

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR THE YEAR 1951-52.

THE report of the Department of Scientific and Industrial Research for the year 1951-52* includes a brief covering report from the Committee of the Privy Council, over Lord Salisbury's signature, and the thirty-seventh annual report of the Advisory Council, signed by Sir Ian Heilbron, together with the usual summary of work carried out by the various research stations and boards and research associations. The appendixes include a classified list of departmental publications issued during the year, besides lists of assessors to the Advisory Council and of members of the research boards of the Department, of research associations and of grants for special investigations in progress during the year. While the report is an indispensable work of reference on the activities of the Department and is a very readable account of what Britain is getting for the £6 millions provided for these activities in the 1953-54 estimates, with its rising price the report is less than ever a popular account but rather one addressed strictly to the scientific and industrial world.

The gross expenditure of the Department for the year ended March 31, 1952, was £5,452,165, as against £5,007,822 in the previous year; this was reduced by receipts from various sources to £4,956,819, the net increase on 1950-51 being £402,397, and on 1949-50, £1,033,037. The staff of all grades employed in the Department on October 1, 1952, was 4,035 (including 149 part-time), a decrease of 53 compared with the previous year. The largest single item of expenditure was, as usual, the annual grants to research associations, totalling £1,334,863, besides special grants of £52,624. Gross expenditure on the National Physical Laboratory was £840,439, reduced by receipts to £559,335 net. Grants for special researches amounted to £313,693, a decrease of £74,209; and the list of grants for special researches in progress during the year ending September 30, 1952, is of interest in connexion with the recent argument in favour of giving the Department at least the right to carry over unspent money from year to year, if not to extend to the Department the principle of quinquennial grants so as to stabilize its budgetary expectations on a longer-term basis. The majority of the grants listed are spread over a period of years, the largest five being £487,500 to the University of Liverpool for the construction of a 400-MeV. proton synchrocyclotron for nuclear research, £317,700 to the University of Glasgow for the construction of a 300-MeV. electron synchrotron for nuclear research, £231,500 to the University of Birmingham for the construction of a 1,000-MeV. proton synchrotron for nuclear physics research, £191,000 to the University of Oxford for construction of a 140-MeV. proton synchrotron for nuclear physics, and £168,000 to the University of Manchester for radio-astronomy covering from four to six years.

Grants to students amounted to £251,241 net, an increase of £14,529. Net expenditure on mechanical engineering was £267,434, an increase of £129,868; on the Geological Survey and Museum £196,552, an increase of £38,351; on road research £273,259, an increase of £29,277; on the Chemical Research Laboratory £96,523, an increase of £22,346; on

hydraulics £53,082, an increase of £27,084; and on fuel research £219,154, an increase of £15,223. Net expenditure of £498,123 on building research, £22,805 on fire research, £185,949 on food investigation, £97,288 on forest products research, £51,632 on pest infestation, and £55,842 on water pollution was of the same order but slightly higher than during 1950-51, while expenditure on radio research was £23,016, a decrease of £6,590. Net expenditure on headquarters administration, etc., was £208,029, and on overseas liaison £66,086, while research contracts again decreased to £34,310 compared with £70,606 during 1950-51. Expenditure on the Provision of Technical Equipment under American Aid increased from £498 to £97,433.

The number of students-in-training was 923, compared with 910 during 1950-51, and, of these, 384 were new. The senior research awards were thirteen in number, of which nine were new, compared with ten in 1950-51, and thirty-eight new grants for special investigations brought the total of such grants to ninety-one, compared with ninety-five in 1950-51. The preponderance in chemistry and physics continued: of senior research awards, five were in chemistry, six in physics and two in engineering; and of the grants for special investigations, twenty-six were in chemistry, forty-one in physics and fourteen in engineering. Of the grants to students, 390 were in chemistry, 276 in physics, 73 in biology, 71 in engineering, 48 in mathematics and astronomy, 38 in geology and mineralogy, and 27 in metallurgy.

