° C. Very simple and convenient types of bimetallic thermometers were on view. These are made in all sizes from the larger industrial type to very small pocket thermometers. A very small dial-indication clinical thermometer with stainless steel stem has obvious advantages over the old mercury in glass type—which requires shaking to reset and a magnifying glass to read. The dial is reset after taking a reading by simply pressing a knob.

In the realm of optics a good display of the latest types of optical glass was shown. Blocks of borosilicate crown optical glass, dense barium crown (cast from a platinum 'pot'), and phosphate-base ultraviolet filter glass were on view. In addition to these, glasses prepared from melts of most unusual chemical compositions were shown; for example, glasses of complex tellurites containing at least one of the oxides of lead, barium, lithium or sodium and usually also containing one or more oxides of zinc, magnesium, boron, phosphorus, germanium, vanadium, columbium, titanium, molybdenum, tungsten, tantalum and thorium. Curves showing their excellent transparency to infra-red radiation of wave-lengths at least up to 6 microns were presented. A useful addition to a conventional microscope is provided by a simple unit-magnification concave mirror attachment, which enables the instrument to be used at a much greater working distance than that normally possible. In other exhibits a good display of spherical mirrors, lenses, prisms, windows, proof planes, angle gauges, spectrometers and spectrophotometers was shown. The Physical Society Colour Group staged a series of splendid demonstrations illustrating many of the colour effects obtained by dispersion, diffraction, interference and polarization. Examples were shown of the formation of colours by diffraction gratings having different rulings, of the colours due to difference in refractive index, of interference colours associated with thin films, and of the Lippmann method of colour photography employing stationary waves. Other exhibits of the Colour Group showed how the colours of a butterfly's wing appear to vary according to the position from which it is viewed.

A simple, but effective, device was a magnetic stirrer in which a rotating magnetic field induces a vigorous rotary motion in a small magnetized bar (totally enclosed in a glass or polythene tube) placed in the liquid to be stirred. This device is particularly useful in closed systems where gas volume changes have to be observed. Various demonstrations were shown of the optical properties of 9 mm. electromagnetic waves—dielectric and metal tube lenses, phase-contrast resolution, and the transmission of radiation power by the use of directional transmitting and receiving aerials. In one demonstration of millimetre waves the analogue of the Fabry and Perot interferometer was shown—this required the production of reflectors which had adequate reflectivity without seriously absorbing the millimetre waves, by using dielectric sheets a quarter wave-length thick, spaced a quarter of a wave-length apart in air. In an electronic digital computing apparatus a demonstration was given of the use of a magneto-striction device as a delay line in place of the more conventional mercury tube. This device has the advantages of greater simplicity and ruggedness, requires less space, small insertion loss and the output is easily available at any point along the delay line and may be obtained without interference with the acoustic pulse on the magnetostriction line. As Prof. Bates remarked in his opening address, it was pleasing to note that instruments for enabling the blind to do scientific work are now being made. One of these instruments is the blind man's 'AvoMeter', fitted with a braille scale and various essential audio-click devices.

An interesting exhibit demonstrated the phenomenon of electrophotoluminescence. The cells or 'luminous capacitors' used in the demonstration are made up of two plates separated by a dielectric layer containing the active material, which is usually of zinc oxide or sulphide composition. One of the plates is a sheet of glass with an inner transparent conducting layer, whereas the other plate is usually a conducting layer of aluminium applied as a backing to the dielectric. The active material is caused to glow by the application of a suitable alternating voltage between the plates. Good displays of charged-particle accelerator equipment, electron microscopes and mass spectrometers were on view. These instruments have now reached an advanced stage of development for industrial use and for research purposes. A model demonstrating the separation of gas mixtures by thermal diffusion was shown. The gas mixture, in this case bromine and helium, is contained in the annular gap between two glass tubes. The inner tube is heated and a temperature gradient is set up across the annular gap. Thermal diffusion is used at Harwell to produce the rare isotopes oxygen-18 and helium-3 from the naturally occurring isotopic mixtures and for separation of gases for analytical purposes. Another exhibit showed a very beautiful series of radiographs illustrating the application of pile-produced radioactive sources in industrial radiography. The Admiralty Naval Construction Research Establishment showed a miniature reflecting polariscope used in conjunction with complicated celluloid structural models of ships to indicate the directions of principal stress—this method obviates much of the tedious analysis associated with the use of large numbers of strain gauges.

The exhibition of work by apprentices and learners employed in the design and construction of scientific instruments again reached a very high standard. This competition in craftsmanship and draughtsmanship is a regular feature of the exhibition introduced with the object of encouraging skill and interest in the younger generation engaged in scientific instrument work. The beautiful work in glass-blowing, mechanical and electrical instruments, and drawing was a pleasure to see.

At the exhibitors' meeting held during the exhibition various matters, for example, allocation of tickets, days and hours of opening, and stand-fitting, were discussed with the view of the improvement of future exhibitions.

In conclusion, it is sufficient to state that the thirty-sixth exhibition was well up to standard. The Council and Exhibition Committee of the Physical Society deserve congratulation on the success of their annual effort.

A. B. Wood