manium by the indium, alloying and cooling. The kinetics of the gas-phase erosion of germanium are being studied by observations of changes of pressure and weight. Fast junction diodes are being made by heavily doping the germanium with nickel; their performance was demonstrated.

Collectively, the exhibits showed three broad features of progress in telecommunications. First, an increasingly large part is played by electronic engineering, backed by improved materials and new components. Secondly, the role of mechanical engineering is changing as fewer new components have moving parts or require fine clearances; it may lie rather in the machines making the components or assembling them. Thirdly, reliability has to be studied more intensively than ever before, and in good time, if applications of new scientific discoveries are to be successful.

COLOURS AND FLAVOURS

THE first of a series of four meetings under the general title of "Some Nutritional and Allied Problems confronting the Food Manufacturers", arranged by the Nutrition Panel of the Food Group of the Society of Chemical Industry, was held in the Society's rooms at Belgrave Square, London, on October 23. These meetings are concerned with food additives, the first dealing with "Colours and Flavours" and the subsequent ones with "Anti-oxidants", "Emulsifying and Dispersing Agents" and "Chemical Preservatives". Interest in food additives has increased considerably since the end of the War, especially in view of pending legislation in this field, and the first meeting was very well attended.

The first paper at this meeting, under the chairmanship of Dr. F. Aylward (Borough Polytechnic), was read by Dr. B. R. J. Thomas, of A. Boake, Roberts and Co., Ltd., on the "Technological Aspects of Colourings". Dr. Thomas pointed out that the arguments for the use of colours in food were well known and well founded and were accepted by all authorities. The main object of his talk was to deal with the present British list of permitted colours, indicating the problems it raised for the food colour supplier and the food manufacturer. In view of the importance of appearance in the selection and appreciation of a food, the manufacturer is anxious to obtain the right shade for a particular use to which a colour is put, although public taste can be schooled to accept minor departures from previous standards. From the point of view of cost, colour is not an important item to the manufacturer as long as he has not to change it frequently. Thus, speaking in approximate terms, 1 lb. of amaranth will colour 2,000 gallons of raspberryade or 4,000 gallons of ice cream. This means that the cost of colouring raspberryade is approximately 0·09*d*. per gallon or 0·045*d*. per gallon of ice cream, assuming a price of 15*s*. per lb. for the dye.

The desirable properties of an ideal colour were then enumerated. Such a colour must be without suspicion of carcinogenic activity and must be obtainable in a pure form free from carcinogenic impurities. It must also be stable to a temperature range of $-10°$ to $100°$ C., and also to pH's of 2–8 and to light during storage. It should be resistant to oxidation and reduction and to preservatives, especially sulphur dioxide, and there should be no colour variation from batch to batch. The colour should also be obtainable in oil-soluble and water-soluble forms. On the basis of the above properties, the British list[1] was examined, the discussion being confined mainly to the so-called *A* colours (colours which, from the available evidence, would seem unlikely to be harmful when consumed in foods in the customary amounts) and vegetable extracts.

Reds. The British list[1] contains seven red *A* colours (Ponceau 4*R*, Carmoisine, Amaranth, Red 6*B*, Red *F.B.*, Ponceau *SX* and Fast Red *E*) which conform to most of the points mentioned above, although not one of them is oil-soluble and not one of them is absolutely satisfactory from all points of view. Rhodamine *B*, and Erythrosine of seaside rock and canned cherry fame, are now classified as *C* and *B* colours, respectively, yet for the specific purposes mentioned they are irreplaceable. (*B* colours are those for which the available evidence is deficient or conflicting although there is no apparent reason on structural or other grounds to expect them to be harmful in the amounts ordinarily consumed. *C* colours are those which have been shown, or are suspected, to have harmful effects.) Not one orange colour has been given an *A* rating, and this means that the manufacturer has to use a blend of other *A* colours, which at once raises all kinds of difficulties as a result of the differing stabilities of the constituent colours of the blend. The absence of satisfactory red and orange oil-soluble colours is a serious limitation in the coloration of dairy products and frying oils.

Yellows. The three *A* colours, Tartrazine, Naphthol Yellow *S* and Sunset Yellow *F.C.F.*, cover most of the needs of the colour user, but the alkali stability of these water-soluble dyes is not high enough for all applications. Again, there are no oil-soluble yellows in the *A* list.