The note of anxiety which characterized the report for last year recurs, both in the report of the Committee of the Privy Council and in that of the Advisory Council itself. The reasons for this anxiety and the implications of the measures adopted to meet the financial situation are discussed elsewhere (see p. 709). Apart from this, the most important feature of the former report is the intimation of the decision, in conjunction with the Committee of the Privy Council for Medical Research, and with the subsequent approval of the Lord President of the Council, to appoint two joint committees to study human problems in industry (see *Nature*, April 18, p. 684). The first, the Committee on Individual Efficiency in Industry, will be asked to keep under review the progress of knowledge bearing on the technical efficiency of the individual in industry, advise on general policy in research in this field, direct attention to gaps, make recommendations for filling them, and to consider and report from time to time on the requirements for the training of research workers and technologists in this field. The second, the Committee on Human Relations in Industry, will examine current activities concerning the study of human relations in industry and direct attention to problems of special timeliness and promise on which research might be undertaken or supported by the Department of Scientific and Industrial Research and the Medical Research Council, or other bodies.

The membership of these Committees was announced in the House of Commons on March 24, and the reasons for the decision to appoint the Committees are briefly indicated in a section of the Advisory Council's report. Fundamentally, they arise out of the recognition that the successful introduction of new methods and new equipment depends

* Department of Scientific and Industrial Research. Report for the Year 1951-52. (Cmd. 8773.) Pp. 293. (London: H.M. Stationery Office, 1953.) 8s. net.

largely on human factors and that, while the responsibilities of the Medical Research Council and the Department of Scientific and Industrial Research in such matters as affect individual efficiency can be quite clearly defined, a joint approach to the whole field offers real advantage. Human relations are less tangible and more difficult to handle, and both Councils believe that a joint committee, with the first task of reviewing what is being done in this field in Britain and abroad, offers the best means of selecting the most promising lines of work for support by either Council.

Apart from this, and from the financial situation of the Department, the chief features of the Advisory Council's report are the comments on the increasing interest of the research associations in operational research, on the recommendations of the Cremer report regarding research in chemical engineering, on technical information services, and on the Advisory Council's visits during the year to establishments of the Department. These included the Geological Survey and Museum of Practical Geology at South Kensington, the Building Research Station and the Radio Research Station; and the Advisory Council once again expressed itself as being well satisfied with what it saw and with the manner in which the directors are endeavouring to meet the demands on their restricted resources. In regard to operational research, the report comments on the value of such work in showing where laboratory research can be most profitably directed, and in the experience which it gives the man of science of working with all kinds of people in an industry. The pioneer work of the Cotton Research Association and the Boot and Shoe Research Association in this field is well known, and the Wool Industries Research Association has now made a close study of faults and irregularities in wool cloth, showing in which of the various stages from preparation to finishing they originate. Since the industry, until recently, employed about one mender for every two weavers, this investigation bears on the use of man-power, as well as on quality. An analysis has now been made of the time required for mending each type of fault and the frequency of its occurrence, thus enabling priority in planning research to be given to the investigation of those faults which are economically the most important, and the industry has shown great eagerness to apply the results of these studies in the mills.

An operational research team set up by the Joint Iron Council and the Cast Iron Research Association has visited more than two hundred foundries during the past two years, and the information gained is leading to the wider adoption of sound and economical practices throughout the industry. A statistical survey of children's feet carried out by the Boot and Shoe Research Association has led to the development of a new series of lasts for children's shoes, which, besides greatly increasing the ability of the industry to make children's shoes fit accurately and comfortably, is of importance for the export market. The Iron and Steel Research Association is making a survey to assess the optimum size of ships that can be handled at the principal ports from which iron ore is dispatched to Britain, and is also studying unloading methods to discover the reasons for the rapid discharge of ships at certain foreign ports and the applicability in Britain of the techniques employed.

In regard to the Cremer report, the Advisory Council agrees that the national interest demands a

central organization working in collaboration with manufacturers so as to ensure correlation between basic research and actual operation, but the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers' Association have already arranged to make a more detailed study of information that is available in industrial research establishments and of the resources of these establishments for carrying out further investigations. The survey is expected to take a further six to twelve months and to lead to the establishment of a properly staffed documentation unit. In view of the emphasis laid by the Cremer Committee on improved documentation, arrangements have been made by the Department of Scientific and Industrial Research to prepare bibliographies of selected topics; one on drying has been completed, and another, on crushing and grinding, has been initiated in co-operation with the Institution of Chemical Engineers.

