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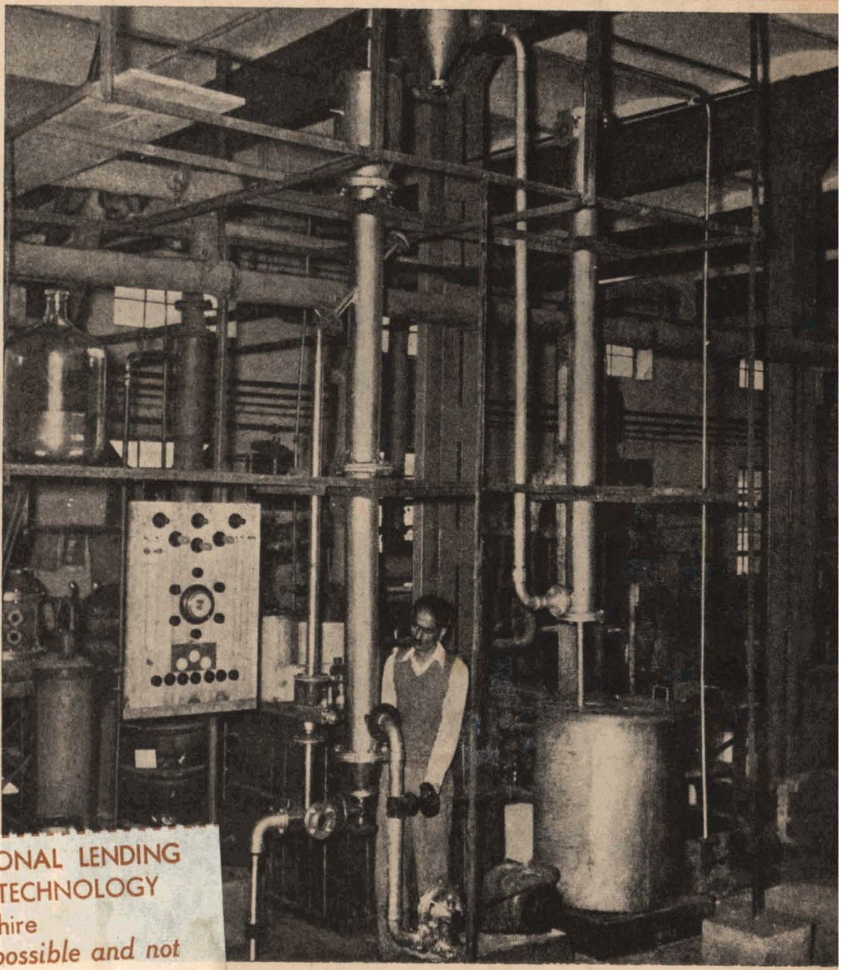

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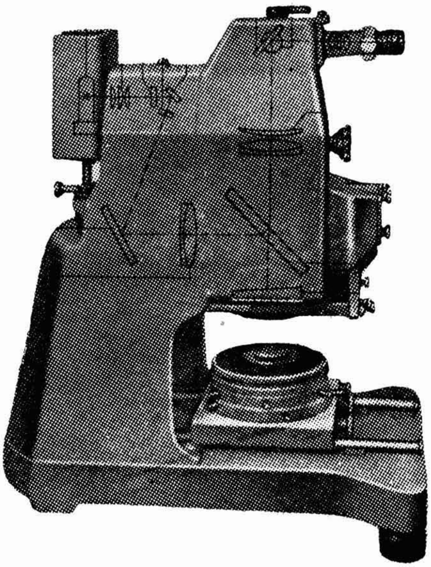

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Journal of
Scientific & Industrial Research

Vol. 17A, No. 3, MARCH 1958

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COVER PICTURE

The picture on the cover shows the pilot plant fabricated at the Shri Ram Institute for Industrial Research, Delhi, for the production of maleic anhydride from benzene. The process involves passing a mixture of benzene and air over a catalyst bed of a mixture of vanadium and molybdenum oxides at 400°-450°C., when 90 per cent conversion into maleic anhydride is achieved. The capacity of the plant is 2 lb. maleic anhydride per hour.

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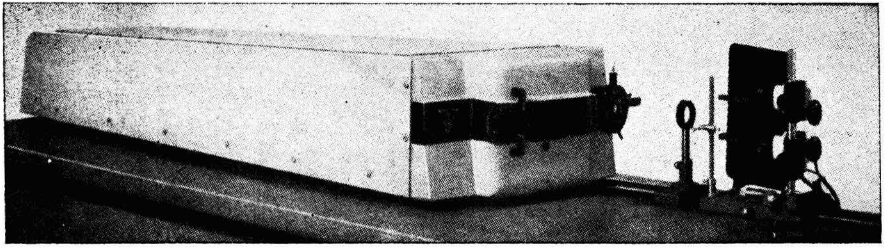

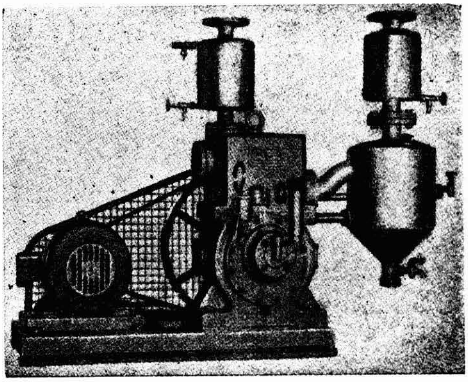

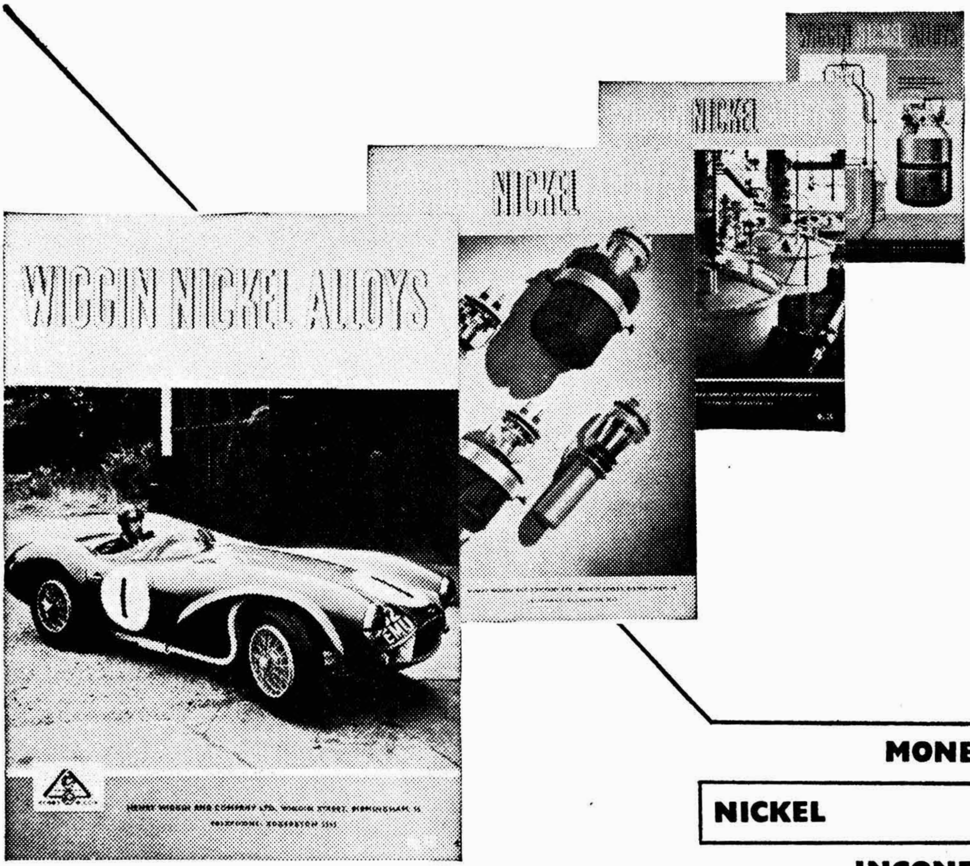
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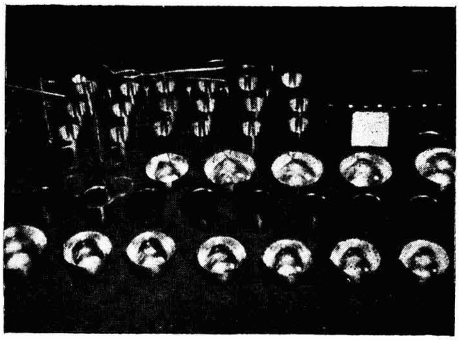

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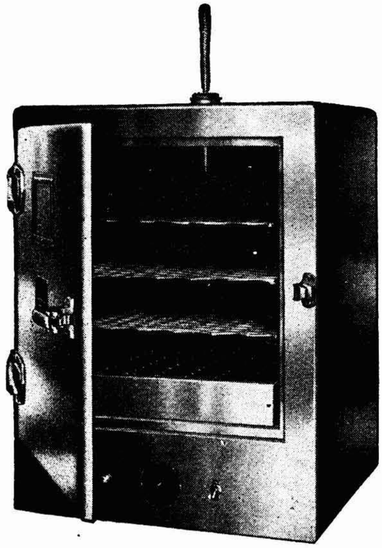

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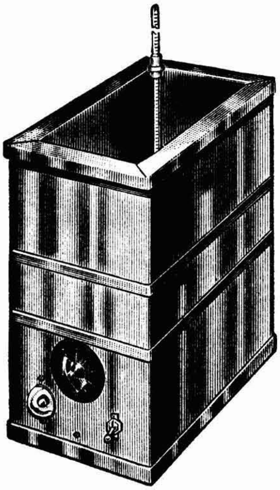

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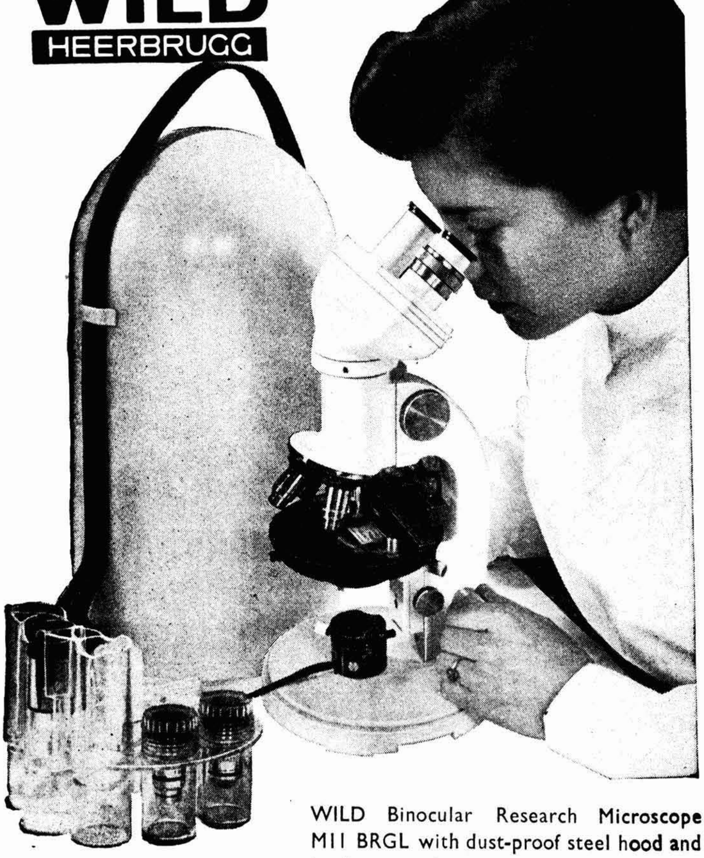

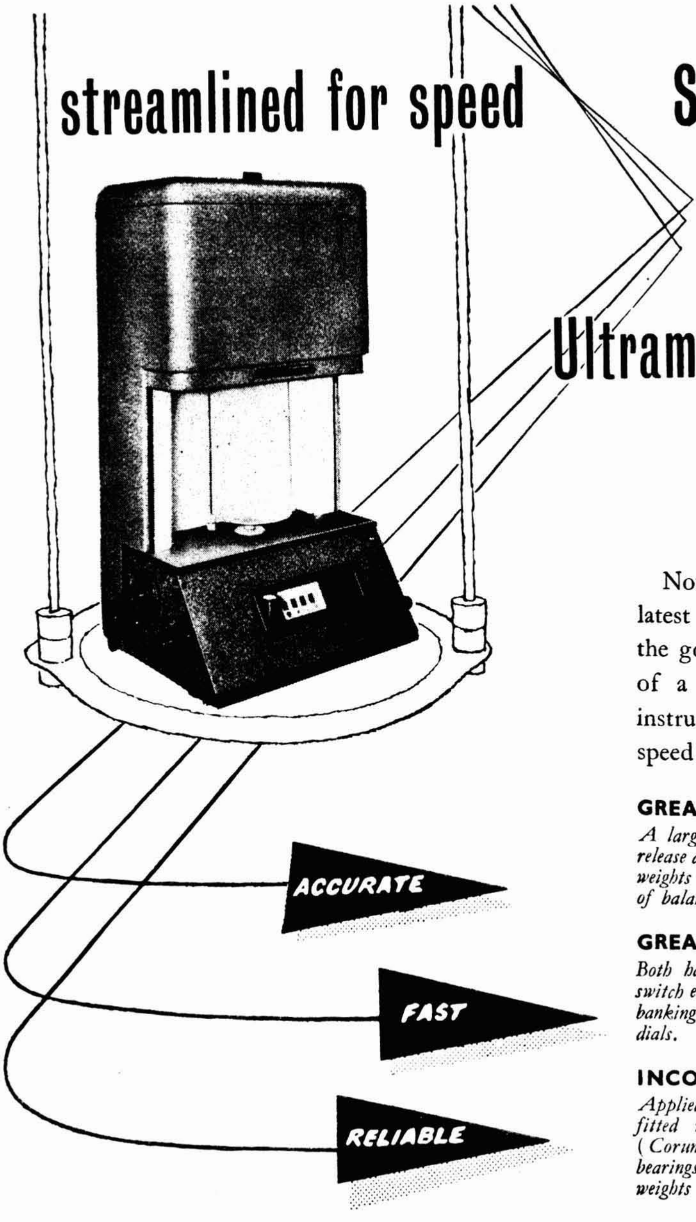
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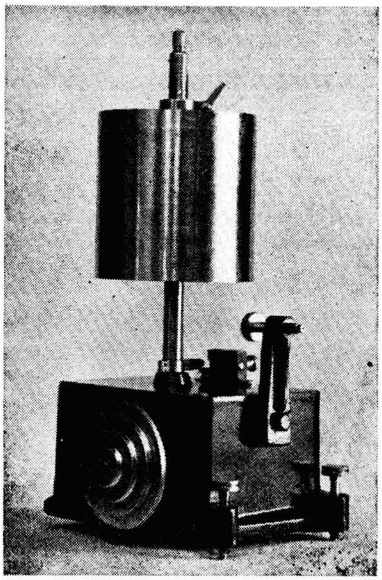

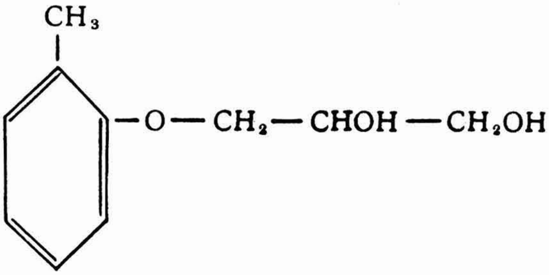
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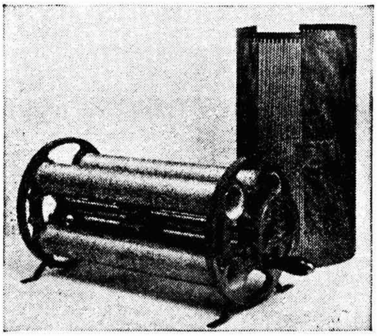

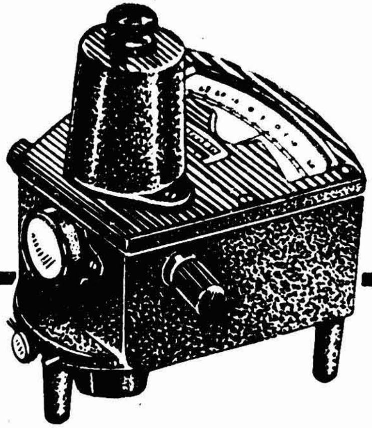

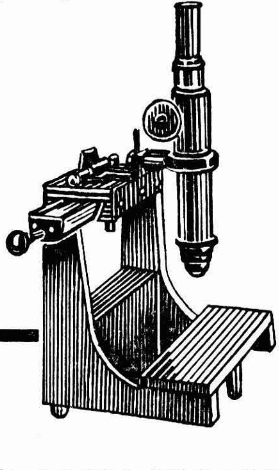

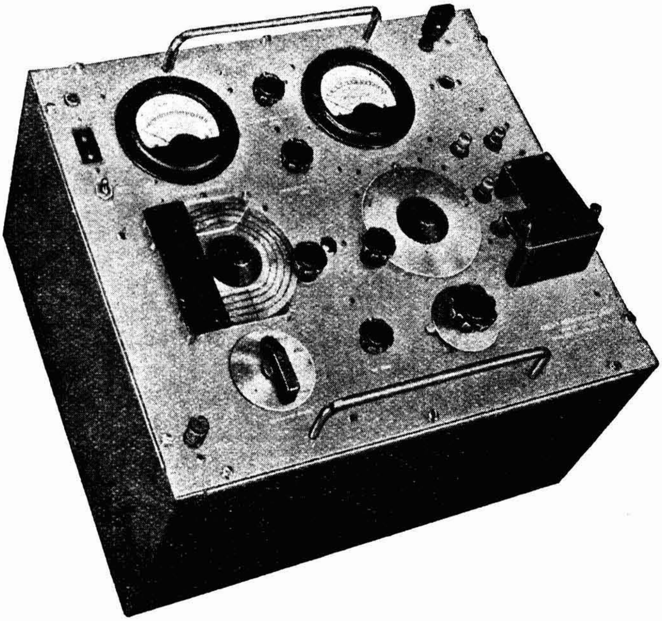

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(Lavoisier—'Elements of Chemistry in a New Systematic Order Containing All the Modern Discoveries', translated from the French by Robert Kerr, 3rd Edition, 1796.)

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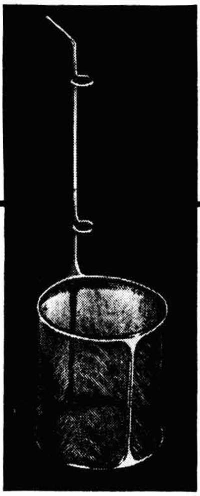

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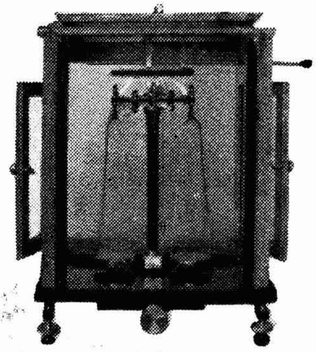

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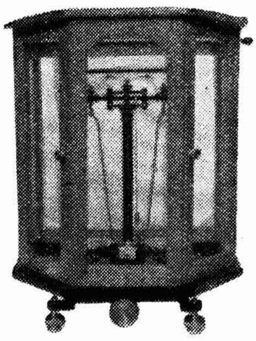

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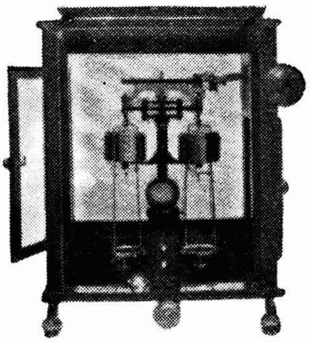

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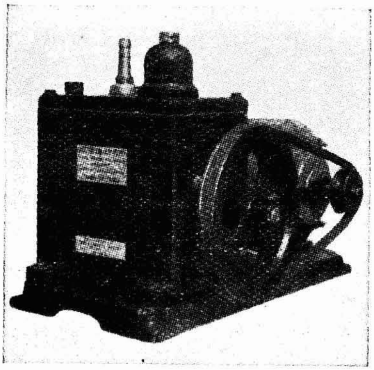

INDEX TO ADVERTISERS

The Present Position of Darwinism*

THIS year we are celebrating the centenary of Darwin's first publication of his theory of evolution by natural selection, and it seems reasonable to examine the present status of this theory.

It is fairly universally accepted that evolution has occurred, in the sense that the plants and animals, including men, alive today, are descended from ancestors very different from the modern types. This doctrine was opposed in Europe because it disagreed with Christian theology. But the Pope has recently permitted Catholics to accept it. I can see no reason why any Indian should oppose it on religious grounds. The evidence for evolution, based mainly on the fossil record, has been vastly strengthened in the last century.

Darwin, however, did not merely state that evolution had occurred. He gave an explanation of how it had occurred, namely by natural selection, or the survival of favoured races. It is this hypothesis which we must examine today. I must emphasize that if we accept evolution as a historical fact, we can still explain it in many different ways. For example, three men may accept the same fact in ancient Indian history. But one may give a Marxist interpretation of it, the second the explanation offered in the *Puranas*, while the third says he does not know why it happened.

Now Darwin's theory of natural selection, like any other century-old scientific theory, cannot be accepted as it stands. It requires some revision in view of facts discovered in the last hundred years. It is instructive to ask what are the most important facts discovered in the last century which, had he known them, would have induced Darwin to formulate his theory differently. I think the four most important facts are the distinction between phenotype and genotype, the particulate nature of inheritance, the existence of allopolyploidy, and that of stabilizing selection. I shall consider these facts in rather more detail.

By the phenotype of an organism I mean those of its properties which are observable, for example colour, shape, size, immunity to disease, milk production, and so on. By its genotype I mean its genetical composition judged from its capacity to produce offspring with various phenotypes. For example, some purple-leaved rice plants breed true, others, when self-fertilized, may give $\frac{1}{4}$ or $\frac{7}{16}$ green-leaved progeny. I think when Darwin used the phrase 'favoured races' rather than favoured forms or types, he was groping for the notion of genotype.

Phenotype and genotype are always correlated. But they are not the same. Selection, of the kind which Darwin considered, is entirely based on phenotypic differences, though human breeders select for genotypes when, for example, they breed from a bull because the mother and sisters of the bull gave high milk yields. Phenotypic selection may be quite ineffective when all the individuals in a population have the same genotype, because they are all members of a clone such as a named variety of banana trees, or of a pure line such as a named variety of wheat or rice. It may be very slow when several genotypes have the same phenotype, for example homozygous and heterozygous dominants.

As Mendel first showed, inheritance is particulate, as it must be if it has a material basis. This removes one of the serious objections to the theory of natural selection as formulated by Darwin. Fleeming Jenkin

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*Lecture delivered by Prof. J. B. S. Haldane at the Forty-fifth Session of the Indian Science Congress, Madras, 8 January 1958.

pointed out that the effect of blending inheritance would be that even if exceptional individuals were favoured by natural selection their descendants would regress rapidly to mediocrity. Darwin, although he had discovered particulate inheritance in *Primula* at the same time as Mendel in *Pisum*, and obtained Mendelian results, did not realize their significance. In fact selection would occur if inheritance were not particulate, but it would be a good deal slower than it is in fact, at least in some cases.

Winge suggested, and Kihara and Ono proved, the existence of allopolyploidy. This is the fact that when plants of two different species are crossed, and the hybrids are normally sterile, the hybrid chromosome number may be doubled, in which case fertility is restored, and a true breeding hybrid arises. Many plant species have arisen quite abruptly in this way, and human beings have made new species. I deal later with stabilizing selection.

Now most of the differences between varieties of a species depend on genes which are generally inherited as units, though the unity is occasionally broken, and a gene is occasionally replaced by an unlike gene, an event called mutation. A very few differences in animals, and many more, but still a minority, in higher plants, depend on extranuclear structures of which we know much less, though they seem to be more easily affected by environmental changes.

We have, therefore, to ask whether the differences between species are determined in the same way. If so, but only if so, Darwin was right in his claim that 'varieties are incipient species'. We can only detect genes if we can rear the progeny from a heterozygote which has got two different genes at the same locus from two different parents. And if the hybrids are too fertile we may reasonably doubt whether the parents belonged to two different species. So there are not many very well-established cases. But there are quite enough to say that many of the differences between related species are so determined. Perhaps the largest body of work on this topic is that of Cole, Irwin and others on the antigenic differences between species of doves and pigeons; but these are not taxonomic differences on the ordinary sense, whereas (partly in my laboratory) Spurway, Lanz and Callan found that a number of taxonomic differences in newts did depend on single genes. Examples in plants are commoner, because one can grow fair numbers of seedlings even if less than one seed per hundred germinates.

We next ask whether natural selection has been observed. The answer is surprising. It is extremely easy to observe natural selection. But it is much harder to observe the kind of natural selection which Darwin postulated, and which does occur, as we shall see. Curiously enough, natural selection is more easily observed among men than in any other animal or plant species. Let me take two examples. About one male in 25,000 is born with haemophilia, a condition in which the blood clots very slowly. Such boys generally die young, and their average number of children is only about a quarter that of normal boys. There is very strong natural selection against haemophilia. In any particular family it seldom appears in more than three generations. But unfortunately this selection is balanced by mutation. As often as haeomophilia disappears in one family it appears in another. As I first showed, this equilibrium enables us to calculate the mutation rate.

Again Karn and Penrose showed that while about 4½ per cent of all babies born under the care of a certain London hospital died at birth, just before it, or within four weeks of it, only 1½ per cent of those weighing between 7½ and 8½ lb. did so. Those who were lighter or heavier than this optimal range had a smaller hope of survival. Similar results have been obtained with swallows, snails, duck's eggs, moths, and so on, but on smaller numbers.

We see that in these cases natural selection, so far from causing species to change their character, brings them back towards the normal if they diverge from it. In addition, it is natural selection which plays a large part in conserving the differences between species. For hybrids between species are commonly inviable or sterile, and if they are not, their progeny is commonly inviable. To take a well-known example, mules are nearly, though not quite, sterile. Natural selection eliminates them as parents of future generations. If it did not, the species which we call horses and donkeys might merge.