Green and blue. The British list[1] is very deficient in these colours, two blues only, Indigotin and Blue *V.R.S.*, being available. The former is very unstable, and when green is needed the manufacturer is reduced to the unsatisfactory course of using blends of other dyes. Of blacks, there are no *A* colours, but Black *B.N.* is on the permitted list as a *B* colour, although Black *B.N.*, has a definite blue tinge, which is a disadvantage.

After reviewing the British list[1], Dr. Thomas suggested that an intensive study is needed of higher wave-length colours both from the point of view of use and of carcinogenicity. Furthermore, he pointed out that the British list differed from those of other countries, and this raised difficulties if a food manufacturer wanted to export. Thus, Naphthol Yellow *S* was on the British list but not on the American list, while Britain and Australia were the only countries which permitted Blue *V.R.S.* Light Green *S.F.* Yellowish was permitted in the majority of countries except Britain. There was therefore a strong argument for some international agreement upon colours permitted as food additives.

A reference was made to vegetable colours which may find increasing use in the future in view of the dearth of synthetic oil-soluble colours. These colours are difficult to produce and standardize. There are ten vegetable extracts in the British list[1], but apparently only five of these appear in the lists of other countries.

Mr. G. R. A. Short, of W. J. Bush and Co., Ltd., spoke about the "Technological Aspects of Flavouring", and introduced his subject with a brief mention of the important function of added flavours to make food more attractive and to create a desire for more. Knowledge of added flavours is very old. Cassia bark is mentioned as far back as 2700 B.C. and cloves from 266 B.C. onwards by the Chinese, who eat otherwise monotonous rich dishes. Wood smoke for fish and meat is also a very old practice.

When a food processer decides on a new flavour, he has many problems to solve. For clear beverages or table jellies a soluble essence is needed; for cloudy beverages an emulsion flavour will be best. In sugar confectionery work, fondants and chocolate centres, a delicate essence in a volatile solvent is needed, while for boiled sugars there is need of a more powerful essence in a high-boiling solvent. Whether a natural or a synthetic flavour is to be used depends on cost, for natural fruit flavours are of low flavouring value, difficult to standardize and are needed in large quantities. The use of a fruit juice concentrate in a table jelly crystal would not be satisfactory since it would produce an unsaleable sticky mass. Synthetic flavours, however, are obtainable in a pure state which maintain the strength and quality of the flavours they contain. To-day many moderately priced essences are blends of natural and synthetic ingredients. There are also the problems of public taste; one peculiar difficulty facing the flavour industry is to decide whether public taste favours the flavour of fresh fruit or of the cooked variety. Thus the public is more familiar with the flavour of cooked than fresh raspberries, and it often demands a flavour remote from that of the natural product, such as amyl acetate as the major constituent of pear-drop flavour.

Natural flavours are extremely complicated. Thus, raspberry juice has been found to contain acetic, *n*-caproic and benzoic acids, ethyl, phenethyl and benzyl alcohols, benzaldehyde, diacetyl, ethyl acetate, γ-methyl-*n*-butanol, and many other unidentified substances, including lactones, phenols, aldehydes, ketones and acids. The number of constituents contributing to the aroma of coffee is as many as seventy and include hydrogen sulphide, methyl and furfuryl mercaptans, dimethyl sulphide, acetaldehyde, furfural, methyl-furfural, vinyl guaiacol, methylpyrrole, etc.

The flavour chemist has at his disposal, in addition to natural extracts and essential oils, a very wide range of synthetic materials which include alcohols, acids, esters, aldehydes, phenols, phenolic ethers, ketones and lactones. The flavour value of most of these synthetics is so great that less than one to three hundred parts per million are necessary to flavour food or beverages. Thus, only 5–6 parts per million of diacetyl added to a fat are needed to impart a flavour similar in strength to that of butter. So far, very few of the flavours have been found to be harmful, but we still know very little about the effects of flavouring materials on the human organism.

Prof. R. T. Williams (St. Mary's Hospital Medical School) then discussed the biochemical and pharmacological aspects of colours and flavours. It was pointed out that some of these additives were potentially toxic and in some cases carcinogenic. There was no doubt that, in the future, colours and flavours would be subject to close scrutiny from a biochemical, toxicological or pharmacological point of view.