A feature of the summary of work is the increased proportion of space given to the work of the research associations. This is in accordance with the trends of recent reports; it now occupies some 115 pages, as against 72 pages for the work of the research establishments of the Department. The work of the Chemical Research Laboratory and of the National Physical Laboratory has recently been reviewed in these columns, and, from the accounts of the work of the other establishments and the research associations, only a selection can be here made to illustrate the range and extent of the contribution which they make to the national welfare and economy. That of the Joint Fire Research Organization, for example, is preventive rather than of direct value in relation to increased productivity, and is planned mainly in relation to the needs of the various government departments which have responsibilities in connexion with fire protection, and to assist the Fire Offices' Committee and local authorities in framing their requirements. Annual losses from fires usually amount to about £24 millions, approximately half of which is from large fires involving more than £10,000 damage each, and against such figures the significance of the work on smouldering, on the study, with the use of models, of the growth of fire, on the use of water and foam in fire extinction and on dust explosions can be appreciated. Analysis of fire statistics indicates that, while the rate of incidence of fire in television receivers continued to decrease, the hazard is still three times as much as that with radio sets.

Under the Food Investigation Organization, in view of the importance of the problems of storage of home-produced beef, work is being concentrated on improving the quality of frozen meat through the controllable factors prior to slaughter and during storage. Two members of the staff of the Low Temperature Research Station, Cambridge, are working during 1952-53 in the Abattoir Laboratories at Brisbane of the Australian Commonwealth Scientific and Industrial Research Organization and will apply to beef animals on a commercial scale the techniques which have shown promise on the laboratory scale at Cambridge. Preliminary experimental shipments indicate that the better the initial quality of the meat, the less the damage suffered as a result of freezing. Surveys have continued of the wastage and deterioration which occur during the distribution of lettuce, plums, strawberries and Cornish broccoli to the home market, and also experiments on the best storage conditions for certain new varieties of apples

and pears. Work on the production of heat by potatoes stored in bulk has permitted general recommendations regarding the height of stacking and the need for ventilation, and progress has been made in identifying some of the many compounds shown by chromatographic methods to be present in apples. Basic investigations have related to the recovery of ascorbic acid from aqueous extracts of lucerne, and a study of the mechanism of action of phenolases on the naturally occurring phenols present in many plant and animal substances has shown that ascorbic acid is a useful inhibitor of enzymatic browning. The demonstration that *isocitric* and malic acids can be oxidized by enzymes isolated from peas by successive transference of hydrogen from *isocitric* and malic acids through coenzyme II to glutathione, thence to ascorbic acid and finally to oxygen, allocates possible functions to the important plant constituents--ascorbic acid and glutathione. Other investigations on the respiration of plant organs promise to illuminate the balance between carbohydrate and acid constituents which accompanies the ripening of fruits, and may lead to control or prediction of the losses of ascorbic acid during storage of plant organs; they have indicated that sterilizing foods with intense beams of high-velocity electrons is a promising process.

Some basic research has been maintained in all sections of the Forest Products Research Laboratory, but much time has been given to the testing of Colonial and other imported timbers, in order to keep pace with the increasing demand for information on their properties and uses. Measurements on adsorption and desorption within the hysteresis loop have been concluded and confirm earlier findings, and work is now in progress on the effect of temperature on the hysteresis loop. A new system of loading has been developed for testing stresses and similar structural units, and research on the physiology of fungi has included the study of the metabolic products of wood-inhabiting fungi. Much time has been devoted to the development of a new technique for observing the collapse of wood during pressure treatment which will facilitate the accurate determination of the relation between temperature and pressure, while work on the treatment of timber in stick, for the prevention of attack by *Lyctus* powder-post beetles, has aimed at finding improved methods of applying DDT and benzene hexachloride to stacks of timber. Fuel research has included investigations on the nature of the processes of maturing of coal, which are believed to change when the coal acquires a minimum density, and on the mode of occurrence of certain minor constituents in coal. The development of a pilot plant for the generation of water-gas from small-sized non-coking coals in a fluidized bed at about 900° C. is proceeding, and in work on the Fischer-Tropsch process it has been found that the activity of an iron catalyst prepared from magnetic iron oxide and alkali is greatly increased by reduction with hydrogen at 300° C. instead of 450° C. and by removing surface alkali by leaching with water. Investigations on the formation and prevention of external deposits on boiler heating surfaces, on the removal of sulphur compounds from flue gas and on the development of combustion chambers to enable solid fuels to be used in industrial gas-turbines has continued, while many new designs of domestic appliance have been tested and much attention given to atmospheric pollution and its prevention.