Now this is a most surprising situation. Darwin postulated natural selection to explain evolution, that is to say a certain kind of change. With some difficulty it has been discovered and measured, and in the best observed cases it has been found not to cause change but to oppose it. The reason for this paradoxical state of affairs is very simple. Natural selection must be fairly intense before one can measure it. Suppose for example that X and Y are two types of animals or plants, say light and dark, or hairy and glabrous, and the intensity of selection in favour of X against Y is 1 per cent, that is to say if selection is by survival, 100 X survive for every 99 Y. The most favourable case for measuring it is when the numbers of X and Y in a population are nearly equal. If so one would need to count about 70,000 individuals to reduce the probability that the observed difference was due to chance below one hundredth. This is easy enough with small insects in a laboratory, and practicable with human beings, but very difficult in the field. Nevertheless the existence of natural selection of about this intensity has been observed by Sheppard and Cain on counts of much smaller numbers by a most ingenious method which I shall describe later.

Natural selection certainly occurs with high intensity. But if so it is either balanced by another ' force ' such as mutation or segregation, or it causes rapid evolution. Now evolution is usually a very slow process, how slow we shall see later. Hence when we find that selection is intense we are usually dealing with a population near equilibrium. Where two or more genotypes are about equally frequent the balancing agency is almost always segregation. Selection can and often does favour a heterozygous type. And if reproduction is wholly or mainly asexual almost all the population may be heterozygotes. But if reproduction is sexual, at least half* the zygotes formed in each generation must be homozygous. There may be very strong selection against them, but they appear again in the next generation in undiminished numbers.

Much quantitative work has been done on artificial selection. But it is seldom adequately controlled. In the most scientifically valuable experiments, such as those of Falconer, selection of about equal intensity has been made in two directions, this obviating effects due to the environment, to inbreeding, and so on.

By far the best established cases of natural selection of the kind which Darwin postulated have been observed by workers at Oxford University under the direction of Dr. E. B. Ford, the most striking of all by Dr. Kettlewell. In about seventy British species of Lepidoptera the frequency of dark forms has increased during the last century, particularly in districts blackened by coal smoke. *Biston betularia* is a moth whose wings used to be white with a pattern of fine black spots which render it inconspicuous on tree trunks covered with whitish lichens. This type is still universal in south-western England. In 1840 some black moths were found near Manchester. By 1900 they were in a majority in most industrial areas, and now number from about 80 to 99 per cent of the population. It was of course suspected that this was due to natural selection against the conspicuous forms. But competent biologists argued against this view, and only in the last few years has Kettlewell proved it.

The black form *carbonaria* is due to a dominant gene C. The spread cannot be due to the frequent appearance of this gene by mutation, for hundreds of the light-coloured moths have been bred together and no mutation observed. Kettlewell released two groups of about 1000 moths consisting of about equal numbers of light and dark, and marked under the wings with spots of lacquer invisible when they are resting. These moths spend the whole day resting on tree trunks, and fly and mate during the night.

One group was released in a wood in south-western England where the trees were covered with grey lichen, the other in a smoke-blackened wood near Birmingham. They were released at daybreak. Throughout the day they were eaten by small birds which chose the more conspicuous form preferentially. The next night males were caught with a light trap. In each wood the samples caught contained only about one-third, instead of half, of the more conspicuous form. Without data as to the times at which these insects emerge, mate, and lay their eggs, one cannot estimate the intensity of selection. But the less conspicuous form is clearly about twice as fit as the more conspicuous. Selection is intense. Twenty-five years ago I calculated that the dark form had an advantage of about 40 per cent, and this may

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*Negative assortative mating can lower this number to one-third.

be true on the whole, for Kettlewell quite correctly worked in woods where he expected selection to be intense. Here, then, both an evolutionary change and the selection producing it have been measured.

Sheppard and Cain showed that in the snail *Cepea nemoralis* a recessive greenish yellow form was commoner in green grass and woods than in grass which becomes brown in summer, or in woods with brown soil or leaves below the trees. It appears that this is not true in France. Sheppard marked about equal numbers of yellow, brown or red snails where the mark was invisible to birds, and then took advantage of a curious habit of a common English bird *Turdus ericetorum*, the thrush. These birds do not eat many snails during most of the year. But while feeding their young, especially in May, they crack the shells on stones or tree stumps where they are left, thus furnishing a record of predation. During the early spring when there were few leaves, the yellow snails were killed preferentially; later on when the leaves were green, they were preferentially spared. But only about 3 or 4 per cent of the marked snails were killed by thrushes, and the selective advantage of the less conspicuous form was only about 1 per cent. Confirmatory results were obtained on a natural population.

Perhaps the most rapid evolutionary process which is going on in India at the present time is the development by mosquitoes and other insects of resistance to DDT and other substances used to kill them. Quantitative data on it are much to be desired. No other agency than natural selection is known which can produce rapid evolutionary changes in large populations. But evolution is usually so slow that other agencies cannot as yet be completely excluded.

There is no great difficulty in determining the effects of selection of a given intensity on the frequency of a gene, provided that, in the case of dominance, we can distinguish between its effect on the fitness of homozygotes and heterozygotes. To take the simplest possible example, if a gene is maintained by mutation at a frequency of 10^{-4}, in the face of adverse selection, and then becomes advantageous, the advantage being 1 per cent in heterozygotes and 2 per cent in homozygotes, it will only take about 1800 generations until it is present in all but 1 gamete in 10,000. This is a very short time geologically, though in the case of men, it would take us back for some 50,000 years, perhaps to before the last ice age. So long as selection is weak its rate is proportional to its intensity, but when it is intense matters are very complicated.

The next step in the argument is rather surprising. Think for a moment of Kettlewell's case. When the industrial area of England was blackened, a great many moths were eaten because they were now conspicuous, which would not have been eaten before. We saw that perhaps half of all the adults must have been killed in this way. Some species were no doubt extinguished completely. If five or ten other characters had been selected with the same intensity there can be little doubt that *Biston betularia* would have become extinct. Natural selection cannot be too intense. Now we can calculate how many members of a species must be killed in substituting one gene for another in a population by the survival of the fittest. It turns out that this number is independent of the intensity of selection unless this is very strong, and probably averages about thirty times the number of members of the species in any one generation. In consequence evolution by natural selection is usually a slow process, and probably about one gene substitution occurs per three hundred generations on an average, though each such substitution may be a slow process lasting for a hundred thousand generations. The figures for cytoplasmic changes, changes in chromosome number, and so on, are similar. That is one reason why evolution is so slow.

How slow it is we can judge from two facts. It appears to take about half a million years, on an average, to make a new mammalian species, and longer to make a new molluscan species. The average rate of increase in a quantitative character such as tooth length or body length in several evolutionary lines has been about 4 per cent per million years, though increases of 100 per cent or more occur exceptionally.

Biologists in the Soviet Union have obtained remarkable changes as a result of grafting. Now that Benoit and his colleagues have obtained Michurinist results on ducks in Paris, the French, at least, may begin to believe Michurin. However, grafting is very rare in nature, and any new genotypes resulting from it must withstand the test of natural selection like products of mutation. Thus an acceptance of these results does not alter our general conclusion. The transformations claimed by Lysenko, for example of autumn wheat into spring wheat, appear to be reversible, and however important for agriculture, have little bearing on the usually very slow process of evolution.

There are other reasons why evolution is slow. One is that a change giving increased fitness can sometimes only be obtained by several gene substitutions, any one of which by itself would be harmful. For example, some genes determining the lengths of the upper and lower jaws of dogs are independent, so on crossing dog races one may get dogs which only eat with difficulty, and could not survive in nature. However, in small closed populations such genes may occasionally occur together. Wright believes that such populations have been very important in evolution. Fisher disagrees with him. Posterity will decide between them. I am inclined to favour Wright.

I am tempted to think that the elementary theory of natural selection is now nearly complete. This does not mean that evolution has been explained. It does mean that we can see the next questions to ask. One is this. Spurway has shown that in a given species a character can be variable in the sense that several genes affect it without upsetting the remaining developmental physiology of the organism in question too seriously. This suggests that for any species there is only a certain range of evolutionary possibilities. Natural selection can decide which path or paths will be taken. It cannot force a species to take a path which is not open to it.

Let me take an example. The rather ancient Hemipteran family of the Fulgoridae, or lantern flies, includes species with the most fantastic outgrowths. If I were a young Indian zoologist I should, I think, try whether I could breed one of the more normal looking species under laboratory conditions, and if so, whether mutations in it produced anything strange. It is at least possible that developmental processes are less integrated in this family than in most insects, so that a mutant with a large outgrowth from its thorax is otherwise normal. This is not the case with *Drosophila*, for example.

Darwin devoted a chapter in *The Origin of Species* to instinct. He saw that the obvious hypothesis that instincts are ancestral habits, or inherited memories, broke down in the case of the most striking of all instincts, those of social insects such as bees and ants. A worker bee has an extremely complicated code of behaviour which is nearly independent of experience, including the performance of a dance which communicates the direction and distance of food sources, and the capacity to respond to it correctly. These are slightly, but not very greatly, improved by experience. I should add, however, that a worker bee can learn a great deal, including the main features of the landscape around its hive. As its ancestors are all queens and drones, which do not gather food or dance, it is clear that these instincts are not inherited memories. Further, if memories were inherited, the worker bees would gradually come to behave like their sexual parents, and lose their peculiar instincts.

But can we explain such instincts by natural selection acting on mutations which are random, not of course random in the sense that they are in principle unpredictable, yet random in the sense that they are not directed to improve instinctive behaviour, though a few may do so? Haldane and Spurway have taken up this challenge, partly because if success is possible here, it is possible in the case of simpler instincts.

What is inherited in bees is not instinct, or a tendency to a particular kind of behaviour, but the capacity for producing daughters who behave in certain ways. This means that if not all, at least a substantial fraction, of the workers in a hive will have similar instincts. The dance, in our opinion, is a prelude to a flight in a particular direction relative to the sun, for a particular distance. The centres governing the muscles used in dancing and in the subsequent flight are co-ordinated, as for example are those in a man which control the muscles of his eyes and arms. Hence he is able to catch or hit a rapidly moving object which he is following with his gaze. A bee following another in the dance is automatically prepared for a flight in the same direction, and for the same distance, as the bee which she follows. A genetically determined change in the symbolism by which a dance represents a flight, if it occurs in one bee, will occur in some of her sisters, so that communication remains possible. If the change makes for greater efficiency of communication, the genes determining it will spread. But it may already be valuable before it is universal. Thus a genetically determined language is possible. On the other hand, just because the birds in a flock are not brothers and sisters, a novel type of call note will not be automatically understood. Hence birds have to learn many of their call notes. The fact that an insect society is a family makes an unlearned language possible.

While in social insects some novel kinds of activity are instinctive from the first, in vertebrates they are probably usually learned to begin with, and later become instinctive by a slow evolutionary process. The intermediate stage is probably one in which a particular kind of learning is genetically facilitated. This intermediate stage is found in many species of birds. They do not sing the song characteristic of their species if brought up by human beings, and may learn the song of another bird species. But they learn the song of their own species much more readily than that of another. Still other species of birds sing perfectly even if they have never heard this song. The fact that this intermediate condition between learning and instinct is quite common suggests very strongly that instincts can evolve, and gives at least a hint as to how they have evolved.

I have unfortunately no time to follow up this fascinating topic, but I have very little doubt that the study of it will become increasingly important. But we can already see, if only dimly, how a single enterprising or intelligent animal may start a new activity. Others may imitate it and the tradition may spread. For example, the practice of opening cardboard-topped milk bottles has spread among *Parus major* in Britain and Holland. Any slight genetically determined change in brain organization which makes this imitation easier, for example on aesthetic preference for white circular objects, now has a selective advantage, and by successive small changes a new instinct may arise. Thus ideas of individuals may become biologically incorporated into a species.

Many of the important steps in animal evolution must, I think, have depended on mental processes, particularly such fundamental steps as the origin of flight or climbing. Some animals in a species were slightly better pre-adapted for gliding than others. But not all which were so pre-adapted used their powers, any more than men use their powers fully. Those which did so, in certain cases, enjoyed a selective advantage. Even plant evolution was to some extent guided by animal minds. Plants gained no advantage from producing flowers until there were insects which could see and smell them.

I have perhaps laboured these points unduly for the following reason. Critics of Darwinism have said that it reduces evolution to a mechanical process in which mind plays no part. This is a fair criticism of some vulgarizations of Darwinism, but not of the theory presented by Darwin or his more intelligent successors. It may, however, be thought that the admission of mind as an agency in evolution is incompatible with a belief in natural selection. The following analogy may prove helpful.

To understand human thought I must certainly understand grammar. For human beings communicate, and even think, mainly by means of words. But an account of grammar is very far from an account of mind, though some ancient Indian thinkers who deified words appear to have thought that it was so. Speech and writing can be fully described in physical terms. So can natural selection. Evolution and thought cannot at present be so described. And according to dialectical materialism, which is probably the most vigorous of living philosophies, they will not be so describable in future.

An even more mistaken criticism is that natural selection reduces evolution to a matter of blind chance. Just the opposite is true. The effects of natural selection are predictable because it operates on large populations. One cannot predict that a bird will eat a particular white moth. One can predict that birds will eat more white than black moths.

Finally various forms of human violence and injustice have been defended as somehow conforming to Darwinian principles. But in fact the struggle for life is seldom conducted with violence. The fitness of an animal or plant from a Darwinian point of view is measured by the number of progeny which it leaves. And this, statistically, depends on efficiency in the life process of the species to which it belongs, whether it be a deer or a tiger. During the last few thousand years the main agents of natural selection in man have probably been infectious diseases, and the struggle for life has been a struggle with bacteria and other pathogens, and not with fellow human beings. I do not know what is the case in India, but in Western Europe and America the poor breed quicker than the rich, even when full allowance has been made for their higher death rate. Thus those who are victorious in the struggle for wealth are defeated in the struggle for life. The view that Darwinism is an immoral doctrine is based on ignoration of such elementary facts as this.

To conclude, I believe that natural selection is a major causal agency in evolution, determining which of many possible paths will be followed. It is not, of course, the only agency. But it was the last to be recognized. The existence of heredity and variation were known before Darwin. By postulating natural selection he made an intellectually coherent theory of evolution possible. The fact that it is not exactly what Darwin supposed it to be in no way diminishes the greatness of his achievement. He was quite aware of his ignorance of details, but in fact he was astonishingly prescient in many of his formulations. We do well to celebrate the centenary of his discovery this year.

National Scientific Policy

THE following is the text of the resolution placed before the Lok Sabha on 4 March 1958 by the Prime Minister.

The key to national prosperity, apart from the spirit of the people, lies, in the modern age, in the effective combination of three factors, technology, raw materials and capital, of which the first is perhaps the most important, since the creation and adoption of new scientific techniques can, in fact, make up for a deficiency in natural resources, and reduce the demands on capital. But technology can only grow out of the study of science and its applications.

The dominating feature of the contemporary world is the intense cultivation of science on a large scale, and its application to meet a country's requirements. It is this, which, for the first time in man's history, has given to the common man in countries advanced in science, a standard of living and social and cultural amenities, which were once confined to a very small privileged minority of the population. Science has led to the growth and diffusion of culture to an extent never possible before. It has not only radically altered man's material environment, but, what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism.

It is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of a recognition of this possibility that the idea of a welfare state has grown. It is characteristic of the present world that the progress towards the practical realization of a welfare state differs widely from country to country in direct relation to the extent of industrialization and the effort and resources applied in the pursuit of science.

The wealth and prosperity of a nation depend on the effective utilization of its human and material resources through industrialization. The use of human material for industrialization demands its education in science and training in technical skills. Industry opens up possibilities of greater fulfilment for the individual. India's enormous resources of man-power can only become an asset in the modern world when trained and educated.

Science and technology can make up for deficiencies in raw materials by providing substitutes, or, indeed, by providing skills which can be exported in return for raw materials. In industrializing a country, a heavy price has to be paid in importing science and technology in the form of plant and machinery, highly paid personnel and technical consultants. An early and large-scale development of science and technology in the country could, therefore, greatly reduce the drain on capital during the early and critical stages of industrialization.

Science has developed at an ever-increasing pace since the beginning of the century, so that the gap between the advanced and backward countries has widened more and more. It is only by adopting the most vigorous measures and by putting forward our utmost effort into the development of science that we can bridge the gap. It is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankind's greatest enterprise today.

The Government of India have accordingly decided that (the aims of) their scientific policy will be:

(i) to foster, promote, and sustain, by all appropriate means, the cultivation of science, and scientific research in all its aspects — pure, applied, and educational;

(ii) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation;

(iii) to encourage, and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;

(iv) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity;

(v) to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom; and

(vi) in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The Government of India have decided to pursue and accomplish these aims by offering good conditions of service to scientists and according them an honoured position, by associating scientists with the formulation of policies, and by taking such other measures as may be deemed necessary from time to time.

Maulana Abul Kalam Azad (1888-1958)

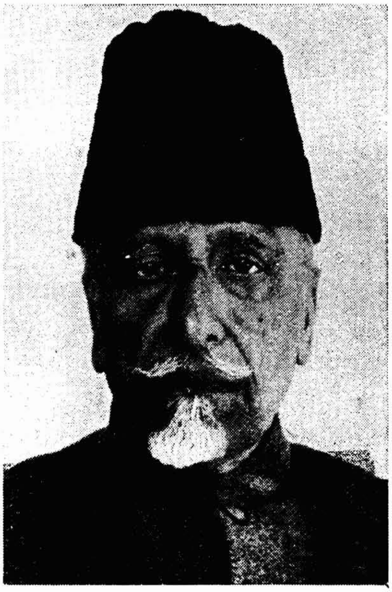
WE regret to announce the death of Maulana Abul Kalam Azad, Union Minister for Education and Scientific Research and Vice-President, Council of Scientific & Industrial Research, on 22 February 1958 at New Delhi.

Maulana Azad was born in Mecca in 1888. He passed his childhood in Arabia and was educated under private tutors. At the age of 14 he had finished his studies in Arabic and Oriental Theology and had commenced teaching. He then visited Iraq, Egypt, Syria, Turkey and France, and, through private study, acquired knowledge of European languages and literature.

In 1898 he came to India with his illustrious father. In 1912 he started an Urdu weekly, *Al-Hilal*, in Calcutta, which, under his brilliant editorship, vigorously espoused the cause of national freedom. The Government of India suppressed the publication and interned him in Ranchi.

Maulana Abul Kalam Azad had been a prominent figure in Indian politics for nearly three decades. He took a leading part in successive national civil disobedience campaigns and was imprisoned several times. In 1923 he was elected President of the special session of the Indian National Congress in Delhi and again in 1930. He was elected President for the third time in 1940 and continued to hold the office till 1946. He was the chief spokesman of the Congress Party during the Cripps negotiations in 1942 and later in the negotiations with the British Cabinet Mission in 1946.

In January 1947, Maulana Azad joined the Interim Government as Member for Education and Arts. In August 1947, he became the Minister for Education in the first National Government. In 1950, he became the Minister for Education and Natural Resources and Scientific Research. Maulana Azad was the Vice-President, Council of Scientific & Industrial Research, since May 1952 and was closely associated with all its activities.



MAULANA ABUL KALAM AZAD

Under the guidance of Maulana Abul Kalam Azad as Education Minister, marked progress was made in all fields of education — elementary, basic, secondary, technical and university — and the Central budget for education rose from rupees two crores to thirty crores. He took a keen interest in literary and cultural activities. It was under his direction that the three national Academies of free India — the Sangeet Natak Akademi, the Sahitya Akademi and the Lalit Kala Akademi — came into being.

Maulana Azad was the author of several books on philosophy and literature including a commentary on the *Quran*.

Tracer Techniques in Polymer Chemistry

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THE purpose of this paper is to show how tracer techniques can be used in polymer chemistry; in many cases these techniques provide the only feasible methods for attacking outstanding problems. It is not intended to present a comprehensive list of research projects which have been completed, but instead the subject is treated rather generally, and examples are given to illustrate the principles involved. It should be pointed out that radioactive isotopes of many elements and the electronic equipment needed for assay can now be obtained without difficulty; it is possible to equip a research laboratory for tracer work without great expense.

In this paper, emphasis is placed upon work with radioactive carbon and synthetic polymers. It is likely that tracer techniques will be useful also in connection with some of the newer inorganic polymers. To illustrate the value of the techniques in the study of natural polymers, it is necessary only to call attention to the work of Calvin and his collaborators on photosynthesis[1].

Isotopes of carbon

The characteristics of the important isotopes of carbon are shown in Table 1.

The chief use of carbon-13 is in spectroscopic studies and it is not often used in tracer work. The assay of this isotope, and of most other stable isotopes, requires elaborate equipment and the sensitivity is never as good as that achieved with radioactive isotopes. The half-life of carbon-11 is only about 20 min. and so it is usually not feasible to use this isotope in tracer experiments. On the other hand, carbon-14 has a half-life of about 5500 years and corrections for decay during the course of an experiment are unnecessary.

TABLE 1 — CHARACTERISTICS OF SOME IMPORTANT ISOTOPES OF CARBON

ATOMIC WT. OF ISOTOPE	PROPERTIES AND ABUNDANCE
11	Radioactive; short-lived
12	Stable; the most abundant isotope
13	Stable; occurs naturally to a small extent
14	Radioactive; long-lived; occurs naturally to a very small extent

Carbon-14 is produced by the nuclear reaction $^{14}N(n, p)^{14}C$. The target and product elements are different so that it is possible to obtain carbon-14 at high specific activity.

Carbon-14 emits only β-rays; their maximum energy is quite low, viz. 0·155 MeV., and so they are only feebly penetrating. This factor makes assay of carbon-14 somewhat difficult but it means that the radiation hazard is very small. The radiations from carbon-14 are completely absorbed in the walls of ordinary containing vessels and their maximum range in air is about 25 cm. The only significant hazards which can arise during work with carbon-14 are those resulting from ingesting or inhaling insoluble material. The long half-life of the isotope is an important factor in this connection. Careful working is essential at all times but particularly when handling powdery labelled materials. As a guide, it can be said that the precautions should be similar to those employed when handling powdered potassium cyanide. It is also important that a substance of very low activity should not become contaminated with traces of materials of high activity, otherwise quite erroneous conclusions may be drawn.

Carbon-14 is usually recovered in the form of barium carbonate which is, therefore, the chief starting material for the synthesis of labelled compounds. Syntheses must normally be performed on quite a small scale and rather special methods of working have been developed in order to avoid excessive handling and to ensure good yields. Whenever possible, preparations are carried out on a vacuum line. Many useful examples of syntheses with carbon-14 have been collected together[2]; many of them refer to substances of biochemical and biological interest resulting from the fact that tracer method were adopted rather more readily by workers in these fields than by those in the more physical branches of chemistry.

A number of organizations offer ^{14}C-labelled substances for sale, included among them being the Radiochemical Centre, Amersham, which is one of the establishments of the U.K. Atomic Energy Authority. It is usually possible to obtain a substance which can be converted quite readily to the desired labelled material. It will be shown later that it is often important to choose carefully at which site in a molecule a labelling atom is inserted in order not to obtain misleading results.

In Table 2, some information is given concerning the preparation of a few labelled substances of interest to the polymer chemist.

In planning the preparation of a labelled substance, it is necessary to consider what specific activity is required in the final product, and it must be noted that only a fraction of the molecules may contain carbon-14. Consider the case of a labelled initiator such as azo-*iso*-butyronitrile; usually if the specific activity of the initiator is about 30 μc./g. it is possible to determine accurately the end-group content of polymers of average molecular weight up to about 10^6. It is usually convenient to start with about 100 μc. of a labelled substance and this quantity of activity will be contained in a few milligram of the substance; at some stage, therefore, it is possible to add a considerable quantity of inactive material.

Consider now the assay of carbon-14. As mentioned already, the low energy of the radiations from this isotope makes assay somewhat difficult; several methods are, however, available.

TABLE 2 — PREPARATION OF SOME LABELLED SUBSTANCES

Labelled product	Labelled starting material	Method of preparation
Benzoyl peroxide	Benzene	Through benzoic acid and benzoyl chloride
Azo-*iso*-butyronitrile	Acetone	Through the hydrazo compound formed from acetone, hydrogen cyanide and hydrazine
Monomeric methyl methacrylate	Methanol	Ester exchange between methanol and monomer
Monomeric styrene	Malonic acid	Decarboxylation of cinnamic acid formed by condensation of benzaldehyde and malonic acid
Polyvinyl acetate	Sodium acetate	Acetylation of polyvinyl alcohol with a mixture of acetic anhydride and labelled sodium acetate
p-Benzoquinone	Aniline	Oxidation

It is possible to use Geiger counters with very thin end-windows for the assay of solids containing carbon-14. It is advisable to convert all substances to some standard material for assay, and for this purpose barium carbonate is commonly used; combustion of specimens is, therefore, required. For reliable results, the samples for assay must be prepared in a very careful fashion. The chief objection to this method of assay is its insensitivity. For certain types of solids, improved sensitivity can be obtained by using special flow counters; the specimens are placed inside the working space of the counter. This method of assay is not widely used.

In many ways, the most satisfactory procedure for the assay of carbon-14 is the method of gas counting. Several methods of working have been described including one which has been extensively used in polymer chemistry[3]. It involves first the combustion of the substance and then the transference, on a vacuum line, of a measured quantity of carbon dioxide into a counter of special design. The technique is, with practice, relatively simple; good sensitivity and reliability can be achieved. Usually a specimen of about 20 mg. is required, but of course it cannot be recovered. Figs. 1-3 show that the equipment required for gas counting need be only simple. The method of wet combustion is satisfactory for most substances; the glass apparatus for filling the counter and the electronic apparatus for subsequent measurements are not at all elaborate.

A newer method of assay for carbon-14 having the advantage that the specimen is not destroyed, is the method of scintillation counting. A solution of the specimen together with a scintillator, such as *p*-terphenyl, is put in front of a photomultiplier. The radiatons from the specimen cause the scintillator to emit flashes of light, and the resulting pulses from the photomultiplier are counted electronically. It is necessary to take a number of precautions to obtain reliable results but good sensitivity can be achieved and the method seems attractive.

At this point, it should be stated again that the levels of activity used in tracer work are low. No evidence has been obtained that the radiations produce any significant effects in the systems.