Ideally the information needed before a substance could be used as a food additive would consist of data concerning acute and chronic toxicity, carcinogenicity, absorption from the alimentary tract, biochemical transformations and the toxicity of metabolites, elimination from the body and accumulation in the body. Much time and labour will be involved in obtaining this information; and therefore, in deciding on the suitability of a substance as a food additive, attention should also be paid to past experience, a general knowledge of metabolism and common sense so that decisions are not too long delayed.

From a structural point of view, most of the permitted food colours are sulphonic acids and azo compounds. Sulphonic acids are usually strong acids, and strong acids are either not absorbed from the intestine, or if they are absorbed then they tend to be rapidly excreted in the urine. It would therefore be of advantage if a food additive were a water-soluble strong electrolyte, since it would tend to be rapidly eliminated. However, dyes are complicated molecules, and it would be an over-simplification to regard them simply as strong acids.

Some azo dyes have been shown to be carcinogenic, and this effect can be due either to the dye molecule *per se* as in the case of butter yellow or because it gives rise to carcinogenic metabolites. Azo compounds are potentially capable of being split enzymically in the body into two amines, and any azo compound (for example, 2-naphthylazo dyes) potentially capable of giving rise to β-naphthylamine, a known carcinogen, is to be suspect[2,3]. On the other hand, 1-naphthylazo dyes have not been regarded with as much suspicion as 2-naphthylazo dyes, because the carcinogenicity of α-naphthylamine is in doubt. Sunset Yellow *F.C.F.*, Amaranth and Ponceau *4R* are examples of 1-naphthylazo dyes which have an *A* classification. It is to be noted that these dyes contain sulphonated ring systems on both sides of the azo link. Ponceau *MX* is also a 1-naphthylazo dye, but it is sulphonated only on one side of the azo link and presumably this is why it has a *B* classification. Some oil-soluble dyes have a *C* classification because they are cathartics[4], for example, Oil Yellows *AB* and *OB*, Oil Oranges *TX* and *XX*.

Most synthetic flavouring agents appear to be compounds of low toxicity, and since they are used in minute quantities little apparent harm is likely to follow from their use. Prof. Williams showed with a series of slides that the body has detoxication mechanisms for dealing with the esters of aliphatic and aromatic alcohols with fatty acids, alcohols, aldehydes, phenols, ketones and acids which are used as flavouring agents. However, this is no reason for not being on the alert for potential toxic agents among flavouring material. Thus, coumarin is a flavouring agent which has recently fallen into disrepute and is no longer used in the food flavouring industry, since feeding experiments on animals have shown that it produces liver damage[5]. Some doubts have also been expressed about citral since it may act as a retinene competitor[6]; but in this case a thorough investigation of its biological properties is needed.

In the discussion which followed, Mr. A. L. Bacharach commented on Prof. Williams's suggestions regarding the general tests which might be needed to pronounce a food additive as safe. It may not be necessary always to carry out all the tests on every substance investigated. By arranging them in suitable order, one test can be made to act as a 'screen' for the next. Furthermore, studies on absorption, metabolism and excretion should be directed more towards substances which appear to do no harm rather than those showing toxic effects, since the former are the ones which might find industrial uses. The question of whether the examination of food additives by isolated enzyme systems would yield useful information was put by Dr. A. Bender. It was agreed by Prof. Williams that useful information could be obtained in this way if care were taken in the interpretation of the results. Since a food additive is usually taken by mouth, it may not be absorbed, and if it is absorbed it does not necessarily follow that it will reach the location in the body where a particular enzyme is found. It is thus possible with foreign compounds that *in vitro* experiments will not always yield the same results as *in vivo* experiments. *In vivo* experiments are considerably more important with foreign compounds than with the body's natural metabolites, which are now largely studied in *in vitro* systems.

The possibility of reproducing natural flavours was also discussed by Dr. V. L. S. Charley (Carters). Since lists of organic compounds that have been found in fruit juices had been recorded in the literature, could not a true flavour be made from a blend of the compounds given in these lists ? According to Mr. Short, experience had shown that mixtures of the constituents reported do not reproduce the true flavour of fruit for the reasons that some constituents remain unidentified, while others, particularly aromatic compounds, decompose during extraction.

R. T. Williams

[1] Food Standards Committee Report on Colouring Matters, Ministry of Agriculture, Fisheries and Food (H.M. Stationery Office, 1954 ; Supplementary Report (1955)).