The development of the new Hydraulics Research Station continued, and considerable progress is

reported in building a second wave-basin in the open in which it will be possible to reproduce tidal currents and the rise and fall of the tide at the same time as waves. Tidal studies have concentrated attention on the problem of siltation in the tidal basin at Tilbury, while a report on the approach channel to Heysham harbour has been submitted and an investigation is being carried out on behalf of Lyttleton Harbour Board, New Zealand, into designs for new extensions to the existing harbour. In the field of coast protection a team of five men, led by an experienced hydrographic surveyor, is making a survey on the south coast of England with the object of recording data for comparison with future surveys, so that an accurate estimate can be made of the gain or loss of beach material; and the team will also attempt to find explanations of how these changes occur.

In the Division of Mechanical Engineering, construction of the Hydraulic Machinery Laboratory, though not of the Heat Transfer and Creep Laboratories, has begun, but most of the work on the properties of materials at high temperatures and the work on the metrology of machine tools and screw threads has to be carried out at the National Physical Laboratory. Fundamental work on grease lubrication has recently begun, and a tentative theory of bearing has been developed to take account of the rheological properties of grease. Experiments on fretting corrosion have confirmed the resistance of phosphated steel surfaces: on surfaces so treated it could be virtually eliminated by suitable lubrication. The performance of precision ball-bearings is being studied with special reference to the dimensional accuracy and finish of the ball and track surfaces, and equipment for investigating high-speed gears has been designed and built by a firm of gear manufacturers. The relation between stress and plastic strain in a polycrystalline aggregate has been used to provide a physical basis for the use of the principle of maximum work in macroscopic theory, tests are being made to establish basic principles governing the plastic deformation of metals in press- and drop-forging, and a micro-technique has been developed for measuring tool-wear so that the machining of large quantities of metal is avoided.

The Pest Infestation Laboratory, which works in close collaboration with the Infestation Control Division of the Ministry of Agriculture and Fisheries and with the corresponding division in the Department of Agriculture for Scotland, is becoming increasingly concerned with Colonial problems relating to the storage of foodstuffs, especially of cereals, where the most immediate needs are for the dissemination of existing knowledge and the assessment of problems on which further research is required. Respiration measurements on wheat grain at different humidities at 25° C., in the presence and absence of micro-organisms, indicate a sharp increase in the rate of respiration of normal grain as the moisture content rises above 16 per cent, accompanied by the development of visible external mould, especially at moisture contents of 18 per cent or more. Subepidermal mycelium appears to have no effect on the respiration of damp grain. The protection against infestation afforded by impregnating jute sacking with pyrethrins or piperonyl butoxide, or a mixture of the two, has been investigated, and all treatments with pyrethrin or the mixtures greatly reduced the likelihood of infestation. Tests have also been made on the relative efficiency of vacuum fumigation techniques and straightforward fumi-

gation at atmospheric pressure. Among the problems investigated at the Road Research Laboratory are the effect of striped pedestrian crossings on road casualties, the braking performance of commercial vehicles, the rear lighting of vehicles in relation to accidents, the behaviour of soils in relation to road construction, the possibilities of prestressing concrete for roads, and the improvement of road tar. Further aspects of the treatment of sewage by alternating double filtration are being studied by the Water Pollution Research Organization, as well as the relative importance of factors affecting the toxicity of poisons to fish, while an increasing proportion of the resources of the Laboratory is being devoted to the study of conditions in the Thames Estuary.

New terms of grant were offered to nine research associations for the next five-year period. The British Boot, Shoe and Allied Trades Research Association receives a block grant of £8,000 a year, conditional on £15,000 from the industry, and an additional £100 for each £100 from industry up to a maximum of £10,000. Reference has already been made to the Association's work on children's shoes, but its day-to-day work on shoe-making materials and components is reflected in all categories of footwear. For the British Cotton Industry Research Association, a block grant of £50,000 a year was made, conditional on £220,000 from the industry, and an additional £100 for each £100 from industry up to a maximum of £40,000 for the period April 1, 1954–March 31, 1957. New developments in the textile industry during the year include the registration of Shirley Developments, Ltd., to take over under formal agreements the many commercialized results already in existence. By this means it is hoped to secure that the practical results of research are more quickly, effectively and fully adopted by the industry. Work on the newer fibres is expected to increase, but cotton still occupies the major part of the research programme. The Association's work on sizing warps is estimated to offer savings in starch to the industry of about £200,000 on £1 million, and the radioactive static eliminator, which has been on trial for two years, is now commercially available.