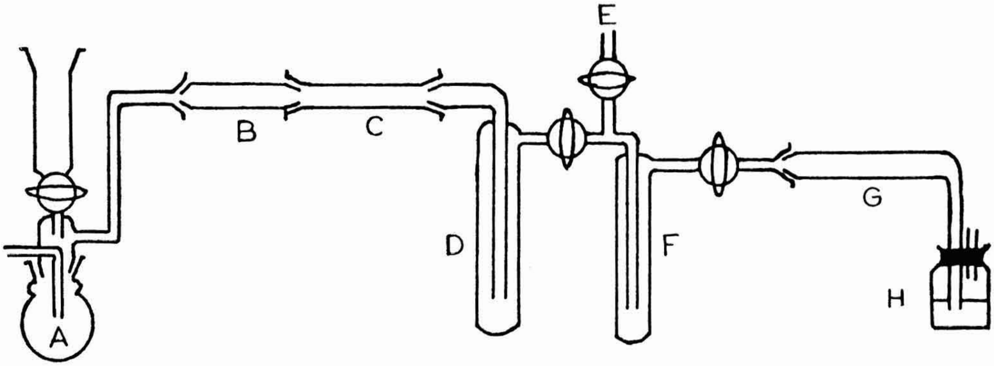


FIG. 1 — APPARATUS FOR WET COMBUSTION [A, oxidation flask; B, tube with red phosphorus and granulated manganese dioxide; C, tube with phosphorus pentoxide; D, trap cooled to −78°C.; E, connection to vacuum line; F, trap cooled in liquid air to condense carbon dioxide; G, tube with phosphorus pentoxide and caustic soda pellets; H, bubbler]

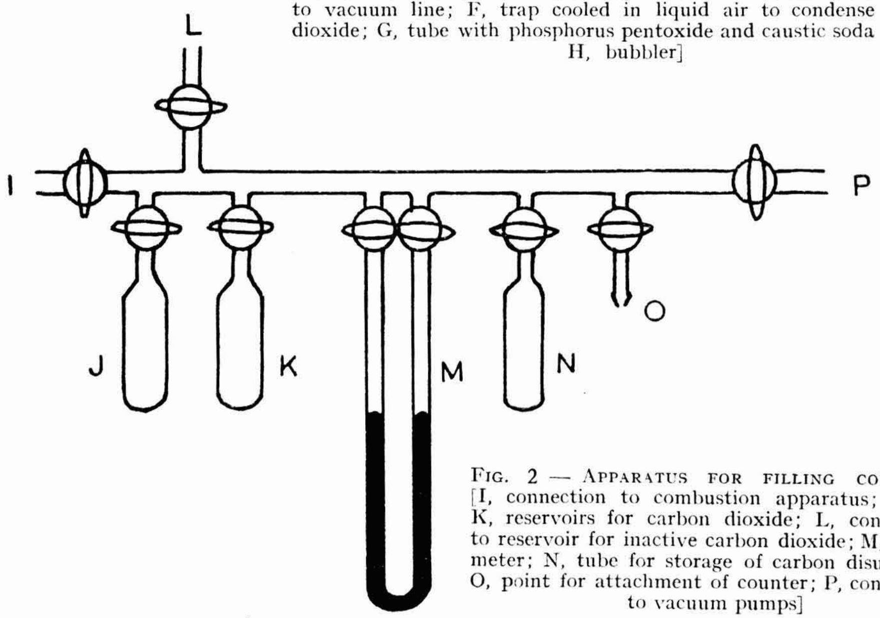


FIG. 2 — APPARATUS FOR FILLING COUNTERS [I, connection to combustion apparatus; J and K, reservoirs for carbon dioxide; L, connection to reservoir for inactive carbon dioxide; M, manometer; N, tube for storage of carbon disulphide; O, point for attachment of counter; P, connection to vacuum pumps]

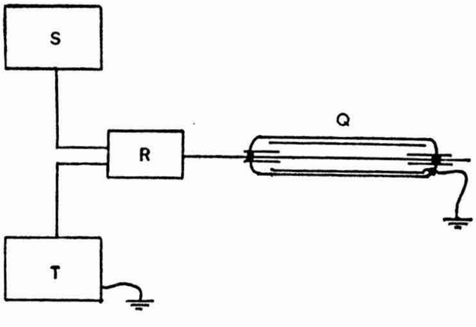


FIG. 3 — ELECTRONIC APPARATUS [Q, Geiger counter; R, probe amplifier; S, scaler; T, stabilized E.H.T. unit]

Isotopes of other elements

After carbon, the element of interest to polymer chemists is hydrogen; this element has two heavy isotopes, viz. deuterium which has atomic weight 2 and is stable, and tritium which has atomic weight 3 and is radioactive. Deuterium has been used for a number of years for studies of reaction mechanisms, etc., but tritium is now available in the form of tritiated water and the elementary gas. The half-life of tritium is 12 years and it gives β-radiation of very low energy (maximum 0·018 MeV.). The assay of tritium must be done by gas counting or by scintillation counting at low temperatures.

Probably the chief use of tritium labelling in polymer and radical chemistry will be in connection with transfer and hydrogen abstraction reactions. There is one very important factor to be considered however, and that is the effect on the bond strength of replacing hydrogen by tritium. The isotope effect is very noticeable if hydrogen is replaced by deuterium in molecules concerned in reactions involving the breakage or formation of carbon-hydrogen bonds; the effect is even larger when the heavier isotope tritium is inserted into a molecule. The isotope effect may make it difficult to obtain by an isotopic method exact information about transfer constants. Use has been made of the isotope effect with deuterium however to decide which particular hydrogen atom in a molecule is concerned in transfer processes[4]. The method depends upon the fact that a carbon-deuterium bond is stronger than the corresponding carbon-hydrogen bond. If deuterium is introduced into the reactive position in a molecule, there is a reduction in the rate of transfer, as measured by the molecular weight method.

There are no radioactive isotopes of oxygen, nitrogen or fluorine which can possibly be used in tracer studies. For these elements it would be necessary to use enriched stable isotopes; as mentioned already in connection with carbon-13, the use of stable isotopes as tracers immediately raises problems of assay and sensitivity.

Certain elements which might be of interest to polymer chemists possess radioactive isotopes of fairly short half-life, about 1 or 2 days; an example is bromine-82 which has a half-life of about 36 hr. This period is rather too short for convenience since it is necessary to obtain the radioactive element, introduce it into the desired substance, use this substance in the experiments and then recover and assay the various products all in the space of about a week. For compounds containing bromine, it may be possible in some cases to use inactive bromine throughout the experiment and then to determine the bromine contents of the various products by neutron activation analysis. This method of analysis has attracted considerable attention and a review article has recently been published[5]. The method involves exposing the specimen to a flux of slow neutrons and then comparing the activity induced by the nuclear reaction $^{81}Br(n, \gamma)^{82}Br$ with the activity induced in compounds containing known proportions of bromine. This procedure is feasible under circumstances which would make the use of bromine-82 as a tracer quite impossible. An example of the application of this technique has been given in connection with the preparation of characterized branched polystyrene[6].

In Table 3 is given a list of radioactive isotopes, including those mentioned already, which might be of interest to polymer chemists.

TABLE 3 — RADIOACTIVE ISOTOPES USEFUL IN POLYMER RESEARCH

ISOTOPE	HALF-LIFE
^{3}H	12 years
^{14}C	5500 years
^{32}Si	700 years
^{32}P	14·3 days
^{35}S	87 days
^{36}Cl	4×10^{5} years
^{82}Br	36 hr.
^{131}I	8 days

Examples of tracer work in polymer chemistry

Determination of minor constituents in polymers — One of the most useful applications of ^{14}C-labelling in polymer chemistry is for the accurate determination of end-groups and other abnormal units in polymer molecules. In radical polymerizations, this type of problem is encountered in detailed studies of initiators, transfer agents and retarders, and in some cases also in copolymerizations. For the most part, discussion here is limited to work with initiators but many of the principles can be applied equally well to the study of other types of substances. Mention has already been made of the sensitivity which can be expected in experiments of this type.

An interesting use for polymers with end-groups derived from labelled initiators is as standards of molecular weight. It is necessary to know the nature and the number of initiator fragments in each polymer molecule; this depends upon chemical factors listed below:

(a) the mode of termination of reaction chains, i.e. by combination or disproportionation or even by some added retarder; (b) the frequency of transfer processes; (c) the precise mechanism of initiation, i.e. whether it is solely by addition of a particular radical to a monomer molecule; and (d) the possibility of fragments becoming incorporated in the polymer by other mechanisms, or even of fragments becoming detached from the polymer during recovery and purification.

In the case of styrene at 60°C., it is now accepted that combination is predominant. For this monomer, it is relatively easy to eliminate retardation and transfer processes and to ensure that direct thermal polymerization is of negligible importance. When using azo-*iso*-butyronitrile as initiator, there is every reason to believe that the initiation process is straightforward and that there are no unexpected reactions by which initiator fragments may become attached to or detached from polymer molecules. It is safe to assume then that if polystyrene is prepared under carefully controlled conditions using ^{14}C-azo-*iso*-butyronitrile, each polymer molecule contains two labelled end-groups. It is an easy matter then to determine the number-average molecular weight of the polymer merely by comparing the specific activities of the polymer and the initiator. If the method of assay is one in which the counting rate is directly proportional to the $^{14}C:^{12}C$ ratio in the specimen, the chain length (n) of the polymer is given by the expression

$$\frac{\text{Counting rate for polymer}}{\text{Counting rate for initiator}} = \frac{m.f}{m.f + g.n}$$

where $m =$ the number of initiator fragments in each polymer molecule; $f =$ the number of carbon atoms in each initiator fragment; and $g =$ the number of carbon atoms in each monomer unit.

In the case of polystyrene prepared at 60°C. with azo-*iso*-butyronitrile as initiator, m, f and g have the values 2, 4 and 8 respectively.

Other methods of determining number-average molecular weights are open to great uncertainty because of possible instrumental errors; for end-group assay by tracer techniques, however, the experimental errors can be made very small, and work is now in progress to confirm finally that conditions (c) and (d) are satisfied. It is suggested that polymers having labelled end-groups might be used as standards for calibration of other methods for determining molecular weights.

Many useful studies with labelled initiators can be performed without knowledge of the precise mode of termination or of the frequency of transfer, and without determining molecular weights. Essentially the procedure is to measure the rate at which initiator fragments become incorporated in polymer. These researches lead to determinations of kinetic chain lengths and rates and efficiencies of initiation. It appears that the tracer method is by far the most satisfactory for measuring these important kinetic quantities.

Several papers have been published concerning tracer studies of azo-*iso*-butyronitrile and benzoyl peroxide as sources of free radicals[7,8]. With these substances, and others to be used in tracer work, it may be necessary to consider very carefully at which sites labelling atoms are inserted. For the azo compound, it is wise to put carbon-14 in the methyl groups and not to label one of the other carbon atoms. If the compound is labelled thus

$$(CH_3)_2\overset{*}{C}(CN).N:N.\overset{*}{C}(CN)(CH_3)_2,$$

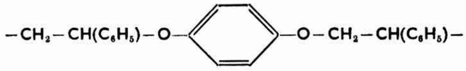
there is the possibility of a small isotope effect on the rate of dissociation; if the cyanide group is labelled, it is possible that the labelling atom may become detached from the polymer either on warming the polymer or by an exchange reaction. In the case of benzoyl peroxide, the easiest way of labelling the molecule is to label it on the carboxyl carbon atoms; then benzoyloxy radicals generated from the peroxide are labelled but phenyl radicals, formed by dissociation of the benzoyloxy radicals, are unlabelled. This means that carboxyl-labelled benzoyl peroxide is of limited value. For measuring rates of initiation in radical polymerizations, the most useful type of labelled benzoyl peroxide is that for which the labelling is confined to the benzene rings.

It is important to call attention to one important limitation to the tracer method for determining minor components in polymers. It is not possible to be certain of the exact structure of the abnormal labelled unit in the polymer molecule. For example, when using azo-*iso*-butyronitrile as an initiator the fragment combined in the polymer may have one of three structures, viz.

$$(CH_3)_2C(CN) \qquad (CH_3)_2C(CN).N:N \qquad (CH_3)_2C:C:N,$$

and in tracer experiments it is impossible to distinguish immediately between them because they contain exactly the same carbon atoms. There are, of course, other ways to decide which of these structures corresponds to the initiator fragment in the polymer.

This type of problem arose in connection with the way in which *p*-benzoquinone becomes incorporated in polystyrene. By using quinone labelled with carbon-14, precise information was obtained concerning the relative numbers of quinone and monomer molecules in various samples of polystyrene[9]. It was thought that the quinone might be attached to the styrene units through ether linkages thus



If this view is correct, it should be possible to remove the quinone from the polymer by treating the material with a reagent which cleaves ether linkages. It was found that this was so; the activity, due to combined ^{14}C-*p*-benzoquinone, could be removed completely from polystyrene by appropriate chemical treatment.

Determination of substances of low molecular weight

The technique of 'isotope dilution analysis' is particularly valuable for the determination of the components of complex mixtures. The special value of this technique is that although it requires isolation of pure specimens, complete recovery of the various components of the mixture is unnecessary. Descriptions of the general procedures are available in a number of standard texts[10]. Applications in the field of polymer chemistry include: (a) analysis of the hydrolysate from proteins[10]; (b) determination of substances of low molecular weight in reaction mixtures, e.g. the products resulting from wasted initiator[7], or the products formed from inhibitors during induction periods[9]; and (c) determination of the products of low molecular weight formed during chemical treatment of high polymers[11].

An example of (c) will be described.

The problem was concerned with the nature of the end-groups in polystyrene prepared using benzoyl peroxide as initiator. The peroxide dissociates to give benzoyloxy radicals but some of these radicals dissociate to phenyl radicals before they are captured by monomer. Two distinct types of end-groups may be present in the polymer, represented by the formulae

$$C_6H_5.CO.O.CH_2.CH(C_6H_5).R \text{ and } C_6H_5.CH_2.CH(C_6H_5).R,$$

where R represents a polystyrene chain.

The first type of end-group is joined to the polymer chain through an ester linkage and it should, therefore, be detached from the polymer on treatment with hydrolysing reagents; on the other hand, the second type of end-group is attached to the polymer chain by a carbon-carbon bond and should, therefore, be stable to hydrolysis. Tracer experiments indicated that all the ester end-groups actually did come off the polymer during treatment with alkali but confirmation was sought by attempting to show that the corresponding amount of benzoic acid was liberated.

Conventional analytical methods could not be used for this problem. If about 50 mg. of polymer were used in the experiment, only a fraction of 1 mg. of benzoic acid could be expected in the solution; polymer and unused hydrolysing agent would also be present. If the original peroxide were labelled, the liberated benzoic acid would be labelled also and it could be determined by isotope dilution analysis. The first step is to add to the reaction mixture a known weight, say 0·5 g., of inactive benzoic acid and to make sure that this carrier acid is completely mixed with any active benzoic acid which may be present in the solution. Benzoic acid is now the major component of the solution and it is relatively easy to isolate a pure sample; a wasteful method of purification can be employed because it is necessary only to recover sufficient for assay, say 20 mg. The specific activity of the recovered benzoic acid is compared with that of the original benzoyl peroxide used in the polymerization. The specific activity, in units such as μc./g. of carbon, of the original peroxide must be the same as that of the benzoic acid liberated from the polymer.

Let a_1 be the specific activity of the original peroxide; a_2, specific activity of the recovered benzoic acid; w_1, weight of active benzoic acid liberated from the polymer; and w_2, weight of inactive benzoic acid added to the system. Then

$$\frac{a_1}{a_2} = \frac{w_1+w_2}{w_1}$$

and the unknown weight w_1 can be calculated.

It was found that the weight of benzoic acid found by this method agreed well with the weight calculated from the fall in specific activity of the polymer.

In all work of this type, it is essential to make certain that the activity in the material being assayed is not due to the presence of traces of highly radioactive impurities. It is usually possible to devise tests on the efficiency of purification. Radioactive samples of likely contaminants are added to an inactive specimen of the material being considered; then tests are made to discover a procedure to remove from the material all traces of activity.

This type of separation test is of great value in other connections in polymer chemistry; for example, it can be adapted for assessing the efficiencies of procedures for fractionating high polymers. This method was used in the course of a tracer study of transfer to polymer and the resulting growth of branched molecules[3]. A mixture of a labelled polymer of high molecular weight and an unlabelled polymer of low molecular weight was made; the mixture was separated into fractions and the distribution of radioactivity through these fractions was examined.

Summary

The production, properties and assay of carbon-14 are discussed in some detail. Radio isotopes of other elements of interest to polymer chemists are considered more briefly. Examples of two of the main uses of tracer techniques are described. The first of these uses is concerned with the determination of end-groups and other abnormal units in polymer molecules; the other type of problem is connected with determination of substances of low molecular weight in the presence of polymers.

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Photogrammetric Instruments & Their Applications

PROGRESS in any field, whether it is in medicine, agriculture or industry, is in some way or other related to the crust of the earth and is consequently associated with the development of cartography. A thorough ground survey is considered both a premise and a base for the planning and execution of a project in any field. As cartography must continuously satisfy the exacting demands made on it, it has to employ, for its development, most up-to-date techniques. This has led, in recent years, to the development of two important cartographic techniques, namely photogrammetry and aerophotogrammetry, now extensively used in topographic survey work. The aeroplane and photography, together with the complex optical-mechanical precision equipment now available, enable the measurement of the minute characteristics of the terrain while reducing the time to be spent on the ground to a minimum. Besides ground surveying, photogrammetrical methods are used in various other fields, e.g. forestry, zoology, anthropology, criminology, medicine, archaeology, ballistics, hydrographology, etc.

Aerophotogrammetry finds the widest application in ground surveying. Photographs are taken from planes in flight, along a predetermined route and at regular intervals, in such a way that complete coverage of the whole terrain is assured by a chain of photographs. Each photograph in the chain has more than half its area in common with both its preceding and succeeding photograph; thus, each feature of the terrain is photographed from at least two different points in space. This procedure allows, in the subsequent plotting, the determination, with continuity, of each detail of the ground, by means of the two intersecting lines from two common ' take ' points. Plotting is done in a completely automatic manner by precision instruments.

In this article are presented some of the latest instruments developed in the field of photogrammetry.

The Ottico Meccanica Italiana Rilevamenti Aerofotogrammetrici of Rome manufacture, under Nistri patents, a comprehensive range of air survey equipment. The first patent of Ing. Umberto Nistri dates back to 15 May 1919, and ever since, the instruments and methods developed by him have found immense use.

Photogrammetric instruments

Among the typical OMI-Nistri instruments now produced, the aerial photogrammetric 'take' camera, FOMA (Fig. 1), is an example. It is a cine camera with a useful format of 23 × 23 sq. cm. and having a wide-angle (90° field) OMI-Rigel 1: 6·3 lens. Its operation is automatic. The ground image is followed through a suitable viewer, while the ground takes are made with continuity according to present norms. The camera is provided with a system of film flattening which ensures that the film, although having a considerable format, rests accurately on the focal plane. Another equipment records the nadir point (the point on the ground which at the instant of exposure is on a direct vertical line from the taking lens) and the time of exposure. The geometrical location of the nadir point allows the re-creation of the angular attitude of the camera at take height. The Nistri instrument arrives at a very close approximation of the nadir point by using two gyroscopes, mounted parallel to the focal plane of the camera and normal to each other. From the primary axes of the gyroscopes are obtained the data that serve to locate directly on the photograph the components of the nadir point along the axes of the film exposed.

Different types of OMI-Nistri plotters of varying accuracy and for different applications are available. Their purpose is to describe the ground, usually by representing it on a map, according to the methods of descriptive geometry. The instruments operate automatically once they are provided with the photographs of the area to be surveyed, and the co-ordinates of a certain number of