[2] See Badger, G. M., *Brit. J. Cancer*, **10**, 330 (1956).

[3] See Bonser, G. M., Clayson, D. B., and Jull, J. W., *Brit. J. Cancer*, **10**, 653 (1956).

[4] Vos, B. J., Radomski, J. L., and Fuyat, H. N., *Fed. Proc.*, **12**, No. 1243 (1953). Radomski, J. L., and Deichman, W. B., *J. Pharmacol.*, **118**, 322 (1956).

[5] Hazleton, J. W., Tusing, T. W., Zeitlin, B. R., Thiessen, R., and Murer, H. K., *J. Pharmacol.*, **118**, 348 (1956).

[6] Leach, E. H., and Lloyd, J. P. F., *Proc. Nutrition Soc.*, **15**, XV (1956).

NEW LABORATORIES AT UPPINGHAM SCHOOL

THE new Science Laboratories at Uppingham School, which were inaugurated by H.R.H. Prince Philip, Duke of Edinburgh, on November 8, owe their existence to the imaginative and far-sighted generosity of British industry.

The old Science School, built in 1897 and partially modernized and extended in 1927, was proving inadequate even before 1939 because of the increasing number of boys who were specializing in science. The great impetus given to the teaching of science during and since the War had made the provision of additional laboratory accommodation imperative. The buildings could not have been modernized satisfactorily, and space for their extension on the existing site was inadequate. Plans were therefore drawn up for the building of a new Science School, but these could not have been carried out without the generous financial help of the Industrial Fund for the Advancement of Scientific Education in Schools and many firms, which contributed a large proportion of the £100,000 needed for the building.

The new Science School was designed by Messrs. Easton and Robertson, of London, and built by Messrs. E. Bowman, of Stamford. It has the shape of the letter H and consists of two floors.

The Chemistry Department includes two large chemistry laboratories (1,100 sq. ft), one specialist laboratory (540 sq. ft.) and two lecture theatres on the ground floor. Each of the large laboratories is fitted with three island benches (16 ft. × 4 ft.), which can comfortably accommodate twenty-four boys (4 ft. bench space a boy), and there is additional space on the benches which extend down the two long sides of each laboratory. A special feature of these laboratories, apart from their spaciousness, is the generous provision of cupboards and drawers, so that all the apparatus which is in general use can be kept in the laboratories. There are large fume chambers at one end and a raised demonstration bench at the other.

The specialist laboratory has been designed mainly for third-year sixth-form work. It can accommodate twelve boys and contains a thermostat and the more expensive apparatus that is needed for advanced work. It is separated from the senior (sixth-form) laboratory by a balance room, which contains concrete shelves on concrete pillars. This arrangement has proved most satisfactory, because there is no noticeable vibration from the traffic on the main road which passes within 70 yd. of the building.

The two lecture theatres contain tiered benches, a well-equipped demonstration bench and a fume chamber, and blinds so that they can be blacked out for the showing of films, etc. Like the laboratories, they are within easy reach of the chemistry store and preparation room. Although the maximum size of a form is usually twenty-four, these theatres can accommodate fifty boys, which is very useful for the showing of films to two forms simultaneously.

The Biology Department consists of two laboratories, a preparation room, a greenhouse, a small botanical garden, and upstairs a large lecture theatre and small museum.

The laboratories are fitted with working benches each specially designed in rows to accommodate four boys. Each working space is $4\frac{1}{2}$ ft. long, with a bench top 30 in. deep. There is a sink between each pair of places, and beneath are drawers. All positions have gas and mains electricity, and face the main windows to facilitate microscope work in daylight.

Special features of the elementary laboratory include built-in racks for aquarium tanks, a galvanized tank alongside the main wash-up sink for preserving specimens used for dissection, and spacious glass-fronted cupboards.

The advanced laboratory, used primarily by boys taking botany and zoology as separate subjects at Advanced Level of the General Certificate of Education examination, is equipped for both lectures and practical work. It has black-out and facilities for projection. It also contains a light-proof cupboard similar in construction to a standard fume chamber, in which plant physiology experiments can be carried out in the dark.

The preparation room is designed to enable the staff and assistants to prepare specimens, microscope slides, etc., without interference, and for senior boys to set up long-term experiments. There is adequate storage space for reagents and equipment.

The greenhouse communicates directly with the elementary laboratory and is large enough to provide