The new block grant for the British Hat and Allied Feltmakers' Research Association for 1952–54 will be £7,000 a year, conditional on £10,000 from the industry, with up to £5,000 on the £100 for £100 basis. The Association reports advances in the knowledge of mercuric carotting of rabbit fur, which are leading to a better understanding of the process, and an investigation has been started on the effect of different types of dyeing machine on the quality of felt produced. For the two years 1952–53, the British Food Manufacturing Industries Research Association will receive a block grant of £9,000 a year, conditional on £20,000 from industry, with up to a further £6,000 on the customary basis. Besides studies of analytical methods, the keeping qualities of different types of margarine, and the incidence of mould infection, particularly on strawberries and blackberries, the Association is investigating the graining and rheological behaviour of chocolate, which are important in controlling the physical character of the chocolate and in preventing 'bloom'. For the British Non-Ferrous Metals Research Association the block grant for 1954–56 will be £28,000 a year, conditional on £65,000 from industry, with up to a further £15,000 on the usual basis; more than thirty investigations are at present in hand. A novel method of recovering zinc from galvanizer ash has

been developed, the general adoption of which would save the galvanizing industry sums covering its entire subscription to the Association for many years. The Association has also developed an anodic test for a naturally occurring inhibitor of the cold-water pitting of copper pipes, which enables the corrosiveness of a water to be assessed in seven days.

A block grant of £10,000 a year has been made to the British Paper and Board Industry Research Association for the period October 1, 1952–September 30, 1957, conditional on £30,000 from the industry, with up to a further £12,000 on the usual basis. Work on effluent problems continued, and as a first step in a long-term study of fibre structure and properties as they affect paper manufacture and, in particular, of the fundamental effects produced by the beating process, a literature survey has been made and new techniques have been developed in preparing fibres for study under the electron microscope. The possibility of incorporating fungicides in the packaging material during manufacture so as to prevent attack of paper and board by bacteria and moulds is being investigated. Besides a block grant of £40,000 a year conditional on £50,000 from the industry, and up to a further £40,000 on the usual basis for the two years 1952–53, the Production Engineering Research Association has been promised £100,000 towards the cost of a new research building at Melton Mowbray, contingent on at least the same amount from the industry. Research in progress has included investigations to enable the accurate calculation of punch loads for a wide range of ferrous and non-ferrous materials, on the performance of experimental aqueous cutting fluids containing various additives and rust inhibitors, and on the effect of tool surface finish on tool life. For the period April 1, 1952–March 31, 1957, the Coil Spring Federation Research Organization will receive a block grant of £5,000 a year, conditional on £6,000 from industry, with up to a further £10,000 on the £100 for £100 basis, and plans have been made for the establishment of a central headquarters in the Midlands; further work on decarburization and its relation to type of steel, spring manufacture and performance has revealed some important features of the manufacture of springs from black rolled bar, and a study on avoiding hydrogen embrittlement has shown that a variety of oxidizing agents, including chromic sulphuric acid, are effective. The Wool Industries Research Association will receive a block grant of £40,000 a year for the period October 1, 1953–September 30, 1956, conditional on £100,000 from industry, with up to a further £30,000 on the usual basis. General recommendations have been made for the use of synthetic detergents in scouring, and work has been started on the effect of chlorination on the dyed strength and shade of nylon, in the presence and absence of wool, while it has been shown that the frictional forces between clean nylon and keratin surfaces are determined by the elastic indentation of the surfaces and the shear strength of the materials.

Other interesting features of the work of the research associations which may be noticed here are the studies on consumer preference carried out by the British Baking Industries Research Association in collaboration with the School of Bakery, Royal Technical College, Glasgow, which have indicated a marked ability to differentiate between shortbreads containing butter and cake margarine, respectively, and between cake products containing margarine with dried egg and butter with fresh eggs, respectively.