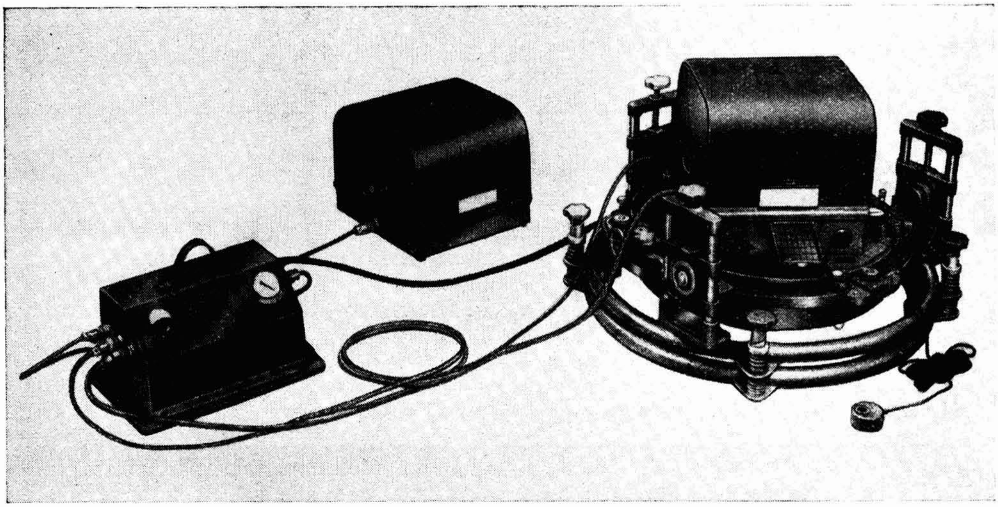

FIG. 1 — NISTRI FOMA 54 AIR SURVEY CAMERA

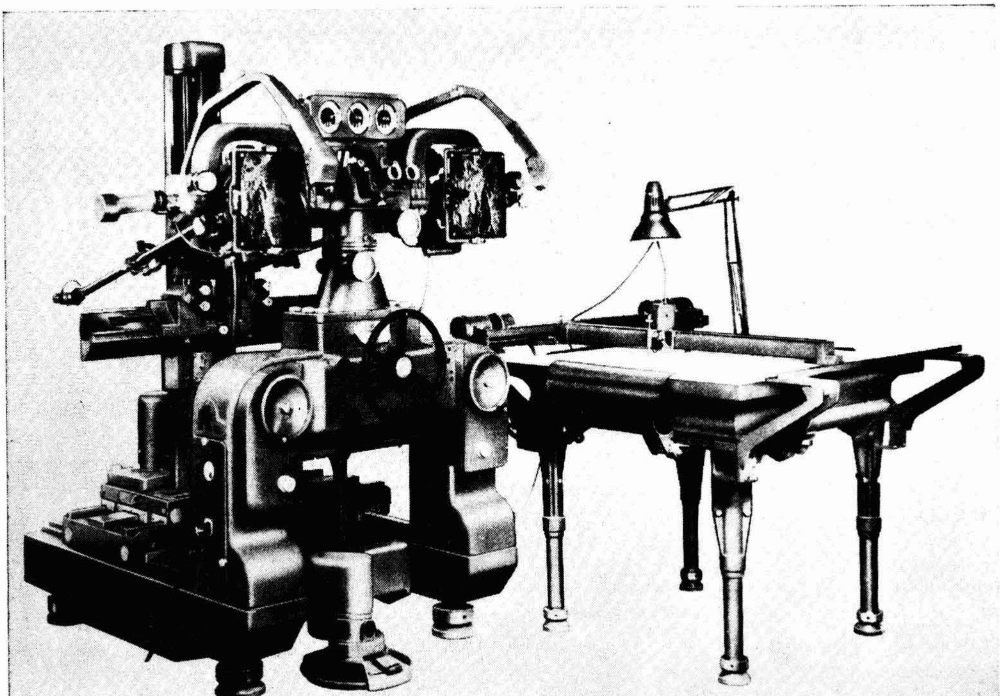

FIG. 2 — NISTRI PHOTOSTEREOGRAPH MODEL BETA/2 WITH COO TABLE

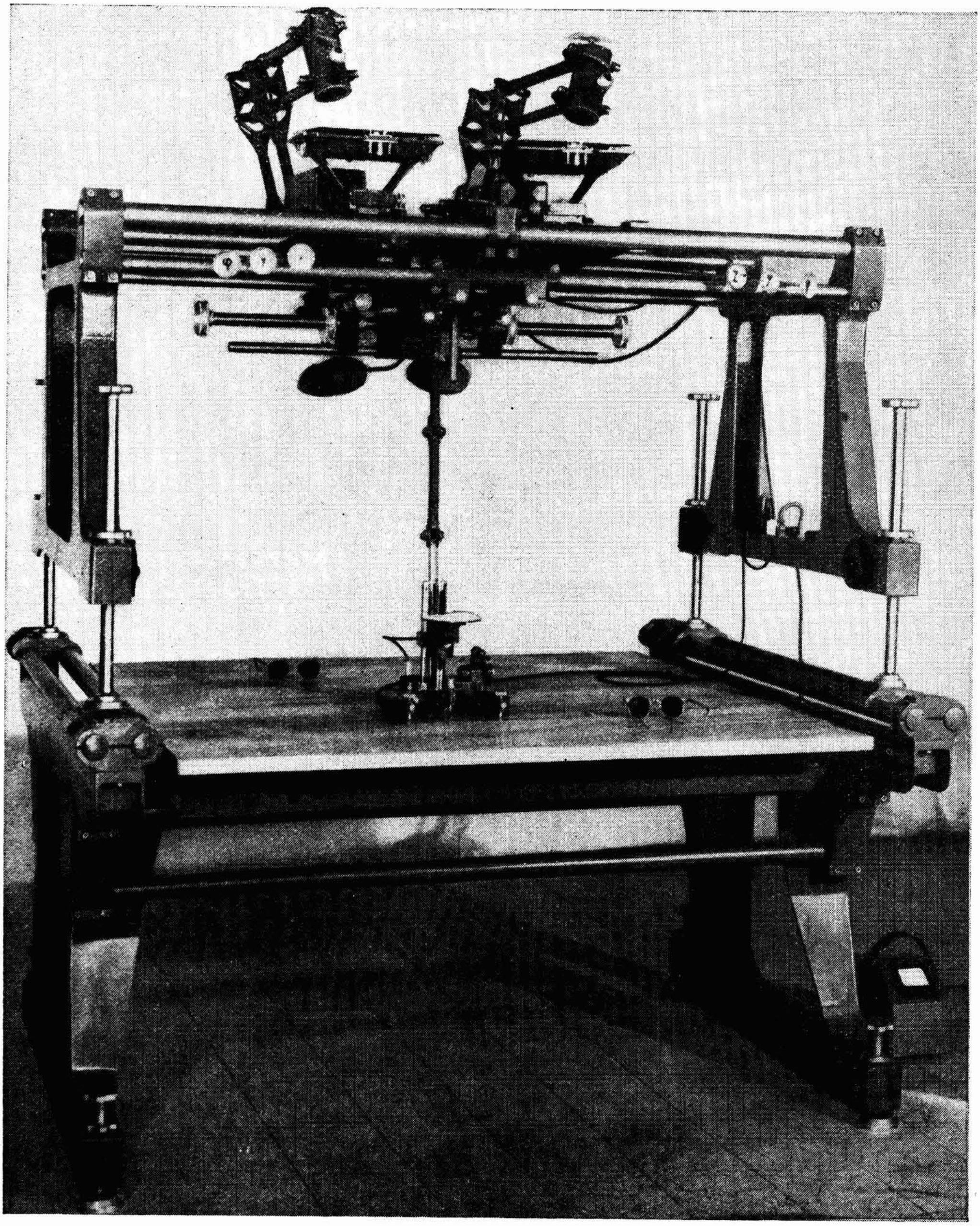

FIG. 3 — NISTRI PHOTOMAPPER

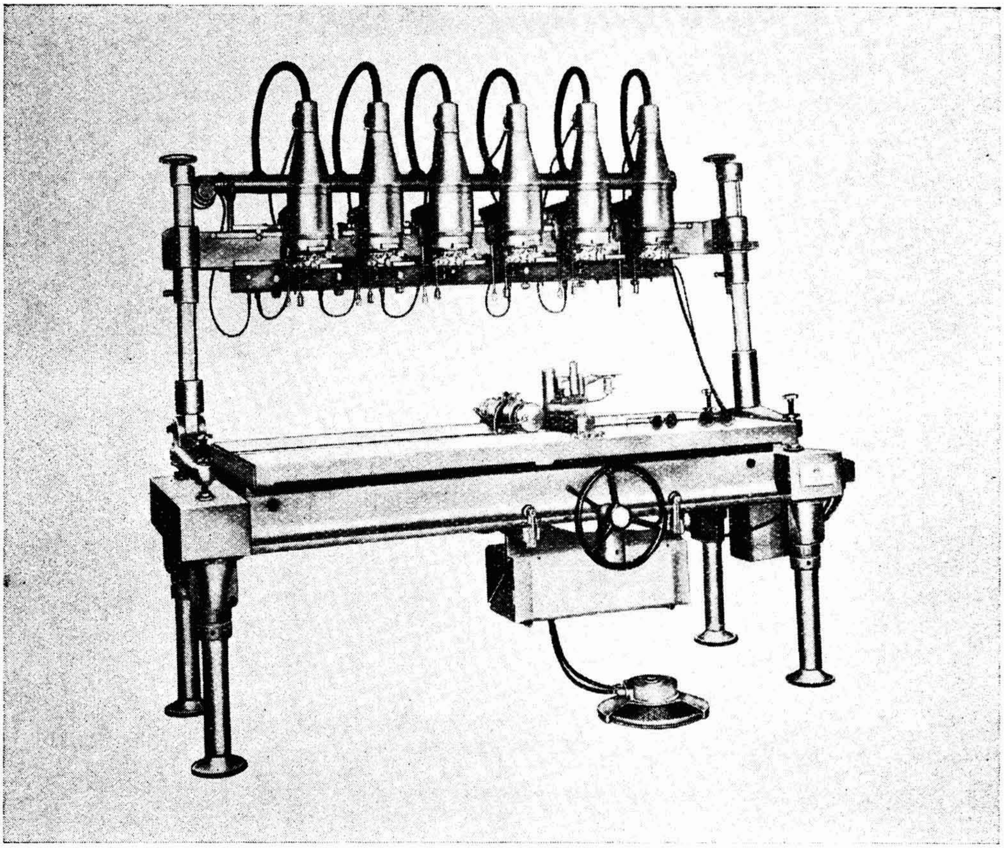

FIG. 4 — NISTRI PHOTOMULTIPLEX MODEL D-III WITH VELTROPOLO

points pre-set on the ground and located on the photographs themselves. The Nistri plotters are completely automatic. The operator, after introducing into the instrument photographs covering a given area of ground and after carrying out on them certain operations leading to the re-creation and orientation in space of the 'optical model' of the ground, can compile the manuscript by means of stereoscopic viewing of such a model and a special 'space mark'; this mark consists of a mobile luminous dot moving on the model at the operator's will along the three directions, X, Y and Z. When by moving the X, Y and Z controls of the instrument, the mark is superimposed on a feature of the model the tip of a pencil automatically draws on the manuscript the planimetry of the feature. At the same time, one can read the elevation of the area above sea level on a counter. By causing the mark to move along a continuous line of ground (such as roads, ditches, railways, etc.), the pencil will describe such features on the map with continuity. If only the X and Y planimetric displacements of the mark are controlled, and the mark is always touching the model, the pencil describes with continuity a contour line.

The Nistri Photostereograph model Beta/2 (Fig. 2) is a universal plotter for terrestrial and aerial photogrammetry, using takes having a lateral tilt; it has high accuracy. The Nistri Photocartograph model VI (Photomapper) (Fig. 3), a plotter derived from the first model of the Photocartograph manufactured by Nistri in 1919, has the same accuracy, but is suitable only for aerial photogrammetry and its performance is less generalized than that of the Beta/2. Its low cost and ability to plot from takes convergent up to 40° are its special features. The Nistri Photomultiplex model D-III (Fig. 4) is a second order plotter, particularly suitable for medium and small scales. Its lower accuracy is compensated by its wide range of uses. The Nistri Stereographometer model 90 (Fig. 5) is a third order plotter suitable for quick surveys or demonstrations and for the revision of existing maps.

Various auxiliary and special photogrammetric instruments such as printers, rectifiers, etc., are also manufactured by OMI-Nistri. The terrestrial taking cameras together with the Stereocomparator represent a complete range of equipment for terrestrial surveys and also with smaller auxiliary instruments for the plotting of the trajectories of mobile objects.

Zootechnology

Zootechnology is an entirely new branch of study and deals with the accurate determination of minute biological changes or microscopic movements in living organisms. An animal can be visualized as a continuously changing entity, both in its posture and in its slow but ceaseless changes in size. The very movement of an animal, due to its breathing, makes precise measurement impossible except by photogrammetric means. In Fig. 6, the contours and profiles on vertical planes of a cow are plotted. The animal was photographed stereoscopically and simultaneously from several directions. By following the stereoscopic image of the animal with the optic mark, first the curves and then the various profiles of the beast were automatically drawn with great precision, accurate up to a millimeter with the Nistri Photostereograph model Beta/2. Periodic takes and plottings of any animal under special treatment are of special significance. By

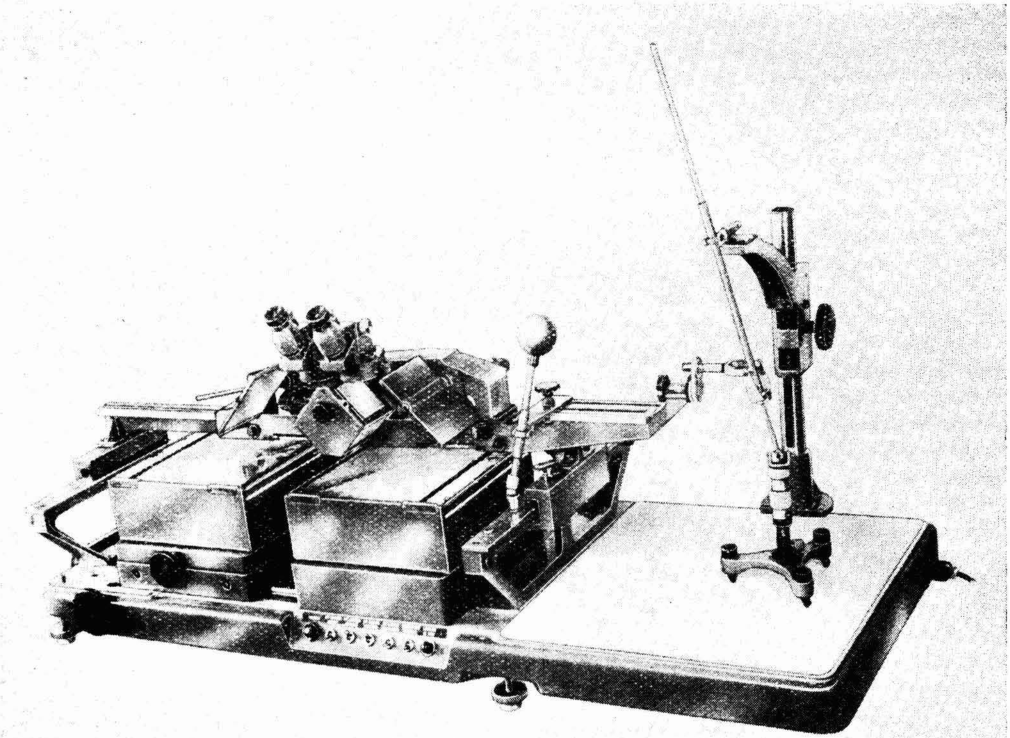

FIG. 5 — NISTRI STEREOGRAPHOMETER MODEL 90

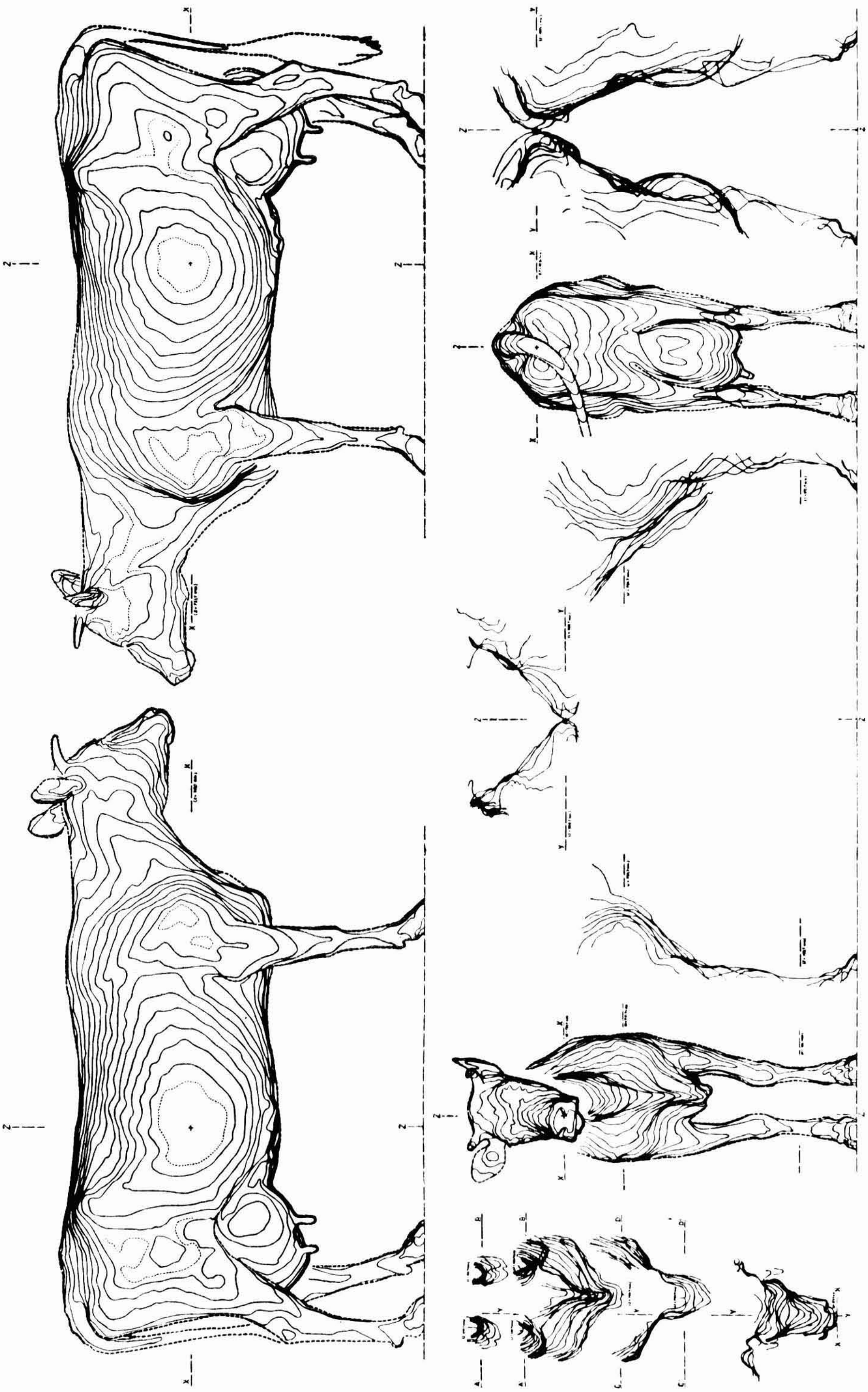

FIG. 6 — PLOTTING OF A COW CARRIED OUT WITH A NISTRI PHOTOSTEREOGRAPH

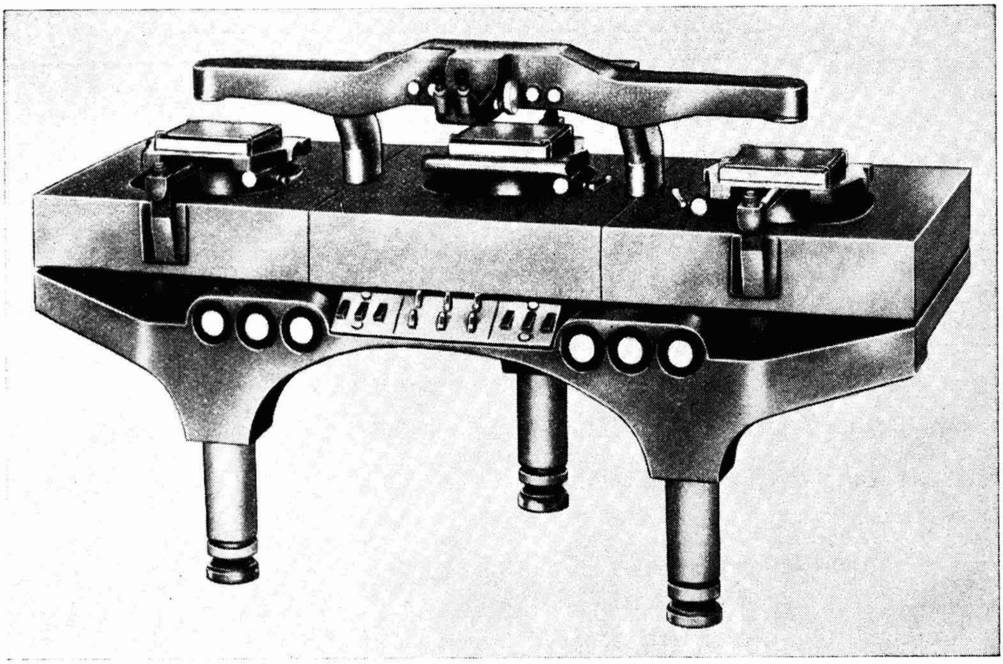

FIG. 7 — NISTRI STEREOCOMPARATOR MODEL TA3

means of photogrammetry, any animal, irrespective of its size, can be plotted; by using special cameras for stereoscopic microphotography, the observation can be extended to minute organisms.

Aerotriangulation

Aerotriangulation, i.e. survey of large areas within prescribed tolerances without the necessity of previously covering the ground with a trigonometrical, geodetic and topographic net, has now entered its operative stage in several countries where small-scale maps still have to be made. This procedure is developing along two different lines: instrumental and analytical. The Nistri equipment especially adapted to instrumental aerotriangulation uses the gyroscopic recording of the nadir point among the aerial take cameras, and the nadir points among the plotters. The Nistri Stereocomparator model TA3 (Fig. 7) instead, is especially suited for analytical methods of aerotriangulation.

Photogrammetry combined with X-rays may be useful if determination of the position of a certain organ, or some foreign object in the human body is desired.

Dendrophotogrammetry is another new branch of the ever-increasing application of photogrammetry. It deals with the study of the extent of growth in a forest.

Rare Metals — A Symposium

THE symposium on 'Rare Metals', jointly organized by the Indian Institute of Metals, the Unesco and the Department of Atomic Energy, was held in Bombay from 1-5 December 1957 and covered the metallurgy of uranium, thorium, plutonium, beryllium, zirconium, and the rare earth metals. The symposium was inaugurated by Dr. H. J. Bhabha, Chairman of the Atomic Energy Commission, and was distinguished by the presence of several foreign delegates from Australia, Burma, France, U.K. and the U.S.S.R. The participation of these foreign delegates was largely rendered possible by the aid provided by the Unesco. In all 26 papers, including 13 from abroad, were presented and discussed at the symposium spread over five sessions.

Inaugurating the proceedings, Dr. Bhabha stressed the importance of developing electric power from atomic energy in the country, and explained as to how and where it would prove economically competitive with power derived from fossil fuels. He said that coalfields in the country were concentrated in the Bengal-Bihar region so that coal had to be hauled to distant industrial centres in other parts of the country. This made the cost of coal high. If the cost of thermal power in these regions was not unduly high, it was because the transport of coal was heavily subsidized. It was, therefore, better to base power generation on something which did not depend on coal.

Dr. Bhabha emphasized the role which metallurgy has to play in the development of special materials required for implementing nuclear power programmes, and referred to the progress made in India in order to make the country self-sufficient in important basic materials essential for such programmes.

The first session was devoted to the resources of rare metals, beneficiation and treatment of uranium ores and ore concentrates. Dr. D. N. Wadia presented a comprehensive paper on India's resources of rare metals and reported, among the recent finds, the occurrence of large deposits of monazite in the Bihar state which promise to outstrip even the extensive sand deposits on the east and west coasts of India.

Beneficiation of low grade uranium ores, acid and alkali leaching of the ores and ore concentrates, and recovery of uranium from lean uranium-bearing solutions by ion-exchange, solvent extraction, and by chemical precipitation, formed the subject matter of the subsequent papers presented at this session. G. P. Mathur and P. I. A. Narayanan of the National Metallurgical Laboratory, Jamshedpur, summarized the world occurrences of uranium ores and discussed the applications of physical methods of beneficiation to uranium ores, giving examples from industrial practices in important uranium mills. In the next paper, R. Krishnaswamy of the Atomic Energy Establishment surveyed the beneficiation characteristics of the Indian uraniferous ores and the beach sands. T. R. Scott of Australia gave a lucid account of the development of uranium industry in his country, laying stress on the nature of the plants and chemical procedures adopted for leaching and extraction of uranium from its ores. It will be remembered that Australia is already a significant producer of uranium oxide, and has the potential of becoming a major world producer. His remarks about the protected acid leaching practice on one of their high apatitic ores were of special interest in view of the similar problems encountered with some of the Indian ores. He reported that control of *p*H enabled preferential acid leach of the uranium minerals in the ore thus leaving behind the apatite, thereby effecting a considerable saving in acid cost. J. Shankar and B. H. Krishna of the Atomic Energy Establishment discussed the special problems encountered in the leaching and extraction of Indian low grade uraniferous ores. This session concluded with a comprehensive account by T. V. Arden of the United Kingdom of the recovery of uranium from acid leach liquors by ion-exchange and the factors influencing plant design.

The second session was concerned with the treatment of monazite, production and application of rare earth metals and the metallurgy of zirconium.

Monazite sand is the main source of thorium and this metal, though not fissionable, can be irradiated to give the fissile uranium-233. Besides, monazite is a good source of uranium. The Indian monazite contains about 0·3 per cent U_3O_8. In this context, the paper on the Indian practice for the extraction of thorium and uranium from the sands and their refining, presented by H. N. Sethna and S. Fareeduddin of the Indian Rare Earths Private Limited, was of special interest. The practice is based on recovery of thorium from the sand using alkali breakdown in lieu of the more conventional breakdown with sulphuric acid. The presentation was illustrated with a detailed flow sheet of the process and brought out the economic advantages of alkali treatment. Brazil is another country using a similar treatment for the sand processing, and the practice followed there was covered in a communication by P. Krumholz of Brazil.

The treatment of monazite for the recovery of thorium and uranium releases very large tonnages of rare earth salts and India is, therefore, specially interested in extending their application in industry. It was apparent from the masterly survey of the extractive metallurgy of the rare earths presented by F. Trombe of France, and from the exhaustive treatment of the applications of rare earth metals by B. R. Nijhawan of the National Metallurgical Laboratory, that great advances have recently been made in these important fields. Among the applications of rare earth metals, special mention may be made of the proposed use of gadolinium and europium as control rod materials for reactor application.

A summary of the present status of zirconium metallurgy was presented by C. V. Sundaram and Brahm Prakash of the Atomic Energy Establishment, in which the importance of hafnium separation to make the metal suitable for thermal reactor applications was specially emphasized. Zirconium, on account of its very good corrosion resistance, low neutron capture cross-section and desirable mechanical and fabrication characteristics at elevated temperatures, is an attractive material for canning the fuel elements required to work at higher temperatures. In the discussion that followed T. R. Scott gave details of a recently developed hafnium separation process in Australia based on the disproportionation of the mixed chlorides which promises to effect great economies in the production of reactor grade zirconium.

The third session was devoted to the metallurgy of beryllium, production of metallic uranium and thorium, and the treatment of irradiated fuel elements and breeder blankets.

Beryllium and beryllium oxides are excellent moderators. Beryllium, due to a unique combination of physical properties, such as very high rigidity, very low density, high dimensional stability, comparatively high thermal conductivity, high heat capacity, high melting point, excellent resistance to oxidation up to 500°C., and non-magnetic nature, is of interest with reference to power production from nuclear sources. But the extraction and fabrication of beryllium and its oxide in requisite purity, made worse by its toxicity, is very complicated, calling for very specialized techniques.

Production methods for beryllium and beryllium oxide were outlined by T. Banerjee and P. B. Chakravarti of the National Metallurgical Laboratory, Jamshedpur, and they briefly reviewed the work done in India. C. W. Schwenzfeier of U.S.A. gave an account of the recent developments in beryllium metallurgy in U.S.A. and made special reference to the practice followed at the Brush Beryllium Company.

Treatment of irradiated fuels and breeder blankets was the theme of the next two papers. This treatment is necessitated because, unlike in fossil fuels, the degree of burn-up possible in nuclear fuels is rather limited due to build up of fission products of high capture cross-section and of physical damage to the fuel elements during the fission process. The processing for this purpose presents very special problems, many of them not encountered before in any other type of plant, mainly on account of the associated radioactivity. The nature of these problems was discussed by R. Manocha of the Atomic Energy Establishment, and there was a very significant contribution on pyrometallurgical techniques of re-processing irradiated fuels by S. Lawroski of the United States, who included in his paper a scheme on the pilot plant facility being designed for a 60 megawatt thermal breeder reactor.

The fourth session was concerned with physical metallurgy and fabrication of uranium, plutonium and thorium. The complexity of the problems encountered in uranium metallurgy was emphasized by K. Tangri of the Atomic Energy Establishment. The highlight of this session was an illuminating paper by L. M. Wyatt of U.K. Atomic Energy Authority, which gave a lucid exposition of the British practice in the various stages of fabrication and canning of uranium. Wyatt dealt with various types of fuel elements used in different reactors and discussed the structure of uranium and various factors involved in its study, the phenomenon of uranium growth, Cottrell effect, and swelling associated with actual behaviour of uranium under irradiation. J. A. Stohr of France dealt with the special features of Sejournet method employed for extrusion of uranium and zirconium, using glass as lubricant. M. K. Waldron and D. M. Poole of U.K. brought to light some recent developments that have taken place in plutonium metallurgy. Plutonium is characterized by some marked peculiarities; it has six allotropic modifications all within the range of room temperature and its melting point of 640°C., and is the only metal which has a negative coefficient of expansion. Its extreme toxicity calls for special handling techniques. The alloying behaviour of plutonium was specially stressed in the paper and it would seem that reactor systems based on plutonium-thorium would have special advantages. M. K. Madhekar and M. K. Asundi of the Atomic Energy Establishment brought this session to a close with a review of the physical metallurgy of thorium.

The last session was devoted to powder metallurgy in reactor applications and the fundamental considerations in alloying behaviour of nuclear metals. V. K. Moorthy of the Atomic Energy Establishment pointed out the importance of rare metal oxides and carbides in nuclear energy programmes and reviewed briefly the special properties of refractories used in these programmes, and the fabrication techniques employed. R. Caillat of France discussed the special problems involved in the sintering of beryllia. He disclosed details of the practice followed in France but emphasized that a good deal of work still remained to be done particularly on improvements in the methods of sintering and manufacture so as to reduce the price of sintered oxide, and on radiation damage. The dispersion type of fuel elements, both of ceramic and cermet type, was dealt with by H. H. Hausner of the United States who brought out the special advantages inherent in them due to their refractory nature and resistance to radiation damage. He briefly discussed the fabrication of various types of fuel elements. In the concluding paper of the session and of the symposium J. Friedel of France gave an account of the theoretical considerations involved in evaluating and predicting the alloying behaviour of nuclear metals. In the absence of the author, his paper was ably presented by L. M. Wyatt.

The symposium served to bring together leading metallurgists from India and abroad for a discussion on the recent advances made in reactor metallurgy. It was clear that very rapid progress is being made in gaining an understanding of the complex behaviour of reactor metals, specially uranium and plutonium. Much, however, remains to be done and the symposium rightly drew attention to the many unsolved or partly solved problems in reactor metallurgy such as the causes of radiation damage and the remedial measures for minimizing it, the difficult problem of making ductile beryllium, and the highly complex metallurgy of plutonium.

REVIEWS

UNSTABLE CHEMICAL SPECIES: FREE RADICALS, IONS AND EXCITED MOLECULES [*Annals of the New York Academy of Sciences*, **67** (1957), 447-670]

Under the auspices of the New York Academy of Sciences a conference on the above subject was held in March 1956. It was jointly sponsored by the Aeronautical Research Laboratory, and the Air Force Base, Ohio. The publication is a collection of papers submitted to the conference on the various aspects of free radicals and excited molecules.

Unstable species are of practical as well as of scientific importance. They play a fundamental role in industrial problems, such as corrosion, polymerization, detonation, cracking of petroleum, combustion, flames and in high-temperature processes of metallurgical interest. Other fields in which these reactive particles are of importance include biology (radiation damage), astronomy (spectra of planets, comets and the sky geochemistry), and the origin of the earth's composition.

The first paper deals with " The estimation of the transport properties for electronically excited atoms and molecules " by Hirschfelder, a well-known authority on the subject. Since the transfer of energy in any combustion process depends upon the frequency of collisions, a method for the evaluation of collision diameters for electronically excited atoms and molecules is clearly necessary. There are three papers on different methods of production of free radicals; the latest of these methods is ' shock waves ' which is described by Hornig. Properties of the radicals can be studied by spectroscopy, mass spectrometry, and paramagnetic resonance; three papers are devoted to this aspect. Broida, from the National Bureau of Standards, gives an account of the interesting results obtained by stabilizing radicals at low temperatures and subjecting them to spectroscopic examination.

There is one paper on the role of free radicals in organic reaction mechanisms and another in biological oxidations. One theoretical paper of great interest is " Vibrational energy transfer ".

For further study, copious references are given at the end of each paper. Publications of the papers submitted at the conference is of great help to research workers in the field of free radicals.

W. M. VAIDYA

VITAMIN A by Thomas Moore (Elsevier Publishing Co., London; *Distributors*: Cleaver-Hume Press Ltd., London), 1957. Pp. xx + 645. Price 76*s*.

During the past thirty years or more, thousands of research papers have been published on vitamin A, and several review articles have appeared often on one or more aspects of this vitamin. But a comprehensive account, taking into consideration the biochemical, nutritional and medical aspects as well as the relation between vitamin A and the endocrine system, particularly the sex hormones, has not been available until the publication of the book under review. Dr. Moore, with his rich experience for over a quarter of a century in the investigation of various aspects of vitamin A metabolism, has very ably treated this subject from both the historical as well as the scientific perspectives.

After an historical introduction, Dr. Moore has dealt with the estimation of vitamin A and its provitamins and has then considered the chemistry of vitamin A and its provitamins and congeners. This is followed by a very lucid account of the physiology and biochemistry of vitamin A and of its provitamins, elaborating on such topics as conversion of provitamins to A and the absorption, storage and distribution of this vitamin in the body. In the next two chapters, the author has described, with the help of a number of excellent photographs, the pathological conditions in vitamin-deficient state as well as under excess vitamin A intake, and has also discussed the role of vitamin A in the human.

Among special topics, mention may be made of the status of vitamin A in farm and domestic animals, the interrelationship which exists between vitamin A and the thyroid and the influence of vitamin A on the sex organs.

Further, though the mode of action of vitamin A is not completely understood at the present day, the author has endeavoured to present a very readable account of the same from clear-cut evidence available in the existing scientific literature. In the last chapter on the assessment of our present knowledge of vitamin A, the author recounts some of the salient features and indicates, at the same time, the gaps in the field where information is lacking. There is a very useful appendix of methods, where detailed instructions have been given for such routine determinations as for carotene and for measurement of vitamin A by chemical and spectrophotometric methods.

While the get-up of the book is excellent, there are a few misprints noticeable such as in pages 172, 206 and 213 which could have been easily corrected at the proof stage. Further, the author appears to repeat certain references in several chapters and one wonders whether the size of the book could not have been appreciably reduced by having only one list of references in alphabetical order at the end of the book. Private communications have also been quoted rather frequently which appears to detract somewhat the authoritative nature of the publication. In fact, one private communication has been printed in page 313 as having been made as far back as in 1942 and it is surprising that reference to published work cannot be made to that finding in 1957. However, these should be considered only as minor blemishes in what is otherwise a well-documented and readable account of this vitamin in all its various aspects. It must indeed have been a herculean task for the author to distinguish the wood from the trees while preparing such a monograph. Biochemists, nutritionists and members of the medical profession will find this volume extremely useful and even indispensable as a reference treatise on vitamin A.

P. S. SARMA

PRINCIPLES OF ENGINEERING INSPECTION by Geoffrey K. King & C. T. Butler (Elsevier Publishing Co., London; *Distributors*: Cleaver-Hume Press Ltd., London), 1957. Pp. viii + 264. Price 25*s*.

The book deals with the inspection of metallic and non-metallic raw materials used in industry, including the inspection and testing of finished products. Critical examinations of machined components, design and manufacture of limit gauges, examination methods and procedures employed for jigs, fixtures and other tools of production have been well discussed. The importance of time in inspection, both as a measure of economy of skill and minimizing production of faulty parts has been emphasized. Necessary methods have been outlined to achieve the purpose.

The book has an introductory chapter on Statistical Quality Control. On page 235, under the head ' control chart ', it is stated that the ranges W or standard deviations σ determined from the sample are plotted. Though the plotting of σ is theoretically sound, in the opinion of the reviewer, this does not agree with popular practice where only the sample ranges and not the standard deviations are plotted. This is done for reasons of convenience and without any prejudice to the sensitivity of the control.

On page 243, in connection with the fraction defective chart for quality control, the sample size and the frequency of sampling suggested are such that at least 5 per cent of the product is sampled. The reviewer is inclined to disagree with this and would suggest sample size and sampling interval to be so fixed that about 20 per cent or more of the product is sampled.

Position gauges and receiver gauges, the two names used so often synonymously, have been treated in this book separately without establishing a clear distinction between them. Design considerations in regard to receiver gauges could have been usefully elaborated and illustrated by suitable examples.

The inspection of gears, splines and serrations has not been included in the book. Similarly, pneumatic and electrical comparators seem to be an important omission. It is hoped these items will be included in the next edition of the book to make it complete and comprehensive.

The book is well written and abounds in useful illustrations. Line diagrams to illustrate the principles of action of instruments have been successfully used. Basic principles have been discussed in support of suggestions given for use in practice. The book will provide a useful text to students and teachers of workshop technology; inspectors and managers in industry will find this volume a useful reference source.

R. MISHRA

ENGINEERING ELECTRONICS WITH INDUSTRIAL APPLICATIONS by John D. Ryder (McGraw-Hill Book Co. Inc., New York), 1957. Pp. x + 666. Price $ 9.50

The United States of America has contributed a great deal towards the development of electronic engineering. Naturally, therefore, the scope and content of a teaching schedule at the university level in the States is constantly under careful review in all branches of engineering but, more particularly in electronics. The book under review represents the dynamic state of affairs in the teaching of electronics. The author states in the preface that many arbitrary decisions have been taken by him for including or excluding material from the scope of this book. It appears to the reviewer that the author's decisions are well-considered and sound, and he should be complimented for the same.

The book is primarily addressed to persons engaged in the application of electronics in fields other than radio communication. The first of the seven chapters running to 206 pages deals with the routine theory of vacuum tubes and vacuum tube amplifiers but the treatment is quite refreshing and rigorous. The seventh chapter is devoted entirely to feedback and this is most welcome as this principle is important in the applications of electronics. There follows a chapter on direct-coupled amplifiers and computing amplifiers, a chapter on switching circuits and digital computation, etc. Power supplies and voltage regulation comes up for a coordinated treatment in one chapter which is followed by a chapter on class C amplifiers, power oscillators and high frequency heating. This is rather a weakness as the reviewer feels that high frequency heating merits a separate chapter by itself. Semiconductors, photocells, power rectification, power control and inversion, relays, timers and resistance welding, electronic motor control and servomechanisms come up for treatment in separate chapters. At the end of each chapter, there are problems and a useful list of references which are carefully selected. There is a useful index.

The subject matter of each chapter is well arranged and the presentation is clear. Diagrams are well drawn and the printing and get-up are of the usually high standard of McGraw-Hill publications.

The reviewer feels that the book should broadly represent the scope of a very desirable syllabus in electronics for power engineering students in Indian universities. It is an extremely useful book for our graduate students in physics who have to deal with the diversified applications of electronics in instrumentation and control. Research students employing electronic methods for experimental work will find the book very valuable. The book should find a place in all science and engineering college libraries. Having regard to the scope and range of the subject matter in the book, the price is reasonable.

S. V. CHANDRASHEKHAR AIYA

SOILS AND SOIL FERTILITY by Louis M. Thompson (McGraw-Hill Book Co. Inc., New York), 1957. Pp. ix + 451. Price $ 6.50

It has been stated in the preface that: " This book has been prepared for use as a text for an introductory course in soils for students in agriculture ".

Soil science " is a field of expansion and rapid advancement. But most agriculture students take only one course in soils, and that course must be broad enough to generally cover the field and yet provide a foundation for the student who becomes a soils major."

The book is divided into the following chapters: Introduction; Physical Properties of Soils; Soil Moisture; Organic Matter of Soils; Chemical Composition of Soils; Soil Formation and Classification; Clay Minerals, Acidity and Alkalinity; Principles and Practices of Liming; Nitrogen; Phosphorus; Potassium; Fertilizers; Utilization of Farm Manure; Sulphur and the Minor Elements; Variations in Plant Composition; Crop Rotations and Soil Fertility; Soil Erosion and Its Control.

It is only too true as mentioned by the author in the preface that soil science is a field of expansion and rapid advancement and it is not easy to ensure a proper balance between basic theoretical principles, experimental results and techniques and useful information of practical interest to a farmer. The author has successfully maintained such a balance and provided a course which is " broad enough to generally cover the field and yet provide a foundation for the student " who wants to prosecute further studies in soil science and its applications. The book gives a survey of the whole field of soil science and soil fertility and experimental data have been selected with care and the basic principles have been illustrated with graphs and sketches which constitute a special feature of the book. The work on soils in U.S.A. and especially in the State of Iowa has received special attention. This is understandable as the book is primarily meant as a text for students of the Iowa State College with which the author is associated as a Professor of Soils and in charge of the Farm Operation Curriculum. This approach has not militated against a treatment of the basic principles and experimental results of general usefulness. The exposition of the subject matter is very lucid and cross references to pages of the book have been minimized although this has involved a certain amount of repetition. Almost half of the book deals with exposition of subjects of practical interest to the farmer and an educated farmer will find these chapters very useful. The chapter on Crop Rotations and Soil Fertility is of special interest to Indian agriculture in which continuous cropping with non-legumes is a necessity because of the low per capita land available for cultivation. The author has cited experimental data to show that " there is no reason to fear any permanent damage to soils by continuous cropping of clean-tilled crops as long as erosion is under control. The fertility level can be maintained by use of commercial fertilizers and lime where needed." It has been possible to maintain adequate yields of continuously cropped sugarcane in some countries and this also seems to be true of paddy. However, the choice of a suitable rotation becomes very important in some countries like India where the same plot of land has to produce food for man and beast and also raw materials for industries. Suitable rotations have maintained the yield of paddy at a high level in several countries and the study of such rotations is quite important under our conditions.

One hesitates to offer any criticism when reviewing a book which is so well written. It seems that it may be a little difficult, if not confusing, to students who have been assumed to have a very elementary knowledge of basic principles of physics, chemistry or plant physiology, to understand some of the theoretical subjects dealt with. This is perhaps true of the discussions on cation exchange and base saturation and problems related to them. However, the very useful references given at the end of each chapter, if followed up, should enable the student to have a critical insight into the basic principles. A subject which might have received more direct treatment is that of soil microbiology and also to a certain extent the methods of irrigation and other aspects of the best utilization of irrigation water.

These remarks do not in any way detract from the merits of the book. Students and teachers of soil science in agricultural institutions will find it very useful.

J. N. MUKHERJEE

SOLVENTS by T. H. Durrans (Chapman & Hall Ltd., London; *Distributors in India*: Asia Publishing House, Bombay), Seventh Revised Edition, 1957. Pp. 244. Price 30*s*.

The use of solvents is very much interlinked with the plastics industry in general and lacquers in particular. The revised seventh edition of the book containing a survey of the specific solvents may, therefore, be said to be the need of the time. The book is divided into two parts: Part I deals with the fundamentals of the scientific principles involved in evaluation and selection of specific solvents and Part II with a host of organic solvents and their properties and specification requirements.

The author has clearly explained the basic scientific principles in Part I such that anybody having a broad scientific education can understand the ideas contained therein. This is particularly necessary because the people in plastics industry may not have advanced scientific education. The problem of selecting proper solvents for a particular purpose is made easy. The chapter on toxicity is a welcome one as we generally do not pay much attention to the harmful effects of solvents with which the health problem is vitally interconnected.

The author has taken pains in selecting appropriate organic solvents from the vast literature on the subject. The presentation is well planned and compact. There can be no doubt about the usefulness of the book which has already proved its worth by having gone into six editions prior to the present one.

A. N. BASU

MICROWAVE MEASUREMENTS — International Series in Pure & Applied Physics — by Edward L. Ginzton (McGraw-Hill Book Co. Inc., New York), 1957. Pp. xvii + 515. Price $12.00

The short wavelength region of the radio spectrum adjacent to the far infrared is commonly identified by the word ' microwave '. Work in this region of the spectrum, which was initiated during the last World War, has indeed been considerable and rapid during the last decade. Research and development plans are so numerous in recent years that a student taking up microwave study today is confronted with a maze of theoretical and technical details published in various journals and books. A book on modern microwave techniques and measurements providing basic principles and methods of electrical measurements in the microwave region of the electromagnetic spectrum, by Prof. E. L. Ginzton, is, therefore, extremely welcome. It may also serve as a microwave-measurement reference book.

The book was to have been written in collaboration with Prof. W. W. Hansen, whose lectures, delivered at the Massachusetts Institute of Technology, contained a wealth of information. Due to his untimely death in 1949 and the delay in the publication of the book, the original plan, scope and emphasis were changed considerably to keep pace with the recent developments. Prof. Ginzton deserves great credit for bringing out this remarkable book which is hallowed by the memory of his distinguished professor and collaborator at the Stanford University.

There are eleven chapters with two appendices. In Chapter I, the theory of klystron behaviour and the practical aspects of the different kinds of klystrons, microwave triode oscillators, travelling-wave tubes, backward-wave oscillator, etc., are clearly discussed. Under isolation of laboratory oscillators are described the attenuating pads and ferrite isolators. Various transmission modulators, power suppliers and frequency stabilization of laboratory oscillators, standard signal generators, crystal rectifier harmonic generators, etc., have also been incorporated in this chapter. Microwave power detection and measurements are included in Chapters II and III. The concepts of impedance at microwave frequencies are important and fundamental. The behaviour of electromagnetic waves in bounded regions and a partial presentation of the transmission-line theory in connection with the standing wave phenomenon form the subject matter of Chapter IV. Besides, the basic definitions of *normalized voltage and normalized current* have been derived in this chapter. The microwave circuit theory in analogy to the conventional circuit theory is also given permitting a systematic approach to the problems of design and testing. For a more detailed discussion of these topics, however, one has to refer to other published literature such as *Principles of Microwave Circuits* by Montgomery, Dicke and Purcell and also to the forthcoming book on " Microwave Theory " by Jaynes. Impedance measurements in the microwave region are fully discussed in Chapter V. In Chapter VI the author has described the T and π networks and other canonical networks with detailed representation and measurement of microwave circuits. While the measurements of wavelengths and frequencies are detailed in Chapters VII and VIII, the measurements of Q of resonant cavity and of R_0/Q_0 are discussed in Chapters IX and X. The different methods of measuring microwave attenuation are elaborated in Chapter XI. A discussion of some important topics, such as transmitter and receiver characteristics, antennas, propagation, measurement of physical properties of materials, microwave spectroscopy, paramagnetic resonance, etc., has been omitted to allow a more complete treatment of material regarded as fundamental.

The two appendices give field configurations and cut-off wavelengths for common waveguides and certain useful formulae and constants.

In short, Prof. E. L. Ginzton has given in this well-written book the essence of all microwave techniques and measurements, the details of which are discussed in the books of the Radiation Laboratory Series and in the publications of the work of the Research Laboratory of Harvard University and of the Bell Telephone Laboratories. Numerous references to these and other sources of information are to be found throughout the book. One recognizes at a glance and appreciates the fundamental approach to the various problems in the microwave field that has been presented in a logical and analytical manner. For this, the author is to a great extent indebted to his late professor and colleague Dr. W. W. Hansen who may be regarded as the founder of the modern microwave techniques. There is no doubt that the book is an important contribution to the literature on modern applied science.

S. R. KHASTGIR

QUANTUM CHEMISTRY — AN INTRODUCTION by Walter Kauzmann (Academic Press Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1957. Pp. 744. Price $ 12.00

This book is intended primarily for chemists but contains a substantial proportion (more than half) of mathematics and physics necessary for a satisfactory understanding of quantum ideas relevant to a chemist.

In the first few chapters, the theory of partial differential equations, ideas about determinants, vibration theory and normal modes are developed at some length. These are followed by a very satisfactory account of the general principles of quantum mechanics and some of the more important applications. These aspects fill the first two parts of the book. Parts III and IV are more directly related to chemistry and deal with atomic and molecular systems from the quantum mechanical standpoint. Part V again deals with certain aspects of optics, such as the interaction of matter with light, which are more closely related to physics than to chemistry. Such distinctions are, however, tending to disappear as a result of increasingly large areas of overlap between different fields of knowledge in recent times. In fact, this book is an illustration in a very full measure of the widely accepted fact that an advanced student of chemistry needs now to know a great deal of mathematics and physics and there is no doubt that he will be in a position to do so only if the latter subjects are presented to him in an ' understandable ' form. The author of the book under review has succeeded in such an attempt to a very large extent. The chapter dealing with the basic mathematical concepts is, indeed, very well written.

Even as it is, the book is voluminous and it has been mentioned in the preface that because of limitations of space, it has not been possible to discuss certain topics of interest to many chemists. It is somewhat disappointing to see that though much space has been devoted to light scattering and molecular structure, no mention has been made of the Raman effect. Similarly, chemical bonds and Van der Waals forces have been discussed at great length, but an accepted concept like the hydrogen bond has not come in for consideration. These omissions do not in any way diminish the usefulness of the book, which, in the opinion of the reviewer, constitutes an excellent addition to the collection most necessary not only to the theoretical chemist but also to the student of quantum mechanics.

S. BHAGAVANTAM

STRENGTH OF MATERIALS by G. H. Ryder (Elsevier Publishing Co., London; *Distributors*: Cleaver-Hume Press Ltd., London), Second Edition, 1957. Pp. xx + 645. Price 76*s*.

The book has been planned and written in such a way that it provides concisely what an engineering student appearing for an examination needs. The subject matter dealt with meets this demand, provided the student has undergone a course of lectures in the class. The book may well be classified as notes on strength of materials with worked examples. Extreme terseness has been employed in presenting the basic principles involved. The physical behaviour of stressed bodies has not been emphasized; only the mathematical expression of this behaviour is given. The treatment thus lacks in clarity, and in explanations and discussions which are desirable in any text for undergraduates.

The whole subject, including the recent advances like photoelasticity, stress concentration, experimental stress analysis, etc., is spread over 334 pages in 19 chapters. There are in all 161 worked examples and 196 problems set for solving, and 32 references out of which 15 are on the last chapter only. In view of the vast published literature on the topics, the references given are meagre. The text contains clear and nicely prepared sketches.

B. M. BELGAUMKAR

DER ULTRASCHALL *Nachtrag* ZUM LITERATURVERZEICHNIS DER 1954 ERSCHIENENEN 6. AUFLAGE (Ludwig Bergmann, S. Hirzel Verlag, Stuttgart), 1957. Pp. 66. Price DM 9

Those working or interested in the field of ultrasonics are familiar with Prof. Bergmann's monumental treatise *Der Ultraschall*. The latest edition of this well-known book, which appeared in 1954, contains, besides an elaborate treatment of the subject, a bibliography of over 5000 original papers. Since then, a large number of papers on various aspects of ultrasonics have appeared. As a revision of such an exhaustive treatise is not possible within so short a period, Prof. Bergmann had produced the booklet under review which is a literature index to over 2000 papers together with their subjectwise classification. The booklet forms a valuable supplement to the main volume (1954 edition) and will be greatly welcomed by researchers in ultrasonics all over the world.

S. PARTHASARATHY

SURVEY ADJUSTMENTS AND LEAST SQUARES

by H. F. Rainsford (Constable & Co. Ltd., London), 1957. Pp. viii + 326. Price 50s.

The author's avowed aim is to provide a reference manual on the adjustment of observations for the survey profession. After a preliminary discussion of the Normal Law of Error, the author devotes some 55 pages to the formation and solution of normal equations and obtaining standard errors. This, in the reviewer's opinion, is by far the best part of the book and the drill advocated by the author as a result of his experience in this line would be helpful to computers and research workers in other branches of science. Such geodetic and geophysical problems as adjustment of gravimeter circuits, determination of calibration constants of gravimeters, determination of parameters of figure of earth, reduction of astronomical observations, etc., demand an expert knowledge of these methods.

It would have been useful if the author had more to say about unstable equations. For these, it can so happen that the equations may be satisfied to six places and yet the solution may not be correct to more than one decimal place. What is the test of instability and what is the remedy?

Also some guidance might have been provided for the novice to tell him what happens if there are one or two redundant condition equations or if two observation equations are exactly identical but only their right-hand sides are different. Some idea of the man-hours required for solving a given number of normal equations would have been of considerable interest.

The main stress is on the adjustment of triangulation which takes up nearly half the book. A full account is given of the difference between adjustment by angles and by directions and the conclusion is reached that least square solution by angles gives better results than by directions.

Chapter VI deals with station adjustments; these only arise when angles are observed in different combinations. This chapter, occupying 25 pages, is unduly laboured and some space could profitably have been devoted to other matter.

Chapters VII and VIII are concerned with the rigorous and approximate methods of figural adjustments; the procedures are explained by suitable numerical examples.

Circuit adjustments are dealt with in Chapter X. The problem in this case is as follows: several series of triangulation in terms of same datum and same spheroid are observed throughout the extent of a country. In addition, several base lines and Laplace stations are available; to find corrections to observed angles so that all the closure errors are satisfied.

There are several methods of doing this. The author gives the least square method but there is no mention of the famous Bowie method developed in U.S.A. which has several important features and is very widely used. There is also the slide-rule method employed by the Survey of India in their 1937 adjustment and described in detail in their *Professional Papers No.* 28. Perhaps no country in the world has made use of such a method for dealing with their primary triangulation. An appraisal of the various methods of adjustment in different countries would have been of considerable assistance to workers in this field. The important method of variation of co-ordinates is dismissed in one paragraph (11.12); it surely deserves a more detailed treatment.

Not many people will agree with the statements in paragraph 10.43. The use of Laplace azimuths in triangulation circuit adjustments is well established nowadays and an astro-geodetic adjustment diminishes the systematic distortion.

There is yet another important aspect of adjustment which has not been touched in the book at all. This is when different triangulations of a continent are on different spheroids and different data; European Triangulation Net is an example. Here some additional complications come in, such as reducing all the computations to a single datum, same spheroid and to a common unit of length — by no means a straightforward task.

Level and traverse networks receive a very condensed treatment in Chapter XI; it is not possible to do justice to them in such a short chapter. The theory of levelling errors and the problem of determining the precision of levelling networks is very complicated and has been receiving special attention in recent years at the meetings of the International Union of Geodesy and Geophysics. There are no references to recent work on this subject in the bibliography and the student will not get much help from this chapter.

The trigonometrical heights are dealt with adequately by least squares (p. 225) but it would have been worthwhile to include semi-rigorous methods for the adjustment of heights. Similarly, Bowditch's method of traverse adjustment and its modified variant should have found a place. There never will be a consensus of opinion on universal application of least squares, especially so long as the uncertainty of ascribing appropriate weights remains and the common-sense methods of adjustment in work of moderate precision will play an important role.

Chapter XI, on Some Special Problems, is of great interest. It embodies such new subjects as geodimeter bases, radar trilateration, apospheric projections, aerial triangulation, etc., and yet there are certain important omissions. The capabilities of modern electronic computers or even punch card machines for the solution of large number of simultaneous equations in one cast are not touched upon. It would broaden the outlook of the reader to know that the Univac electronic computer, which the Americans use, sets its own observation equations, prepares and solves normal equations, makes the back solutions, applies residual corrections and prints out finally adjusted co-ordinates. It is self-checking throughout all operations and it is possible to insert further condition equations on the machine when required to hold bases or Laplace azimuths. These have made possible the adjustments of vast triangulations in one whole rather than by dividing them into parts and adjusting each part separately.

It is also disappointing to find no account of the application of relaxation methods to adjustment problems; they are capable of some neat work.

The author has very wisely refrained from cluttering the book with mathematical proofs of several well-known theorems on the subject and, on this account, the text is easily read. Its treatment of adjustment in various branches of survey is essentially practical; the exposition is clear and concise and the letter-press is excellent and remarkably free from printing errors.

The index is rather incomplete. 'Student's Distribution' on page 296 and 'Standard error of Standard error' on page 298 do not find a place in it. Incidentally, a numerical example would have been very welcome with the latter.

With all its limitations, this should be a good reference book for computers and would undoubtedly form a useful addition to a surveyor's library.

B. L. GULATEE

PUBLICATIONS RECEIVED

THE MEASUREMENT OF COLOUR by W. D. Wright (Hilger & Watts Ltd., London), 1958. Pp. ix + 263. Price 52*s*. net

FLAME PHOTOMETRY by F. Burriel-Marti & J. Ramirez-Munoz (Elsevier Publishing Co., Amsterdam, London, New York, Princeton; *Distributors*: Cleaver-Hume Press Ltd., London), 1957. Pp. xii + 531. Price 65*s*.

WELDING HANDBOOK: PART I — BASIC PRINCIPLES & DATA by Arthurhl Phillips (American Welding Society, New York; *Distributors*: Cleaver-Hume Press Ltd., London), 1958. Pp. 555. Price 72*s*.

PLANT DESIGN AND ECONOMICS FOR CHEMICAL ENGINEERS by Max S. Peters (McGraw-Hill Book Co. Inc., New York, Toronto, London), 1958. Pp. xi + 511. Price $ 11.00

INTRODUCTION TO HEAT TRANSFER by Aubreyi Brown & Salvatore M. Marco (McGraw-Hill Book Co. Inc., New York, Toronto, London), 1958. Pp. vii + 332. Price $ 6.75

ESTIMATING MACHINING COSTS by C. W. S. Parsons (McGraw-Hill Book Co. Inc., New York, Toronto, London), 1957. Pp. xviii + 366. Price $ 8.00

NOTES & NEWS

Thermonuclear power production

RESEARCHES DURING THE PAST two years on the Zero Energy Thermonuclear Assembly (Zeta) at Harwell have led British scientists to the conclusion that control of thermonuclear fusion reactions for the generation of electricity may be possible in future. However, it is considered that the successful tackling of the many engineering problems of design and construction of the prototype of a practical and economic thermonuclear power station and the realization of its commercial applications may take 15 or 20 years more.