There was no evidence that smokers and persons with artificial dentures were appreciably inferior in their ability to taste. The British Electrical and Allied Industries Research Association's preliminary trials of the 100-kW. wind-driven generator in Orkney are being followed by full performance tests prior to permanent commission; preliminary trials of electric weed-killers have given promising results, and work has started on the flash illumination of laying poultry to increase egg production. The British Iron and Steel Research Association's work on graphite electrodes has led to two types of resistivity tests, the adoption of which in some works has offered savings of four to five shillings per ton of steel. The Lace Research Association has developed a new lubricant for lace machines which is as effective as graphite and offers a minor social revolution in the elimination of the saturation of the workers' clothes with graphite which characterized the old conditions. The designs of the Parsons and Marine Engineering Turbine Research and Development Association for turbine machinery in merchant ships have proved so successful overseas that applications are being received for licence agreements from countries outside the United Kingdom, and six licences have been granted. Interest in the use of conophor oil as a drying oil is rapidly developing, and the Nigerian Government, the Colonial Office and the Paint Research Station are co-operating in exploiting the discovery and establishing a conophor-growing industry. The Printing, Packaging and Allied Trades Research Association has patented a new design of book-binding which allows a book to open flat without major strain to the back; 'Patracrat', its light-sensitive material for making photolithographic plates, has been widely adopted, and much interest has been displayed in its journey shock recorder. The British Rayon Research Association has obtained very promising results with methods it has devised using ultrasonics for the removal of oil stains.

These examples should sufficiently demonstrate how varied is the contribution which the Department of Scientific and Industrial Research is making, alike through its own research stations and organizations and through the industrial research associations, to industrial efficiency and productivity and to almost every side of national welfare. The report shows, too, the extent to which contact and co-operation with industry and with other organizations and government bodies enables the Department to keep in touch with practical needs. Manifestly the wisdom with which the work of the Department is conducted in different fields, and the soundness of the selection of its objectives cannot be judged from an annual report of this order. Confidence in that respect is inspired by the three surveys of the work of the Leather, the Cast Iron and the Ceramics Research Associations which have already been made at the request of the Advisory Council, particularly that of the Leather Research Association. As the Advisory Council points out, however, while such surveys are of considerable value in reviewing progress and assessing priorities, they take time to complete and make considerable demands on the time of all concerned. To conduct such surveys every five years, even for the research associations alone, would be too big a task with existing resources, and the Advisory Council's proposal to arrange for such surveys only when special circumstances indicate the desirability seems reasonable, particularly as it also proposes to require a much more detailed review of the work of each research association before the renewal of grants.

REFRACTOMETRY OF LIVING CELLS

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SURPRISINGLY little attention has been devoted in the past to the determination of the refractive index of living protoplasm. Earlier workers who investigated the subject were apparently content simply to record values without interpreting their meaning, and the methods employed were rather crude or subject to considerable error. Vlès¹ pointed out that the refractive index of a spherical or cylindrical cell could be determined by treating it as a lens and measuring its focal length. This method only gave average values for the whole cell, that is, nucleus, cytoplasm and inclusions. Even less-precise methods were sometimes used. Thus, the frequently quoted figures of von Angerer² for the refractive indices of bacteria were estimated by comparing the subjective brightness (under the conventional microscope) of bacteria with that of oil emulsions. Other techniques have been reviewed in the literature³.

Methods

The method which we have developed⁴ originated in a chance observation. During the course of a survey carried out with the phase-contrast microscope on a wide variety of living cells, it was noticed that the cytoplasm of the amoebocytes of earthworm blood appeared bright instead of dark when viewed by positive phase-contrast (and dark when viewed by negative phase-contrast). This was the reverse of the appearance of all other living cells examined in this laboratory, and could only mean that the refractive index of these cells was less than that of the mounting medium. It was then realized that the latter was not physiological saline or serum, as generally employed, but earthworm blood, which contains a considerable amount of dissolved haemoglobin, so that the refractive index is appreciably raised. When the blood was washed out with saline, the cytoplasm of the same cells became dark, as usual. In order to determine the refractive index of the cytoplasm, it was only necessary to dilute the blood until the cytoplasm virtually disappeared, and then to measure the refractive index of the diluted blood. As it was inconvenient to use blood or haemoglobin solutions, a search was carried out for other suitable colourless proteins. After several trials, the material now being used as an immersion medium is a plasma albumin preparation which is available as a dried powder. It is soluble in water or dilute saline up to at least 45 per cent w/v, and its salt content and pH can be adjusted to suit the particular cells being examined.

This method is, of course, the well-known 'immersion method' of refractometry which has long been used in mineralogy. It has not hitherto been successfully employed in biology because most of the common non-aqueous immersion media damage living cells. Any substance to be used for the refractometry of living cells must fulfil the following requirements: (1) it must be non-toxic and must not affect the structure or function of living cells; (2) it must not penetrate the cell; (3) it must exert a low osmotic pressure, that is, it must be of high

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