The significant scientific achievement of the experiments carried out on the Zeta is that temperatures of the order of 5 million degrees centigrade have been reached and have been held for a few thousandths of a second. These temperatures have been repeated every 10 sec. for long periods of time. The results also suggest that ' thermonuclear neutrons ' have been obtained; this needs confirmation.

The process studied in the Zeta is the reaction in which deuterons collide with one another and fuse to form heavier nuclei releasing energy and also some neutrons in the process. A large electric current is passed through deuterium gas which sets up an electric discharge and heats it and also produces an intense magnetic field around the column of hot gas. This magnetic field causes the discharge to become constricted and hence heated still more. Since it also causes the discharge to wriggle about this field itself, it is not enough to keep the discharge away from the walls. The wriggling has been suppressed by applying an additional steady magnetic field parallel to the axis of the tube.

In the Zeta, the number of neutrons produced by each pulse of energy, as the current is doubled, is roughly the number which might be expected from a thermonuclear reaction at the temperatures attained and measured. But electric fields in the gas arising from instabilities can also accelerate deuteron ions and their collision with stationary ions may lead to thermonuclear reactions; they may also be produced due to the bombardment of deuterons with the walls of the vessel. The exact process of neutron production is being studied in detail.

At present, the energy produced in the fusion reaction is only about one millionth of a millionth of the input. To release more and more energy higher temperatures should be attained and maintained at that value for considerably longer periods. It is proposed to realize this, in the first instance, by increasing the current circulating by providing more condensers in the Zeta and its successors.

In order to obtain a net gain in energy from the reaction, it would be necessary to heat the deuterium gas to temperatures of *c.* 100,000,000°C. and to maintain it at those temperatures long enough for the nuclear energy released to exceed the energy needed to heat the fuel and that lost by radiation. Lower temperatures suffice for a deuterium-tritium mixture.

If it is proved, ultimately, that it is possible to construct a power station operating on the fusion of deuterium, the oceans which contain immense quantities of deuterium will provide the most economic and virtually inexhaustible source of fuel. Five gal. of water will yield 1 g. of deuterium. This costs only 2*s.* to produce but contains an energy equivalent to 10 tons of coal. It has been estimated that the world's resources of coal and oil will last for 100 years, of uranium and thorium for about 200-300 years, and of deuterium from sea water for a thousand million years [*British Information Services, Release No. BF* 155].

Conversion of chemical energy into electricity

THE DIRECT CONVERSION OF CHEMICAL energy released by the reaction between oxygen and hydrogen gases into utilizable electric power up to a few kW. has been accomplished at the Research Laboratories of the National Carbon Co., U.S.A., employing a conventional fuel cell. This development represents the first practical fuel cell which can operate efficiently in the ambient temperature range 40°-120°F. and at atmospheric pressure. The heavy and costly pressure vessels required for efficient operation of conventional cells are no longer necessary [*see* this *Journal*, **15A** (1956), 515].

The new fuel cell consists of a sealed jar into which hydrogen and oxygen are fed through special chemically treated hollow, porous, carbon electrodes. The electrochemical reaction of the gases at these electrodes produces an electric current with only water as the byproduct. The efficiency of operation of the new fuel cell depends on how it is used and generally ranges from 65 to 80 per cent at normal temperatures and pressures. The optimum fuel cell design can produce *c.* 1 kW. of power from a package unit of volume 1 cu. ft. The voltage across the electrodes is *c.* 1 V. Varying the number and size of cells, many combinations of voltages and currents can be obtained. For producing smaller amounts of power, hydrogen and air can be used, but for higher current densities the air is to be replaced by pure oxygen. The cell can also operate with standard industrial grades of commercial purity hydrogen. The new fuel cells are at present used to power Army ' silent sentry ' radar sets [*Mech. Engng*, **79** (1957), 1050].

Dry batteries operating at temperature extremes

DRY BATTERIES WHICH DO NOT involve any moving parts and which can work efficiently at temperatures as low as −58°F. and as high as 275°F. were described at the Electro-Chemical Society meeting held recently in Buffalo, N.Y. These batteries are smaller and lighter than conventional liquid batteries of the same degree of efficiency.

One group of batteries which can operate efficiently at −58°F. were developed at the Eastman Kodak Co., Rochester, N.Y. They contain compounds that can react with ammonia to form ammonium compounds with release of energy. The batteries are activated by the addition of ammonia gas. They can be tested by adding ammonia gas and can be deactivated for storage by removing the gas with a vacuum pump. These batteries have been used to operate lamps and small equipment at −58°F.

Another group of batteries designed for use in electronic equipment and capable of satisfactory performance up to 275°F. have been developed at the General Electric Co. Research Laboratory, Schnectady, N.Y. A major ingredient of the batteries is silver iodide which increases the activity of the cells as the temperature of the battery increases. The chief applications of these batteries are in the operation of photomultiplier tubes, scintillation counters and other electronic devices.

The new batteries may lead to the development of thermocells and could be a source of power that is normally non-producing but is activated by heating it [*Sci. Newslett., Wash.*, **72** (1957), 248].

New type of permanent magnets

NEW EXPERIMENTAL MAGNETS developed at the General Electric Research Laboratory, Schnectady, N.Y., by aligning the particles of the magnetic material at low temperatures, can resist dealignment by any method other than being subjected to high temperatures. The magnets show promise as efficient permanent magnets. These magnets exhibit a hitherto unknown phenomenon, called 'exchange anisotropy'; it was the first new magnetic anisotropy ever reported in the last 60 years. Anisotropy implies a certain easy alignment of magnetization.

The magnets are made by putting an oxide coating over very small particles of a magnetic material such as cobalt metal. The particles, when packed together at low temperatures in a strong magnetic field, form a very powerful magnet which cannot be demagnetized by another external opposing magnetic field. This is due to the 'exchange anisotropy' effect by which the oxide coat shields the magnetic anisotropy of the metal atoms in one direction. At low temperatures, the oxide coat on the metal particles which is unaffected by magnetic fields can magnetically align the metal atoms. At higher temperatures, the oxide molecule rows themselves get disorderly and cannot effect the magnetic alignment of the metal atoms [*Sci. Newslett., Wash.*, **72** (1957), 265].

Stable liquid hydrogen

AS A RESULT OF THE RESEARCH work conducted at the U.S. National Bureau of Standards' Cryogenic Engineering Laboratory, Boulder, Colorado, under the sponsorship of the U.S. Atomic Energy Commission, an inexpensive, simple technique has been developed to store (for long periods) and use pure liquid hydrogen. The technique involves the large-scale conversion of the unstable *ortho*-hydrogen to the stable *para*-hydrogen, by using chemical catalysts. This is effected by treating the *ortho*-hydrogen with hydrous ferric oxide, which acts as a catalyst. This development makes possible for the first time, the storage in ordinary Dewar-flask containers of liquid hydrogen either on ground or aboard rockets and avoids the cumbersome, heavy, constantly operating refrigerators. As pure liquid hydrogen releases more heat energy and imparts more thrust per unit of weight than even the highly energetic fuels like lithium and boron hydride now being used as rocket fuels, this may ultimately lead to larger, faster and more powerful rockets and missiles [*Sci. Newslett., Wash.*, **72** (1957), 277].

Low-cost water purification

AN EXPERIMENTAL PLANT FOR THE purification of water for community or industrial needs at half the cost of that by other methods has been developed by Messrs William Boby Ltd., Rickmansworth, England, in association with TNO, Holland and the Chemical Research Laboratory of the D.S.I.R., England. The plant, meant to desalt brackish water at Tobruk, Libya, uses the electrodialytic membrane desalting process and can treat water containing about 5000 p.p.m. of dissolved solids.

In this plant, brackish water to be treated flows through a cell formed from two ion-permeable polystyrene membranes. One of the membranes is permeable to positive and the other to negative ions. A small electric current is passed through the cells between two electrodes situated outside it and rinse water, i.e. water to be purified flows in the electrode compartments. The ions forming the salinity in the brackish water are attracted towards the electrodes according to their electrical charge, and pass through the membranes and into the rinse water flowing through the electrode compartments, and are discarded.

The plant can produce a minimum of 40 tons (using 200 membranes) of potable water per day at a cost of 5*s*./1000 gal. compared to the 11-12*s*./1000 gal. for an orthodox evaporator. The plant needs *c*. 7 kWh. of power for desalting 1000 gal. of 5000 p.p.m. salt water. The water produced is more potable than that by distillation because all the dissolved gases have not been removed. Corrosion risks are reduced to the minimum by the extensive use, in the plant, of plastics piping and valves; the *p*H control provided prevents deterioration of the plant as a result of the precipitation of calcium and magnesium. One ml. of hydrochloric acid is sufficient to treat 8 gal. water and forms entirely soluble salts with calcium, magnesium and sodium [*Chem. Age*, **78** (1957), 405].

Laboratory preparation of C^{13}

A SIMPLE, INEXPENSIVE METHOD for producing enriched C^{13} (as barium carbonate) has been developed at the Chemistry Department, University of Michigan, Ann Arbor. The method makes use of the difference in the rates of isotopic reactions. According to the kinetics of the reaction when a competitive irreversible isotopic reaction is carried out to a high extent of completion, the residual unconverted substrate becomes exponentially enriched in the heavier isotope. The dehydration of formic acid with sulphuric acid has been carried out for C^{13} enrichment by using the above technique. In this study eight experiments were carried out with a number of minor variations in procedure. The initial quantity of formic acid ranged from 1·2 to 132 moles. The procedure for the largest-scale run (132 moles) is as follows. Precooled sulphuric acid (technical, 93 per cent, 18 lb.) is added slowly to formic acid (80-90 per cent, 15 lb.) cooled to 0°C. After 5 hr. at 0°C., the rate of evolution of carbon monoxide greatly diminishes. The solution is then allowed to warm up to room temperature and is transferred to a 12-litre flask. During the next 48 hr., sulphuric acid (55 lb.) is added in instalments. After 92 hr., when the rate of gas evolution is quite slow (3-5 ml./min.), 5 lb. sulphuric acid is added and the first collection of the gas started. The carbon monoxide is swept out of the flask by bubbling a slow stream of dry, CO_2-free air through the solution. The gases then pass through an Ascarite tube (to remove possible CO_2 formed from some trace impurity), then through a copper oxide tube (450°C.) into a gas washing bottle containing ammonium hydroxide. After 13 hr., the collection is stopped and the C^{13} enriched carbonate is precipitated from barium chloride solution, washed, filtered and dried. The carbon dioxide evolved from one-tenth mole of this $BaCO_3$ has been found to be 33·2 per cent enriched in relation to a reference sample of CO_2 obtained from quantitative oxidation of formic acid (which itself happens to be 1·1 per cent enriched in relation to tank CO_2). The study of relative isotope abundance ratios is made on the isotope ratio mass spectrometers. An average enrichment of 38·6 per cent of C^{13} is obtained from three samples, two collected over a period of one week and one obtained by heating the flask for one day to decompose the residual formic acid [*Science*, **126** (1957), 119].

Fatty acids and cholesterol metabolism

THE POSSIBLE ROLE OF ESSENTIAL fatty acids, viz. linoleic, linolenic, and arachidonic acids, in the regulation of serum cholesterol levels has stimulated a great deal of research in order to determine a relationship between essential fatty acids (EFA) and cholesterol metabolism. These unsaturated acids exist in plasma of various species of animals mainly in combination with cholesterol and are necessary for growth, and maintenance of normal body processes. Studies have shown that the liver reflects changes in cholesterol metabolism much more sensitively than does plasma. The deficiency of fat and essential fatty acids in the diets of rats results in an increase in the cholesterol content of liver caused by an accumulation of cholesterol esters and consequently a decrease in plasma cholesterol and an increase in the total liver lipide. Cholesterol feeding to rats kept on an EFA-deficient diet hastened the appearance of the deficiency syndrome and an increase in total liver lipide. An interesting observation is that female rats, when fed on EFA-deficient diet for the same length of time as the male rats, did not exhibit cholesterol accumulation in the liver observed in the male animals. Evidently a sex difference exists in the need for essential fatty acids. The fact that an initial rise in cholesterol concentration, obtained on the hydrogenated coconut oil diet followed by a slow drop to normal, leads to the conclusion that perhaps the animal can use the short chain fatty acids contained in hydrogenated coconut oil for cholesterol esterification in the absence of essential fatty acids and that normal cholesterol metabolism is resumed. The effect of feeding linoleate, oleate and B vitamins to rats placed on EFA-deficient diets shows that there is a definite decrease in cholesterol concentration of liver and slight increase in plasma cholesterol in a group of rats supplemented with linoleate. Oleate and B vitamins were ineffective. Studies on the synthesis of cholesterol in the liver *in vitro* from C^{14} labelled acetate under several dietary conditions show that there is a marked decrease in the synthesis of cholesterol in the livers of rats fed on fat-free and the hydrogenated fat diet. In animals fed with fat-free diet supplemented with linoleate, the cholesterol synthesis is normal. It seems that synthesis is inversely proportional to the cholesterol present in the liver.

The iodine value of fatty acids associated with cholesterol esters in the livers of animals fed an EFA-deficient diet is much lower than the iodine values of the livers of animals fed on a diet containing fat or fat-free diet supplemented with linoleate. This low iodine value is reflected by the absence of polyunsaturated fatty acids. The same general pattern is obtained in the fatty acids of the phospholipide fraction.

These results have led to the formulation of the following theory of the interrelationship between essential fatty acids and cholesterol metabolism: (1) essential fatty acids are used for the esterification of cholesterol. From a purely physical point of view these unsaturated fatty acid esters are more labile; (2) in the absence of essential fatty acids, cholesterol is esterified with more saturated fatty acids, which are less labile and tend to accumulate. When a saturated fat containing short chain fatty acids is present, the animal adapts itself to the change; cholesterol becomes esterified with short chain fatty acids and a more or less normal cholesterol metabolism is resumed. Also, there may be reduced phospholipide synthesis and, therefore, interference with cholesterol ester mobilization and transport. It is possible that short chain fatty acids by combining with cholesterol are able to spare essential fatty acids for phospholipide synthesis. It is also possible that essential fatty acids are involved in certain enzyme systems which regulate cholesterol metabolism [*J. Amer. Oil Chem. Soc.*, **34** (1957), 574].

Reaction of sugars and aromatics

TWO OF THE CHEAPEST AND MOST abundant chemical raw materials — aromatic hydrocarbons and carbohydrates — have been found to react with each other in the presence of anhydrous hydrogen fluoride, and chemicals as diverse as detergents, petroleum additives, pharmaceutical plasticizers, resins, and germicides have been obtained. Some of the water-soluble compounds are surface active. The reaction is carried out in a stainless steel autoclave, a bath of dry ice being employed to cool the exothermic reaction. When the reaction is complete, the product is separated from excess hydrogen fluoride and purified. It has been observed that starch, cellulose and glucose react similarly. Any given pair of reactants gives several products, depending on ratios and conditions. A series of products in which the internal ratio of hydrophobic to hydrophilic parts varies widely can be prepared by adjusting the sizes of the aromatic and carbohydrate reactants. Aromatic derivatives such as phenols can be used to introduce functional groups into the structure. Two products have been prepared: 1-deoxy-1, 1-di-(*o*-xylyl)-D-glucitol is made from *o*-xylene and starch; 1-deoxy-1, 1-di-(*p*-hydroxy-phenyl)-D-glucitol is made from phenol and starch [*Chem. Engng News*, **35**(37) (1957), 84].

Synthesis of new active steroids

A ONE-STEP, HIGH YIELDING METHOD is described for the synthesis of four new pharmacologically active steroids, namely prednisone and prednisolone and their 9a-fluoro analogues. All the four show glucocorticoid and anti-inflammatory action in animals. The new route involves dehydrogenation of hydrocortisone and its derivatives with chloranil. When hydrocortisone is refluxed with chloranil in *tert*-butanol, an 80 per cent yield of Δ^6 dehydrocortisone is obtained while refluxing in xylene gives only 66 per cent yield. Refluxing of Δ^6 dehydrocortisone with *sec*- or *n*-amyl alcohol with excess of chloranil gives $\Delta^{1,6}$ bisdehydrocortisone. The same product can also be obtained by refluxing prednisolone with an excess of chloranil in *n*- and *sec*-amyl alcohol. Cortisone and prednisone behave the same way. The advantages of this dehydrogenation method over others are: (1) Yields as high as 80 per cent are obtained; (2) the dehydrogenation is selective as chloranil reacts with the common Δ^4-3 ketosteroids but not with other types (e.g. Δ^7 or $\Delta^{5,16}$ steroids); and (3) chloranil has no effect on ring substituents sensitive to other oxidizing agents [*Chem. Engng News*, **35**(37) (1957), 66].

Coumestrol, a new estrogen

A CRYSTALLINE COMPOUND, COUmestrol, possessing estrogenic activity has recently been isolated at the Western Utilization Research and Development Division, U.S. Agricultural Research Service, Albany, California, from several alfalfa samples as well as from a fresh strawberry clover. It is isolated by solvent extraction of dried meal followed by several countercurrent distributions, with final recrystallization from methanol. Coumestrol has the empirical formula $C_{15}H_8O_5$ and melts at 385°C. (decomp.). The formation of a diacetate and a dimethyl ether indicates the presence of two free hydroxyl groups in the molecule. Treatment of coumestrol with dimethyl sulphate under strongly alkaline conditions gives a trimethyl ether-monomethyl ester ($C_{19}H_{18}O_6$, m.p. 98°C.) which on mild alkaline hydrolysis gives a trimethyl ether acid ($C_{18}H_{16}O_6$, m.p. 178°C.). The formation of an acid by this means confirms the presence of a coumarin-like structure in coumestrol. Alkali fusion of the compound yields resorcinol and β resorcylic acid and no other identifiable phenols or phenolic acids. On the basis of the above reactions and the analytical data, a tentative structure for coumestrol was proposed which has been confirmed by the synthesis of the natural product in the laboratory. Coumestrol is considerably more potent than genistein but much less active than diethylstilbestrol [*Science*, **126** (1957), 969].

New tranquillizers

THE SYNTHESIS OF FOUR NEW classes of tranquillizers reported is based on the finding that many adrenergic blocking agents, when administered in near toxic doses, interfere with epinephrine action in the brain, and thereby bring on behavioural changes in animals. Working on this theory adrenergic blocking agents have been synthesized to act like psychosedatives by chemically modifying them to strengthen this chemical effect. Hundreds of adrenergic blocking agent derivatives have been synthesized and tested for tranquillizing activity. Potent and specific depressants have been obtained from piperoxan by making the tertiary amine function of piperoxan secondary. Peak activity comes with lower (C_2H_5-C_5H_{11}) aliphatic amino functions. In aromatic substitution, an 8-alkoxy function brings about maximum effect. Another type of tranquillizer has been developed from 1-ethyl-3-phenylpyrrolidine by replacing pyrrolidine ring with a piperidino function and 1-ethyl group by an oxygenated phenylethyl moiety; a series of central depressants, active as chlorpromazine, is obtained. A 2-methyl group in the piperidine ring changes this class of depressants into drugs that stimulate mice in a way similar to morphine. These compounds are neither narcotic nor analgesic agents. One group of tranquillizers is made from 1-methyl-4-phenylpiperazine. When an oxygenated phenethyl side chain replaces the methyl group a series of depressants, with one to 10 times the potency of chlorpromazine, results. More than 300 compounds derived from aminoethyl benzodioxanes have been made. Many are 10-20 times more powerful than chlorpromazine. Mice, when given chlorethoxybutanoxane, shed their dislike of being handled [*Chem. Engng News*, **35**(37) (1957), 68].

New organo-phosphorus pesticides

NIALATE, *bis*-[S-(DIETHOXYPHOSphinothioyl)-mercapto]-methane, developed in the laboratories of the Niagara Chemical Division of Food Machinery & Chemical Co., is very active against a variety of pests that attack cotton, citrus and deciduous fruit, and other crops. It is synthesized by reacting sodium O, O-diethylphosphorodithioate with either dibromomethane or bromochloromethane (yield 85-90 per cent). The technical product is a slightly coloured liquid with a mild odour. The pure compound is a water white, nearly odourless liquid. It is specially effective against two-spotted mite on cotton and has been used successfully in fighting rosy apple aphid and several other aphid species. It has relatively low toxicity to mammals.

The second pesticide is Phostex which is a mixture of *bis*-(dialkoxyphosphinothioyl)-disulphides. The most active component is the disulphide containing three ethyl groups and one *iso*propyl group. Phostex is prepared by first reacting a mixture of ethyl alcohol and *iso*propyl alcohol with phosphorus pentasulphide to form a mixture containing three dithiophosphoric acids. This mixture is then oxidized, forming a mixture of six disulphides. Maximum yield of the most biologically active component is obtained when the ratio of ethyl alcohol to *iso*propyl alcohol in the starting reaction is about three to one. The pesticide is a pale yellow oil with a characteristic ester-like odour. It has been specially developed for controlling various pests that attack deciduous fruit. It is effective in controlling the overwintering stages of certain mites, aphids and scale insects. It is particularly useful against the blister mite and bud mite complex on pears [*Chem. Engng News*, **35**(37) (1957), 87].

Preparation of pure niobium

A TECHNIQUE, CALLED THE CAGE zone melting, for the preparation of ultra-pure niobium metal, used as a high temperature structural metal, has been developed at the Westinghouse Research Laboratories, Pittsburgh. In cage zone melting a rectangular bar of impure niobium stands vertically on a movable platform, which moves the bar up and down inside a coil of heavy copper tubing. The coil and platform are enclosed in a sealed vessel under very high vacuum. When a strong high-frequency current is passed through the coil, corresponding currents are induced in the bar, which melts from the inside out. The four corners of the bar do not melt, but form a cage in which the molten niobium is trapped. The niobium bar thus serves as its own crucible in which the white hot metal is refined. As the bar rises through the coil, a molten zone of niobium travels down the bar from top to bottom melting the bar progressively throughout its entire length. Successive passes through the coil result in niobium of increasing purity as impurities are removed from the centre parts of the bar. Pure niobium shows promise for use in rockets, missiles, jet engines and nuclear reactors [*Industr. Chem. Mfr.*, **33** (1957), 578].

Plutonium separation

A NEW METHOD PROPOSED FOR the separation of plutonium fission products involves oxidation-reduction cycles between two plutonium oxidation states, Pu (IV) and Pu (VI) and depends upon the quantitative removal of plutonium from acid solution first by bismuth phosphate and later by lanthanum fluoride. Neutron irradiated uranium (the plutonium source) is dissolved in nitric acid. Sulphuric acid is then added to prevent uranium precipitation. Pu (IV) is co-precipitated with bismuth phosphate carrier. This precipitate is dissolved in nitric acid and plutonium oxidized from Pu (IV) to Pu (VI). A byproduct precipitate of bismuth phosphate is formed and removed. The Pu (VI) which remains in solution is reduced back to Pu (IV) and the latter again co-precipitated with $BiPO_4$ and the purification cycle repeated. At this point the carrier is changed to lanthanum fluoride and the oxidation-reduction cycle repeated to decontaminate and concentrate plutonium further. By this time the plutonium is concentrated sufficiently so that final purification is done without carrier compounds, and plutonium is separated as the peroxide from acid solution [*Chem. Engng News*, **35** (37) (1957), 73].

Effect of radiations on catalysts

THE EFFECT OF RADIATIONS ON the Fischer-Tropsch catalyst in the synthesis of hydrocarbons from carbon monoxide and hydrogen has been investigated. It was found that doses of radiation up to 2×10^7 r. effected no change in the activity of the catalyst or the composition of the products when using a reduced cobalt/thoria/magnesia/kieselguhr catalyst. A marked increase in the activity has been observed in the case of unreduced iron catalysts. The catalysts were prepared by impregnating iron oxide with potassium carbonate and calcining for 4 hr. at 1000°-1300°C. and irradiated in an atmosphere of nitrogen. As soon as the irradiation was completed, the samples were transferred to the catalyst testing units in an atmosphere of nitrogen and water gas. The doses of radiations used were in the range of $1\text{-}5 \times 10^7$ r. When particles of the catalysts in the size range 100-200 μ were used in a fluidized system, the rate of conversion of $(CO+H_2)$ increased by 10-40 per cent as a result of irradiation. The results obtained from experiments with irradiated catalysts show that the high activity of the irradiated samples remains throughout the test periods for 48-300 hr. Investigations on the effect of catalyst particle size on the synthesis suggest that the active part of the catalysts of this type is confined to a depth of 0·075-0·1 mm., that is, particles greater than 0·2 mm. have a region in the centre which is not available for the synthesis. Activity induced by radiation becomes apparent only when the catalyst granules are smaller than the critical size. A study of the activity/time graphs shows that during initial stages the irradiated catalyst is not significantly more active than the untreated catalyst and it is unlikely that primary changes produced by radiation (electronic excitation, lattice imperfections) are directly responsible for the increased activity, rather the irradiation produces changes which facilitate and extend the ' conditioning ' of the catalyst (partial reduction and the formation of iron carbides), which always takes place during the initial period of treatment under synthesis conditions, and which is accompanied by a marked rise in activity [*Nature, Lond.*, **180** (1957), 140].

Molecular weight determination of polymers

A METHOD BASED ON THE REPLACEment of hydrogen by deuterium and the determination of intensities of the infrared absorption of the end-groups has been developed for determining the number average molecular weight of polyethylene terephthalate polymer. The end-groups in terephthalate polyester are $-OH$ and COOH groups. Successive immersion of the polymer in fresh heavy water causes the replacement of these groups quantitatively by $-OD$ and $-COOD$. The dry polymer is burnt, the water produced is analysed for deuterium and the total number of end-groups calculated. The intensities of infrared absorption of $-OH$ and $-COOH$ are measured at 3 μ. Based on the determinations of total end-group content and the infrared intensities of the end-groups, a calibration method has been devised also for determining the total number of end-groups in any sample of polyethylene terephthalate directly from the intensities of the infrared absorptions. The number average molecular weight can thus be determined by the calibration method [*Nature, Lond.*, **180** (1957), 141].

Determination of sulphur in glass

THE TOTAL SULPHUR IN GLASS IN the range of 0·01 to 1 per cent SO_3 can be rapidly estimated by an induction furnace combustion method using the equipment generally employed in the determination of sulphur in iron and steel. The sulphur which is present as sulphate and sulphide in glass can be quantitatively volatilized in the induction furnace. A sample of powdered glass is weighed into the zircon crucible and the iron and tin accelerators are added. If arsenic is also present in glass, about 0·4 g. magnesium oxide is added. The crucible is covered and positioned in the apparatus. The oxygen flow is turned on and the furnace and automatic sulphur titrator are then put into operation [*J. Amer. ceram. Soc.*, **40** (1957), 352].

Microanalysis of inorganic compounds

THE RING OVEN, A NEW ANALYTIcal device, ranks amongst the most important advances in microchemical analysis. It has extensive application in many branches of microchemical analysis in industrial and research laboratories. For the present the method is confined to the analysis of inorganic substances which ionize in solution and the separation of the ions or groups of ions is brought about in a drop of the solution. A drop of the test solution is placed on filter paper and with the help of a suitable reagent it is possible to precipitate ions or group of ions and fix them locally in the paper. The unaffected ion can then be washed from the precipitate to the outer region of the paper by making use of its capillarity. The washing out process to remove solute from the precipitate results in a big moist fleck of irregular shape surrounding the central precipitate and containing the soluble ion in a very much diluted form. If only a little solvent is used for washing, the separation is by no means complete. These difficulties are overcome by the use of ring oven, the principle of which depends entirely on constraining the enlargement of the moist area during washing out process by enclosing it within a hot boundary. The ring oven is a cylindrical block of aluminium having a central hole of about 22 mm. diameter drilled out along its entire length. The block is fixed to a base plate of aluminium supported on three legs. An annulus cut out of the base of the block carries a spiral heating element, insulated from the metal of the block and having a resistance of about 30 ohms and operates at 24-30 V. supplied by a variable transformer. This enables the surface temperature of the block to be accurately controlled at the optimum working temperature of about 115°C. A glass tube fixed in an adjustable side-arm controls a capillary pipette, held vertically above the surface of the block and points exactly to its centre. A ceramic ring lies on the surface of the ring oven and holds the filter paper, used during the operation, in a fixed position. During the washing out process, the drop of the test solution on the filter paper spreads concentrically and eventually occupies the entire area of the central hole of the ring oven; but as soon as it reaches the metal boundary, the solvent evaporates and the solute in the drop accumulates in a sharply defined ring. The formation of a ring zone, the area of which does not exceed that of the original spot and in which a quantitative concentration of an ion or group of ions takes place, is thus an important part of the whole operation. The identification of ions is also possible in dilute solutions. As little as 0·1 μg. of common metallic ions in the whole ring can be detected. The ring testing procedure has many applications in qualitative analysis. If several ions are to be detected in a single drop of solution without any preliminary separation, the drop can be washed into a ring zone and the paper can then be cut into suitable number of sectors. Individual identification reactions can then be applied on each sector by making use of specific reagents. The systematic separation and identification of sixteen common elements contained in a single drop of solution can be effected in an exceptionally short space of time. The sharp ring zones are ideal for colorimetric comparison and a new analytical procedure, that of ring colorimetry, enables the quantitative or at least semi-quantitative analysis of minute amounts of sample. The ring oven procedure in combination with the electrographic analysis has been found to be a very convenient means of carrying out simple metallurgical analyses. The combined procedures, which have been applied to qualitative and quantitative analysis, have been termed electro-ring testing and electro-ring colorimetry respectively [*Research*, **19** (1957), 429].

Fungal mycelium as paper-making material

FUNGAL MYCELIUM HAS BEEN found to be a good source material for the manufacture of certain varieties of paper and paper products. The mycelium is disintegrated, as other paper stock, suspended in water and made into a sheet. Sheets of the pure mycelia tend to become brittle but the addition of 10 per cent by weight of cellulose fibre gives sheet of paper with nearly the same characteristics as normal paper. Transparent and flexible sheets are obtained by subjecting mycelia sheets to heat and pressure. Fungal mycelium is a valuable sizing agent and paper sheets containing it have high gloss and good printing characteristics. It can also be used in the manufacture of flame resistant paper and paper products [*Sci. Newslett., Wash.*, **72** (1957), 294].

Recent advances in terpenoid compounds

A SYMPOSIUM ON RECENT ADvances in the Chemistry of Terpenoid Compounds, organized by the British Chemical Society, was held at the University of Glasgow during 11-12 July 1957, and was attended by representatives from several countries. A marked feature of the symposium was the emphasis placed on the biogenesis of the terpenoid compounds and also on the use of physical methods like infrared, ultraviolet and optical rotatory determinations, etc., in elucidating the probable structures of the terpenoid compounds.

Studies on the absorption spectra of the sesquiterpene ketone, zierone, and its derivatives obtained by dehydrogenation and methylation at the carboxyl group and adjacent to it, showed that zierone is a derivative of a new natural azulene. A paper by Prof. W. Cocker illustrated another aspect of the effect of light: its ability to isomerize some substances to interesting structures of higher energy level. In this case the product obtained by irradiation of santonin in aqueous solution and its transformation products were discussed, and it was concluded that the initial product contains a cyclopropane ring. The autoxidation of sesquiterpenes of the eudesmane series containing an α β unsaturated system has been found to be much influenced by the configuration of the side chain. Investigations on the chemistry of hydroxy hopanone show that it is pentacyclic but the nucleus could not be related to a known series. The ' carvone camphor ' obtained by illumination of carvone has been shown to contain a cyclobutane ring the presence of which leads to very interesting rearrangements. In two papers, one on the alkaloids from *Aconitum nepellus* and the other on delpheline, the occurrence of nitrogen in terpenoid structure was shown and it was emphasized that terpene chemists will in future have to take into account the chemistry of nitrogen [*Nature, Lond.*, **180** (1957), 470].

New plant growth regulators

SOME NEW PLANT GROWTH REGULATORS, other than gibberellins, were reported at a symposium on the Chemistry and Physiological Actions of Gibberellins, sponsored by the Biological Chemistry Division of the American Chemical Society. The new substances, which act like gibberellins but are not chemically identical, have been extracted from higher plants such as bean and cucumber. They have the empirical formula $C_{17}H_{22}O_6$ and their R_f values with some solvents in chromatographic columns differ widely from those for gibberellic acid [*Chem. Engng News*, **35**(37) (1957), 68].

Research in climatology

THE PROBLEMS RAISED BY CLIMATE in the world's arid lands are presented in *Climatology*, a review of research in this field which has just been published by the Unesco.

The tenth in a series of publications concerning arid lands research, this report was originally prepared for a symposium on arid zone climatology which was held in Canberra, Australia, in 1956. It brings together under one cover, researches carried out by scientists from Australia, Israel, the United States, France, the United Kingdom and Sweden.

Among the subjects covered in *Climatology* are evaporation and the water balance; climatic factors in arid zone animal ecology; radiation and the thermal balance; climates and vegetation; how climate affects man and domestic animals; the modification of ' microclimates '; the chemical climate and saline soils in the arid zones, and the requirements for climatological observations in these zones.

One of the striking aspects of this report is the stress it places on the influence of man himself upon the climate in which he lives — an influence which, until now, has seldom been a beneficial one. He has changed ' microclimates '— that is, the sum of the physical properties of the atmosphere in which plants and animals live in a limited area — not only through indiscriminate destruction of forests, but also by building his modern cities. The publication is priced at Rs. 25.00.

Silikaty

Silikaty, A NEW QUARTERLY JOURNAL in Czech language in which each paper is summarized in Russian and a western language, began publication this year in Prague. It is published by the Publishing Institute of the Czechoslovak Academy of Sciences, Prague II, Vodickova 40, Czechoslovakia. It deals with a number of topics like basic silicate research, mortar materials and building, ceramic and heat resistant materials, glass and enamels.

Current Contents

Current Contents, A NEW WEEKLY service designed to give information on a group of pharmaceutical publications, has been offered by Eugene Garfield Associates, 1523 Spring Garden Street, Philadelphia 30, Pa. It contains reprints of the contents pages of such journals as *Chemical and Engineering News, Chemical Week, Journal of the American Chemical Society, Journal of Agriculture & Food Chemistry, Chemical Engineering Progress, Industrial & Engineering Chemistry, Journal of the American Medical Association, Lancet* and *American Journal of Psychiatry.*

Al-Masudi millenary celebrations

THE MILLENARY CELEBRATIONS OF Al-Masudi, the tenth-century geographer, were celebrated under the joint auspices of the Indian Society for the History of Science and the Institute of Islamic Studies, Aligarh, during 18-19 January 1958, at the Aligarh Muslim University, Aligarh. About thirty papers were received from U.K., U.S.A., France, Holland, Egypt, Lebanon, Iran and India. Amongst the distinguished visitors present at the celebrations were Professors Bernard Lewis, Von Grunebaum, Myron Smith, Academician Tolstov, Nicola Ziadeh and Said Naficy. In addition to these visitors, members of the diplomatic corps of Iran, Sudan, Syria and Lebanon were also present. The Vice-Chancellor of the Muslim University, Aligarh, Col. B. H. Zaidi, welcomed the delegates on behalf of the University, Dr. A. Aleem, on behalf of the Institute of Islamic Studies and Prof. M. S. Thacker on behalf of the Indian Society for the History of Science. Mr. A.A.A. Fyzee, Vice-Chancellor, University of Jammu and Kashmir, in his presidential address, dealt on the need for studies on humanities in the universities, particularly in view of the technological changes taking place in India. Prof. M. S. Thacker, Director-General, Scientific & Industrial Research, dealt with the works of Al-Masudi which, among other things, gave an insight into the status of technology in different countries during the tenth century.

National Science Foundation, U.S.A.

THE NATIONAL SCIENCE FOUNDATION has announced 316 grants for scientific projects during the fiscal year 1958; a sum of $ 5,500,000 has been awarded for this. Since the beginning of the programme in 1951, over 4000 such grants amounting to about 66 million dollars have been made. The scope of these projects includes basic research in a number of sciences, short-term medical research, exchange of scientific information, training of science teachers and conferences to advance the growth of sciences. The research fields coming under the scope of these grants include anthropology, astronomy, chemistry, physics, medical, mathematical, engineering, geological and sociophysical sciences.

Announcements

▪ *National Institute of Sciences of India* — The following have been elected office-bearers of the Council of the Institute for the year 1958.

Prof. P. C. Mahalanobis (*President*); Prof. D. S. Kothari and Dr. V.R. Khanolkar (*Vice-Presidents*); Prof. P. Maheshwari and Shri S. Basu (*Secretaries*); Dr. B. Mukerji (*Foreign Secretary*); Prof. Ram Behari (*Treasurer*); Prof. R. C. Majumdar (*Editor of Publications*); Dr. K. N. Bagchi, Prof. K. Banerjee, Dr. U. P. Basu, Dr. K. R. Dixit, Prof. C. S. Ghosh, Prof. C. Mahadevan, Prof. G. P. Majumdar, Dr. B. P. Pal, Dr. B. N. Prasad, Dr. Atma Ram, Prof. T. S. Sadasivan, Prof. B. Sanjiva Rao, Prof. B. R. Seshachar, Prof. N. R. Tawde, Dr. K. Venkataraman, and Dr. W. D. West (*Members*).

The following have been elected as Fellows of the Institute: Shri Salim Ali, Dr. T. Banerjee, Dr. T. V. Bhat, Dr. N. N. Das Gupta, Dr. S. N. Das Gupta, Shri D. Lahiri, Dr. V. S. Manglik, Shri S. R. Mehra, Dr. S. Minakshisundaram, Dr. E. S. Narayanan, Dr. V. N. Patwardhan, Dr. B. Peters, Dr. B. Prasad, Dr. M. Ray, Dr. A. P. Subramanian (*Ordinary Fellows*); and Dr. Hitoshi Kihara (*Hon. Fellow*).

▪ *An International Congress on Metallurgical Research* will be held during 17-21 June 1958 at Liege, Belgium. Full particulars regarding the Congress can be obtained from Centre National de Recherches Metallurgiques, Section de Liege, Abbaye du Val Benoit, rue du Val Benoit, Liege, Belgium.

▪ *A Colloquium on 'Physics of Very Low Temperatures'* in commemoration of the first liquefaction of helium by Kammerlingh Onnes, sponsored by the International Union of Pure & Applied Physics, will be held during 23-28 June 1958 at Leyden, Netherlands. Queries in this connection may be addressed to Prof. C. J. Gorter, Department of Experimental Physics, State University of Leyden, Nieuwsteeg 18, Leyden, Netherlands.

▪ *Dr. Sampurnanand Prize* — A sum of Rs. 1000 will be awarded through the National Academy of Sciences, India, for the outstanding contribution from an Indian scientist to any one of the physical, chemical, mathematical, psychological, physiological, etc., aspects of space travel. Contributions should not exceed 100 pages (typed on one side of foolscap paper). Four copies should be submitted for consideration to the General Secretary, National Academy of Sciences, India, Lajpatrai Road, Allahabad 2, so as to reach the Secretary at an early date. Only one of the four copies should contain the name and address of the author on the title page.

▪ *L.T.M. Course of the School of Tropical Medicine, Calcutta* — The three months' course of instruction, conducted annually by the School, for the Licenciate in Tropical Medicine Examination for the year 1958 will commence from 15 July 1958. Only medical men are eligible to join the course. Applications, in the prescribed form, should reach the Director, School of Tropical Medicine, Calcutta, by 14 May 1958.

INSTRUMENTS AND APPLIANCES

HIGH TEMPERATURE GAS CHROMATOGRAPHY UNIT

At the International Symposium on Gas Chromatography sponsored by the Analysis & Instrument Division of the Instrument Society of America, two novel high temperature gas chromatography units have been reported. The unit of E.I. du Pont de Nemours & Co. consists of a gas-liquid partition column containing a silicone grease as the partitioning medium. The detector uses model aeroplane 'glow plugs' as sensing elements. Mixtures boiling over 400°C. can be analysed by the unit.

The second unit, devised by the Fisher Scientific Co., combines a wide temperature range with high sensitivity and operating stability. In this instrument rapid vaporization of high boiling materials at temperatures up to 400°C. is accomplished by means of a modified sample injection system. An integral cooling system gives controlled operating temperatures below the ambient temperature and enables the operator to change the temperature rapidly between runs. Independent thermal control of the chromatographic column and thermal conductivity cell allows the operating temperature to be changed during an analysis without affecting the recorder baseline. High operating stability throughout the greatly increased temperature range is achieved by the use of improved electronic control in the temperature and power supply regulations [*Chem. Age*, **78** (1957), 563].

ELECTRONIC SCALE

A scale that can deliver free-flowing granular or powdered materials at a constant predetermined rate by weight is manufactured by W. & T. Avery Ltd., Soho Foundry, Birmingham 10. Two or more of these scales are suitable for feeding ingredients in constant proportions, in a continuous process.

Material is fed continuously from a suitable source of supply into the hopper on the scale, from which it is withdrawn through a gate opening by a moving feed belt. The material is transferred from the feed belt to the moving weight belt mounted on a scale. The scale is fitted with a 'light and heavy' indicator head and an electronic switch controls the size of the gate opening in the hopper so that a constant weight of material is maintained on the weigh belt (demonstrated by the indicator remaining at zero). Provision is made to change the speed from 200 to 1000 weight lengths per hour. Accuracy of the weighings ranges from $\pm\frac{1}{2}$ per cent upwards according to the nature of the material being handled, generally lower for lumpy or non-free flowing materials. The scale is unsuitable for material in the form of large lumps [*Chem. Age*, **78** (1957), 517].

SOLAR MAGNETOGRAPH

The basic unit of a new instrument, the solar magnetograph, which is unique in the whole of Europe for the detection of extremely low solar magnetic fields, was successfully tested at the Observatories of the University of Cambridge. It is sensitive enough to register fields as low as one gauss over narrow strips of the sun's surface (*c.* 100 seconds of arc long). Only one more similar instrument, the first of its kind, is in operation at Mount Wilson Observatory, California.

In this instrument two narrow slits are placed on each wing of a line, $\lambda 5250{\cdot}2$, sensitive to the Zeeman effect. The light from the slits falls on two photomultipliers connected to a difference amplifier. The resulting signal is amplified by a selective frequency amplifier followed by a phase-sensitive detector and a recorder. The analyser of the circular polarization on the wings of the Fraunhofer line is a crystal of ammonium dihydrogen phosphate in conjunction with a polaroid. The crystal is excited to 3400 V. (400 c/s.). This type of analyser eliminates the systematic errors resulting from the use of rotating quarter-wave plates [*Discovery*, **18** (1957), 437].

Progress Reports

COFFEE RESEARCH IN INDIA

The ninth Annual Report (1955-56) of the Research Department of the Coffee Board contains records of the results of researches carried out in the various sections of the Department and useful information is provided on improving the yield of coffee by employing better growing methods and through control of pests.

The important research results obtained by the various sections are briefly summarized here.

Agronomy — Observations on the setting of berries and the final harvest in relation to the number of flowers produced conclusively showed that retention of berries to the ripening stage was directly proportional to the amount of leaf carried by the branch. Studies on the viability of germination of seeds revealed that seeds sown with their parchment cover split or removed germinated 10-15 days earlier than those with their covers intact. Germination is less in the case of stored seeds and ashing and similar treatments seem to have little effect on germination.

Chemistry — Manurial experiments with N.P.K., singly and in combination, led to the following conclusions: application of nitrogen and phosphates gave the highest yield and was superior to nitrogen only or nitrogen and potash. Field manurial trials with Arabica coffee in different soil climatic zones on the application of 40-100 lb. of nitrogen in split doses, with and without P and K, show that when nitrogen is applied at levels higher than 40 lb./acre annually, it is more profitable to apply it in more than two doses. Phosphate at 30 lb./acre level increases the beneficial effects of nitrogen up to 80 lb./acre. When the nitrogen level exceeds this, more phosphate is necessary. In experiments on the manuring of seedlings in the nursery, the interesting observation was made that nitrogen in combination with phosphate, both in soluble forms, applied in weekly doses produces considerable increase in growth.

A quick and cheap method of processing the cherry into parchment has been evolved, which involves treatment of the cherry with suitable concentrations of caustic soda solution. It was possible to complete cleaning of the coffee in less than 1 hr. as against the 24-36 hr. required for normal digestion and fermentation. A number of plantations are adopting this technique, especially for Robusta variety. The quality of coffee does not seem to be affected by this treatment.

Botany — Attempts to double the number of chromosomes in Robusta coffee by colchicine treatments have been successful. Seedlings treated at the cotyledon stage have coarse, thick and crinkled leaves and have a chromosome number $2n = 44$.

Entomology — Trials for the control of Green bug using organo-phosphorus compounds, including systemic insecticides and mineral oil emulsions, showed that Ekatox 20 (0·1 per cent) and Folidol E605 (0·02 per cent) were equally effective when used in Bordeaux spray, and better than white oil emulsion. Applying the insecticide soaked in cotton and wrapped around a portion of the main stem and covered over by an impermeable film of alkathene (to prevent evaporation and facilitate slow absorption) proved effective.

In the control of the shot hole borer pest, reinfestation was less in plants treated with G1250 and B.H.C. (50 per cent) than in Dieldrin (applied in two stages separated by an interval of 40 days). Experiments on the pesticidal treatments in the control of eelworm have shown that soil emendation with calcium cyanamide, urea and sulphur is effective in arresting the increase of eelworms. Repeated applications of Ekatox also arrest the further increase of the pest.

SCIENTIFIC & INDUSTRIAL RESEARCH IN NEW ZEALAND

The thirty-first Annual Report (for the year ending 31 March 1957) of the Department of Scientific & Industrial Research reveals considerable activity of its different units and research associations in applied and basic research problems. An important aspect of the Department's activities during the year was the successful establishment of the necessary observation and research centres at Scott Base, Hallett Bay, Roxburgh, Wellington, etc., in connection with the programme for the International Geophysical Year. A notable item of research conducted at the Fats Research Laboratory was on the composition of animal fats. In a study of hydrogenated ox kidney fat the range of *n*-fatty acids has been found to extend from C_2 to C_{26} including the *n*-odd numbered fatty acids from C_3 to C_{23} except C_{11}. Margaric acid was isolated for the first time from butter fat. Acids with double bonds separated by two or more methylenic groups have been discovered in the lamb caul fat. These discoveries are significant in view of the widespread interest shown in the relation between properties of animal and vegetable fats and cholesterol deposition as a cause of atherosclerosis.

A brief account of the important research activities in the various fields is given below:

Crops — A new general purpose wheat, *Aotea*, bred at the Crop Research Division (the result of 16 years of breeding and selection) combines very high yields with good baking quality and improved agronomic characteristics (compared to the *Arawa* variety). The average increase in yield, without sacrifice in the quality of the baking flour, is 22 per cent (calculated on the individual yield of Cross 7). *Aotea* has short straw, does not lodge or shatter, threshes well and is more resistant to leaf diseases. The annual return from this new variety, in the smaller farming industries, promises to far exceed the total expenditure on wheat breeding work in the last 30 years.

Geology — Contour mapping carried out from the data on air photo-interpretation in the Buller Gorge region enabled a number of predictions on the structure of the area, stratigraphy, frequency and nature of the uraniferous beds which have been subsequently confirmed by field work. This observation strengthened the hypothesis that uranium minerals occur in a granite phase. Mineralogical studies have resulted in the discovery of coffinite (hydroxyl-substituted uranium silicate), a recently discovered, primary ore mineral of the Colorado area. Deposition of coffinite is accompanied by carbonate, pyrite, haematite and fluorite, the mineralization imparting a distinct red and black colouration to the host rock.

Compilation of data for a wall map with complete coverage of New Zealand on a scale of 32 miles to an inch (1: 2,000,000) has been completed.

Nuclear sciences — An isotopic sulphur survey to examine the origin of sulphur compounds in the Wairakei, Rotorua and White Island thermal areas revealed that the sulphur in the geothermal area is isotopically different from sea water sulphate; this result offers additional support to the assumption that the hot chloride waters issuing from fumaroles are of magnetic origin. A technique has been developed for the study of nitrogen uptake from enriched N^{15} atmospheres. It has been found that certain plants such as *Epilobiums* and *Coprosmas* have also the ability to fix nitrogen by some process taking place in leafy shoots, foliage of trees, pioneer shrubs and various weeds and which is generally associated with pigments other than the green of carbon dioxide fixation. The element nitrogen must be much less inert than has been assumed to be generally and it must circulate rapidly through vegetation and soils.

For the radioactive detection of tritium in normal water samples, electrolysis plants have been successfully designed and assembled; these plants achieved the necessary enrichment of tritium concentration by means of a volume reduction of 2500, i.e. from 10,000 ml. to 4 ml.

Seismic studies — An analogue computer using electrical methods to estimate the effects of earthquakes within the 'elastic' limits on buildings up to ten storeys (and by a method of 'pairing' storeys, up to twenty storeys) has been constructed at the Dominion Physical Laboratories and the effects of earthquakes on sixteen different designs of buildings have been studied.

Medical instrumentation — To determine the characteristics and limitations of the differing hydraulic systems encountered in practice, equipment has been devised at the Auckland Industrial Development Laboratories to produce a synthesized wave-form representing an arterial pulse. By this means, it is possible to determine the effect on the frequency response of the change in stiffness of catheters and tubing with temperature or even with ageing.

A fast-acting drip rate recorder covering a wide range of 5-80 drops/min. has been developed with which it was possible to specify the drip rate for a particular patient and a special pump was arranged to deliver the pitocen drip at a positive controlled rate independent of the instantaneous venous pressure.

Transpiration studies — Measurements made at the Dominion Physical Laboratory on the transpiration rates of mustard plants grown in a controlled environment indicated that the transpiration rate does fall at a critical moisture content, depending upon the experimental conditions, but usually well before the wilting point is reached. Comparative transpiration rate measurements on paired unwetted leaves and on leaves of perennial salvia sprayed with water in varying amounts showed that the stomata closed at a higher moisture content on the wetted leaves, the net result being a conservation of water within the leaves so treated. This result is significant from the point of view of the effect of dew on plant growth.

Photosynthesis — Using isolated chloroplasts as starting material, it has been shown at the Plant Chemistry Laboratory that it is possible to prepare a particular protein in a highly purified form by a rapid procedure; this pure protein has been found to be the enzyme responsible for carbon dioxide fixation in the photosynthesis process.

Timber research — An effective and economical treatment has been developed using boron compounds applied by diffusion impregnation for the preservation of timber used in building construction above ground and where timber is not in contact with water. This method is being increasingly utilized by the commercial timber-treating plants.

Plant pathology — Field work of the Plant Diseases Division has revealed that in the autumn of 1956 the perfect stage of the fungus causing dry rot of swedes in New Zealand has been found on plant residues of a number of brassica crops. The perfect stage gives rise to wind-borne spores which may spread infection over long distances. This finding is of considerable economic significance as it changes the whole approach to the control of the disease which has been infructuous till now.

Potassium Chloride from Sea Bittern: Part I

G. T. GADRE, A. V. RAO & H. M. BHAVNAGARY
Central Salt Research Institute, Bhavnagar

(*Manuscript received* 11 *July* 1957)

A process has been worked out by which potassium chloride of 97-99 per cent purity can be obtained from the waste bittern of the marine salt industry. The desulphation of the bittern is carried out using commercial calcium chloride. Sulphate-free bittern deposits, on concentration, the double salt, $KCl.MgCl_2.6H_2O$, from which potassium chloride is recovered by leaching it with cold water or by cooling a supersaturated solution of the double salt.

ABOUT three and a half million tons of common salt are produced every year in India by solar evaporation of sea water. From the resulting waste bittern about 85,000 tons of potassium chloride can be recovered. Indigenous production of potassium chloride is almost negligible at present and the requirements are met mainly by imports. The country's annual requirement of potassium chloride by 1960-61 is estimated at 47,500 tons[1]. It is thus clear that the utilization of bittern for the recovery of potassium chloride and other salts is of considerable importance to the country. Though attempts have been made previously[2-4] to exploit this source in India, no systematic data are available for the recovery of potassium chloride.

Ballard[5] first reported, in 1850, a process for the recovery of potassium chloride, sodium chloride and sodium sulphate from the sea bittern. A number of processes have since been reported[6-16] for the recovery of potassium chloride from this and other sources.

The bittern discharged from salt pans at 29°-30°Be contains magnesium and potassium salts and combined bromine. Further concentration to 34°Be deposits common salt containing magnesium sulphate and the double salt, carnallite, $KCl.MgCl_2.6H_2O$. It is, therefore, necessary to remove magnesium sulphate prior to the concentration of the bittern for obtaining carnallite. This can be achieved by double decomposition with calcium chloride.

After the insoluble calcium sulphate is filtered, the bittern contains mainly potassium and magnesium chlorides from which carnallite can be crystallized by concentration. The latter on fractionation yields potassium chloride of about 97-99 per cent purity. Cheap calcium chloride from Solvay process waste can be used for this purpose[3,12]. It can also be obtained by treating magnesium chloride, a byproduct of this process, with lime.

Experimental procedure

Bittern of density 29°Be was concentrated to 33·5°Be by solar evaporation to eliminate most of the sodium chloride. The chemical analyses of bitterns are given in Table 1. Data for bitterns from other sources are also given for comparison. Commercial calcium chloride used analysed 95 per cent $CaCl_2.2H_2O$.

Removal of sulphate — A known volume of bittern was taken in a beaker and calcium chloride solution added slowly with agitation for 1 hr. The precipitate was then filtered off. To see the effect of dilution on the efficiency of sulphate removal, the

TABLE 1 — COMPOSITION OF BITTERNS FROM DIFFERENT SOURCES

	BHAVNAGAR SALT WORKS, BHAVNAGAR*		TATA CHEMICALS, MITHAPUR†		WADALA SALT WORKS, BOMBAY‡	
	Density 29°Be	Density 33·5°Be	Density 29°Be	Density 34·5°Be	Density 30·0°Be	Density 34·5°Be
NaCl, %	10·20	3·65	9·20	1·60	10·50	1·60
$CaSO_4$, %	—	—	0·30	—	0·30	—
$MgSO_4$, %	8·35	10·05	5·60	7·01	5·90	10·10
$MgCl_2$, %	15·08	24·90	12·00	22·10	10·10	17·90
KCl, %	2·49	3·69	2·10	2·30	2·10	2·40
Br, %	—	—	0·18	0·30	0·18	—
Water, %	—	—	70·62	66·70	70·62	68·00

*Analysis by authors. †Analysis by C. B. Joshi of the Works. ‡Analysis by K. Seshadri[17].

TABLE 2 — EFFECT OF DILUTION ON SULPHATE REMOVAL FROM BITTERN

[*Vol. of bittern* (34·5°*Be*) *taken*, 200 *ml.*]

VOL. OF WATER ADDED *ml.*	DENSITY OF DILUTED BITTERN °*Be*	WT. OF $CaCl_2$ ADDED *g.*	WT. OF $CaSO_4$ OBTAINED *g.*	% SO_4'' REMOVAL FROM THE FILTRATE	BULK DENSITY OF $CaSO_4$ *g./litre*
10·00	32	17·40	13·50	94·0	530
20·00	31	17·40	12·50	92·7	430
30·00	30	17·40	13·55	94·0	380
40·00	29	17·40	13·00	93·0	300

TABLE 3 — REMOVAL OF SULPHATE FROM BITTERN BY CALCIUM CHLORIDE

(*Vol. of bittern taken*, 100 *ml.*)

WT. OF $CaCl_2$ ADDED *g.*	WT. OF $CaSO_4$ OBTAINED *g.*	SO_4'' REMOVED FROM FILTRATE %
8·71 (theoretical)	12·1	90·0
9·58 (10% excess)	12·8	96·0
10·45 (20% excess)	13·2	98·0
10·88 (25% excess)	14·0	99·2
11·32 (30%excess)	14·3	99·5
12·19 (40% excess)	14·8	99·0

TABLE 4 — COMPOSITION OF CARNALLITE FROM DESULPHATED BITTERN

(*Vol. of desulphated bittern used for each expt.*, 200 *ml.*)

B.P. OF SOLN.*	WT. OF CARNALLITE OBTAINED *g.*	ANALYSIS OF CARNALLITE				
		KCl %	$MgCl_2$ %	NaCl %	$CaSO_4$ %	H_2O %
120	29·0	17·70	30·40	16·40	1·41	34·09
123	30·0	20·03	30·96	15·70	1·21	32·10
126	36·9	14·20	33·10	14·70	1·63	36·37

*The b.p. of the solution is an index of the degree to which the bitterns are concentrated.

bittern was diluted by adding appropriate amounts of distilled water to densities varying from 29° to 32°Be. The results recorded in Table 2 indicate that dilution has no effect on the efficiency of sulphate removal. However, the calcium sulphate precipitate obtained from the diluted bittern (29°Be) was lighter than that from the higher density bittern (32°Be) and was easy to filter.

It was observed from preliminary experiments that by using theoretical quantity of calcium chloride for the removal of sulphate, only 88-90 per cent of the total sulphate was precipitated. By using calcium chloride, in amounts up to 40 per cent in excess of the theoretical, it was found that 10 per cent excess of calcium chloride precipitates 96 per cent of the sulphate present (Table 3).

The analysis of the filtrate showed that some potassium chloride was held mechanically by the precipitate, giving lower overall yield of potassium chloride. The precipitate was, therefore, washed thoroughly to recover all the potassium chloride, although this meant that some of the calcium sulphate was dissolved and taken into the filtrate. This amounted to 5-6 per cent of the total sulphate. Washing of the precipitate is, however, necessary considering the quantity of potassium chloride recovered thereby.

Recovery of carnallite — Known volumes of the desulphated bittern were taken in three porcelain dishes and concentrated to a point when the temperatures of the boiling solutions were 120°, 123° and 126°C. respectively in the three dishes. The hot liquor from each was cooled to room temperature when carnallite crystallized out. It was filtered, dried at 110°C. and analysed. The crude double salt obtained by concentrating to a point when the solution boils at 123°C. had the maximum potassium chloride content (Table 4). The product was contaminated with more of magnesium chloride, when evaporation was conducted at higher temperature (126°C.).

Extraction of potassium chloride from carnallite — The extraction of potassium chloride from the crude double salt by leaching with cold water has been extensively studied[4-6,8-11,13,16,18]. Carnallite readily breaks into its components, potassium chloride and magnesium chloride, in water. When the amount of water required for the dissolution of crude double salt is controlled, a fine suspension of crystals approximately corresponding to the composition of sylvinite (KCl. NaCl) is obtained. This, therefore, needs further treatment for the extraction of potassium chloride. The product obtained by leaching carnallite with cold water (Table 5) contained 50-80 per cent potassium chloride. This product, although suitable as a fertilizer, is inferior in quality to the one obtained from a supersaturated solution of carnallite in water[7,15,19] (Table 6). A solution of carnallite was concentrated to the supersaturation point (115°C.) and the supersaturated solution gradually cooled to 20°C. when potassium chloride crystallized out in well-defined cubic crystals. A study of the effect of cooling the supersaturated solution to different temperatures on the yield of potassium chloride (Table 7) showed that by cooling the solution to about 10°C., the yield of potassium chloride was 99·2 per cent,

TABLE 5 — POTASSIUM CHLORIDE FROM CARNALLITE (COLD WATER LEACHING)

(*Temp. of water,* 15°C.; *time of contact,* 1½ *hr.*; *wt. of double salt taken,* 100 *g.*)

KCl IN CARNAL-LITE %	AMOUNT OF WATER *ml.*	WT. OF KCl *g.*	ANALYSIS	
			KCl %	NaCl %
19·0	100	26·0	49·2	44·2
10·8	60	20·0	51·5	26·2
16·2	60	16·0	80·0	12·9
16·5	60	16·5	79·0	13·5

TABLE 6 — POTASSIUM CHLORIDE BY COOLING SUPERSATURATED CARNALLITE SOLUTION

(*B.P. of conc. double salt solution,* 115°C.; *wt. of carnallite taken,* 100 *g.*)

KCl IN CARNAL-LITE %	AMOUNT OF OF WATER USED *ml.*	WT. OF KCl OBTAINED *g.*	PURITY OF KCl %	YIELD (ON CARNAL-LITE) %
11·40	70	10·80	99·5	94·50
19·05	65	17·80	99·8	93·45
18·80	60	17·65	99·5	93·50
18·90	60	18·25	99·6	96·50

TABLE 7 — EFFECT OF COOLING TEMPERATURE ON POTASSIUM CHLORIDE YIELD

(*B.P. of carnallite solution,* 115°C.)

COOLING TEMP. °C.	WT. OF CARNAL-LITE TAKEN *g.*	AMOUNT OF WATER ADDED *ml.*	WT. OF KCl OBTAINED *g.*	PURITY OF KCl		YIELD OF KCl ON CARNAL-LITE BASIS %
				KCl %	Mg %	
34	60	80	11·0	96·1	0·145	85·9
20	60	80	12·0	97·3	0·194	94·8
10	60	80	13·0	94·0	0·209	99·2
0	58	72	12·7	93·2	0·224	99·3

while it was only 85·9 per cent at room temperature (34°C.). The product was filtered, washed with a spray of saturated solution of potassium chloride and dried at 110°C. The product analysed 97-99 per cent potassium chloride.

The following procedure represents the optimum conditions for the separation of potassium chloride.

Calcium sulphate is precipitated out from the bittern at room temperature by the addition of calcium chloride, 10 per cent in excess of the theoretical amount. After agitating for 1 hr., the precipitate is filtered off and washed with water to remove the adhering potassium chloride. The desulphated bittern is concentrated to a point when the temperature of the boiling solution is 123°C. It is cooled to room temperature when the crude double salt, $KCl.MgCl_2.6H_2O$, crystallizes out. The latter is dissolved in water and the solution concentrated to the supersaturation point (b.p. 115°C.). The liquor is then cooled to 20°C. when potassium chloride separates, which is filtered, washed with a solution of potassium chloride and dried at 110°C.

Large-scale experiments

Based on the optimum conditions described above, large-scale experiments were carried out with 5 and 10-litre batches of bittern. The procedure adopted and the equipment used for the 10-litre batch experiments are described below.

Ten litres of 35°Be bittern (KCl content, 483 g.) were taken in a three-gallon stainless steel vessel. The liquid was kept agitated by means of a stainless steel propeller-type stirrer attached to a $\frac{1}{6}$ h.p. motor. Concentrated solution of commercial calcium chloride (1155 g.) was added slowly, stirring being continued for 1 hr. and the precipitate filtered under vacuum in a 3 gal. porcelain mug filter. The precipitate was washed thoroughly to remove the adhering potassium chloride. The weight of calcium sulphate precipitate was 930 g. The sulphate removal from the bittern was of the order of 90·8 per cent. The filtrate was taken in a stainless steel vessel and concentrated. When the temperature of the boiling solution reached 124°C., heating was stopped and the liquor cooled slowly to room temperature. Carnallite obtained was filtered in a mug filter and dried at 110°C. (Analysis of carnallite: KCl, 21·9; $MgCl_2$, 30·3; NaCl, 15·8; $CaSO_4$, 2·4; H_2O, 29·5%.)

Carnallite was taken in a pyrex beaker (capacity, 5 litres) and dissolved in minimum quantity of water and concentrated to a point when the temperature of the boiling solution was 115°C. The filtrate was slowly cooled to 20°C. and the crystals obtained were filtered over a buchner funnel, washed with a spray of potassium chloride solution and dried at 110°C. The amount of potassium chloride recovered was 345 g. (overall yield, 75·12 per cent); the purity of the product was 96·8 per cent.

Magnesium was estimated in this investigation by the E.D.T.A. (disodium salt) complexone method[20] and potassium by the sodium cobaltinitrite method[21]. Calcium, sulphate and chloride were determined by standard methods.

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Nutritive Value of Vegetables: Effect of Processing on Protein, Minerals & Ascorbic Acid Contents

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The effect of blanching and canning operations on the protein, minerals and ascorbic acid contents of four vegetables, viz. brinjal (*Solanum melagena*), bitter gourd (*karela*; *Momordica charantia*); *okra* (*Abelmochus esculentus*); and *parwal* (*Trichosanthus dioica*), has been investigated. Of all the nutrients, protein is the least affected and its retention is high in all the vegetables. The loss of minerals was more during blanching than during canning. Blanching causes greater loss of ascorbic acid than canning.

THE present study was undertaken to assess the effects of blanching and canning operations on the nutritive value of some locally available vegetables with special reference to their effect on protein, minerals (iron, calcium and phosphorus) and ascorbic acid contents of the vegetables.

Materials and methods

The vegetables examined were: brinjal (*Solanum melagena*); bitter gourd (*karela*; *Momordica charantia*); *okra* (*Abelmochus esculentus*) and *parwal* (*Trichosanthus dioica*).

The vegetables, after preliminary cleaning, were blanched for 3 min. in boiling water. The blanched product (10 oz.) was canned in 18 oz. A2 (307 × 409) size cans (charcoal No. 2) using 2·6 per cent brine. The ratio of solids to brine was 10: 8·5. The cans were steam exhausted for 10 min. at 180°F., sealed and processed for 22 min. at 10 lb./sq. in. pressure; *okra* was canned in tomato sauce. Representative samples from six cans were examined.

The loss in total solids due to processing in different vegetables was as follows: brinjal, 15; *okra*, 10; *karela*, 5; and *parwal*, 5 per cent.

TABLE 1 — EFFECT OF BLANCHING AND CANNING OPERATIONS ON PROTEIN, MINERALS AND VITAMIN C CONTENTS OF VEGETABLES

(*Results expressed on dry weight basis*)

PARTICULARS	BRINJAL			*Karela*			*Parwal*			*Okra*		
	Raw	Blanched	Canned*	Raw	Blanched	Canned*	Raw	Blanched	Canned*	Raw	Blanched	Canned*
Moisture, g.%	85·27	88·30	92·32	90·24	92·48	94·38	91·36	93·10	92·70	85·28	90·55	88·80
Protein, g. %	8·62 (100)†	8·18 (94·82)	8·00±1·78 (92·39)	12·91 (100)	11·84 (91·33)	11·53±2·56 (89·32)	24·31 (100)	22·91 (94·23)	19·73±2·36 (81·17)	14·47 (100)	13·46 (93·10)	13·12±1·75 (90·65)
Iron, mg. %	13·57 (100)	6·85 (50·57)	6·27±1·11 (46·44)	19·16 (100)	18·07 (94·30)	17·67±4·01 (90·03)	19·22 (100)	19·12 (99·49)	21·92±4·23 (114·0)	10·06 (100)	8·36 (83·28)	7·32±0·18 (72·81)
Calcium, mg. %	160·2 (100)	130·3 (81·84)	117·4±22·23 (58·25)	171·4 (100)	160·4 (93·58)	139·2±30·6 (77·62)	394·2 (100)	361·8 (91·79)	348·1±63·9 (90·36)	534·0 (100)	469·7 (87·98)	478·9±93·6 (89·69)
Phosphorus, mg. %	348·0 (100)	269·9 (77·58)	242·2±44·6 (68·01)	402·7 (100)	374·7 (93·05)	363·9±97·0 (90·16)	465·6 (100)	454·2 (97·54)	439·4±93·0 (96·46)	631·4 (100)	590·2 (93·43)	538·3±89·91 (90·03)
P/Ca ratio	1:2·17	1:2·07	1:2·07	1:2·4	1:2·34	1:2·50	1:1·21	1:1·24	1:1·26	1:1·19	1:1·08	1:1·19
Vitamin C, mg. %	32·52 (100)	26·56 (84·28)	Negligible	580·6 (100)	552·1 (95·10)	419·7±58·8 (70·16)	202·4 (100)	127·3 (62·90)	88·51±9·95 (43·72)	125·6 (100)	98·16 (98·20)	75·96±14·21 (68·00)

*Values for canned materials calculated on the weight of drained vegetables.
†Figures in parentheses represent percentage retention.

Crude proteins in the vegetables was estimated by the Kjeldahl method. Calcium was estimated according to A.O.A.C. method[1], and phosphorus and iron according to the methods of Sterges *et al.*[2] and Moss and Mellon[3] respectively. Vitamin C was estimated according to the method of Robinson and Stotz[4].

Results and conclusions

The results are recorded in Table 1.

Effect of blanching — The results of blanching tests show that of the nutrients present in the vegetables, protein is the least affected and its retention is highest.

The loss in iron was highest (*c.* 50 per cent) in the case of brinjal, the amount retained in the blanched product being 50·57 per cent. The losses in calcium and phosphorus were also highest in brinjal, their retention being 81 and 76 per cent respectively. The ratio of phosphorus to calcium in the vegetables did not undergo any significant change on blanching. The loss in the ascorbic acid content of the vegetables during blanching varied from vegetable to vegetable and retention was lowest in *parwal* (62·90 per cent).

Effect of canning — Losses of nutrient during heat sterilization were not of the same order as in the blanching operation. Vitamin C in particular was found to be the most affected. Maximum retention was observed in *karela* (70·16 per cent) followed by *okra* (68·0 per cent) and *parwal* (43·72 per cent). The amount of the vitamin present in canned brinjal was negligible. The high loss observed in *parwal* is due to the vitamin getting leached into the brine.

The losses in protein and minerals content of the vegetables during canning were not more than that observed during blanching even though the heat treatment is more drastic during canning. It, therefore, appears that loss of minerals occurs mostly during blanching.

The ratio of calcium to phosphorus in the final product is not altered to any significant extent.

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Production of Active Dry Baker's Yeast

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Active dry baker's yeast has been prepared by growing a strain of *Saccharomyces cerevisiae* Hansen var. *ellipsoideus* in a culture medium of the following composition: molasses, 4; ammonium sulphate (or urea), 0·1; and potassium dihydrogen phosphate, 0·1 per cent. The crop of yeast obtained after 24 hr. of growth was centrifuged and then dried in a current of cool air to a moisture content of 8·0-10·5 per cent. In trehalose content (10-12 per cent) and viability ($3 \cdot 5$-4×10^{10} cells/g.), the product compares favourably with imported material and has shelf-life of 6-7 months.

THE total consumption of yeast in India is, at present, a few lakh pounds per annum and much of it is imported. The high cost of imported yeast and its irregular supply are mainly responsible for most of the smaller bakeries in the country not using yeast and depending mostly on leavening of bread dough by natural flora of the flour. If yeast, either in wet or dried form, is made available regularly and at a reasonable price, the consumption of yeast is bound to increase many fold. Since the raw material for the production of yeast is cane molasses which is available in plenty in the country from the sugar factories, and since the process involves only a few simple steps, the possibility of producing active dry baker's yeast, both for internal consumption and export, seems attractive.

Compressed yeast, which normally contains 65 per cent moisture, is highly perishable, and even under refrigeration it keeps well for 1-2 weeks only. Frozen yeast keeps well, but its bulk and the need for refrigeration to prevent it from spoilage make its transport difficult and expensive.

A crude form of desiccated yeast 'Florylin' was first made in Germany and several improved forms of it are now available under the name 'active dry yeast' (A.D.Y.): U.S.A. alone is reported to have produced 6000 tons of A.D.Y. during 1945, and its production is increasing in other countries.

The details of the processes for the manufacture of A.D.Y. are covered by patents. In principle, the process consists in removing as much moisture as possible from compressed yeast by pressing, shredding and drying to 8-10 per cent moisture at as low a temperature as possible (30°-35°C.) in a current of air. The compressed yeast may also be subjected to a pre-conditioning fermentation[1] before drying, mixed with malt, starch, etc. Packing the yeast in vacuum or inert gas and storing in a cool place prolongs the shelf-life of the yeast considerably. Dry yeast has several advantages over compressed yeast. It has a longer shelf-life (6-12 months) and the cost of transportation is low; also, no refrigeration is required. Though the activity of dry yeast is not the same as that of the wet yeast, the former is preferred because of the above advantages.

With a view to study the criteria which determine the quality of dried yeast, some samples of active dry yeast have been prepared in the laboratory and compared with some well-known commercial brands. The results are reported in this paper.

Materials and methods

A strain of baker's yeast, *Saccharomyces cerevisiae* Hansen var. *ellipsoideus*, was used in these studies. The medium used consisted of molasses, 4; ammonium sulphate or urea, 0·1; and potassium dihydrogen phosphate, 0·1 per cent. The culture medium, after boiling and clarification, was inoculated aseptically with yeast from a slant culture to 2 litres of sterilized medium equally distributed in 2 four-litre flasks and kept in a horizontal shaker and aerated for 24 hr. This was used as the inoculum for 20 litres of culture medium in a stainless steel tank. Compressed air filtered through cotton was sparged into the tank with two unglazed porcelain candles (Aerox 30). After 24 hr. this was used as the inoculum for a 50-gal. culture medium. Four Aerox candles, radiating from a central feed tube leading in compressed air from an Ingersoll-Rand compressor, were used in the bigger tanks.

The nutrient solution of clarified molasses was prepared in ten-fold concentration and fed to the tank containing boiled and cooled water at a very slow rate, so that the sugar concentration in the tank did not exceed 0·5 cent. Vigorous aeration was maintained throughout the cultivation period (24 hr.). After this, the yeast was separated by centrifuging in a stainless steel Westfalia separator, washed several times with water till the wash water was colourless. The 10 per cent yeast cream obtained was further concentrated in a basket centrifuge to a moisture content of 60 per cent. The white cake was shredded and dried in thin layers using a current of cool air; drying for 5-6 hr. was sufficient. The data for a typical cultivation experiment are given below: composition of culture medium — molasses, 15 lb.; urea, 200 g.; potassium dihydrogen phosphate, 200 g.; and water, 40 gal.; initial *p*H, 4·5; period of cultivation, 22 hr.; yield of dry yeast, 1300 g.; yeast yield on sugar in molasses, 34 per cent.

The samples were analysed for various factors which are indicative of baking strength.

Moisture content of the samples was determined by drying a 1 g. sample of the yeast for 26 hr. in an air oven at 110°C.

Cell counts — Plate count was carried out by plating out 1 g. samples suspended in sterile water in serial dilution using dextrose agar. Total viability counts were made by the differential staining technique using buffered methylene blue[2]. Direct counts were made with the help of a Spencer haemocytometer.

Trehalose was determined by extracting the disaccharide with hot 70 per cent alcohol, hydrolysing it by acid and estimating it in the hydrolysate as glucose[3].

Glutathione was determined in the cell-free extract by titration against standard iodine solution[4]; the iodine titre is a measure of the degree of deterioration of yeast.

Baking test — Although several elaborate methods have been suggested and used for testing the gassing and baking powers of yeast, a modification of the simplest of them by White was used[5]. The flour (100 g.) was mixed with a suspension of yeast (1 g.) and sugar (1 g.) in water (65 ml.) at 43°C. prepared 10 min. prior to mixing and kneaded well. It was packed in a 250 ml. beaker and the level noted. The beaker was then kept in an incubator at 30°C. and the time taken for 100 per cent rise in the dough noted. If at 1 per cent level of yeast, a 100 per cent rise is obtained in 1-1½ hr., the yeast sample is considered satisfactory.

The shelf-life of the yeast samples stored under different conditions and the effect of temperature, method of packing, metallic contamination, etc., have been investigated.

Results and discussion

The results of analyses of a number of commercial samples of yeast and the experimental samples stored for different periods are recorded in Table 1.

Moisture content of yeast — Higher moisture content (>10-12 per cent) increases the metabolic activity of yeast cells resulting in rapid spoilage of yeast (Table 1). Lowering the moisture content to below 7-8 per cent also seems to have a detrimental effect in that a greater percentage of dead cells is found in

TABLE 1 — ANALYSIS OF DIFFERENT SAMPLES OF A.D.Y.

YEAST SAMPLE	STORAGE PERIOD *months*	MOISTURE %	TREHALOSE %	VIABILITY		DEAD CELLS %	IODINE TITRE (N/100) *ml./g.*	BAKING STRENGTH (TIME FOR 100% RISE) *hr.*
				Pour plate *cells/g.*	M.B. stain *cells/g.*			
Commercial								
I	6	9·9	15·8	$1\cdot60\times10^{10}$	$2\cdot10\times10^{10}$	11·8	5·5	1·00
II	6	12·2	15·9	$8\cdot60\times10^{9}$	$2\cdot30\times10^{10}$	37·0	8·5	1·50
III	12	11·5	7·6	$7\cdot70\times10^{8}$	$1\cdot70\times10^{10}$	59·4	14·1	3·00
IV	6	6·9	9·1	$8\cdot50\times10^{5}$	—	—	22·8	8·00
Fresh compressed	0	72·6	2·3	$1\cdot26\times10^{10}$	$1\cdot28\times10^{10}$	2·0	0·5	1·00
Experimental batch								
I	9	9·5	13·3	$8\cdot00\times10^{7}$	$4\cdot30\times10^{9}$	76·0	10·3	3·00
II	5	7·2	10·5	$2\cdot30\times10^{10}$	$4\cdot00\times10^{10}$	15·6	11·0	1·00
III	3	10·2	9·5	$2\cdot00\times10^{10}$	$3\cdot50\times10^{10}$	10·1	8·0	1·00
IV	1	10·5	10·1	$2\cdot20\times10^{10}$	$3\cdot20\times10^{10}$	12·0	7·0	0·75

the dried product; samples containing 65, 30, 9·5 and 6·5 per cent moisture were found to have 2, 5·2, 12 and 25 per cent dead cells respectively. Drying to 9-10 per cent moisture level and keeping the product in a moisture-proof container is, therefore, essential.

Viable counts — The direct counts for all samples were higher than plate counts since the latter represent only the number of reproducing cells while direct count gives the number of viable cells. The baking strength was found to depend directly on the viability of cells and the period of storage. A minimum of about 10^{10} viable cells/g. of dry yeast was found necessary for satisfactory baking quality. The percentage of dead cells which was determined along with direct viability counts was also indicative of the same, and up to about 35-40 per cent dead cells did not make much difference in the activity of yeast sample. With viability count remaining about the same, the activity is very high when yeast is fresh and it gradually decreases on storage. There is a gradual loss in the enzymic activity independent of the mortality of the cells.

Trehalose — A positive association is supposed to exist between the trehalose content of A .D.Y. and its gassing and baking ability[3]. The trehalose content is least during budding stage and maximum in the finished yeast. During drying, the trehalose content of the yeast increases till its moisture content is 50 per cent, and thereafter the increase is negligible. The increase may be from 8-10 per cent in the finished yeast to 16-20 per cent in the dried yeast. The fermentation of stored trehalose may account for the high endogenous fermentation of dried yeast as compared with intact yeast.

Although trehalose is an α-glucoside, it is not hydrolysed by typical glucosidases like maltase[4]. A highly specific trehalase is involved, which is abundant in top yeasts, but less in bottom yeasts.

A trehalose content of not less than 15-16 per cent is considered to be necessary for good activity of A.D.Y.[3]. Although a high trehalose content seems desirable, the results in Table 1 show that the viability of cells is far more important. Some of the samples, in spite of lower trehalose values (10 per cent), were highly active since viability counts were quite high. It was also found that freshly dried yeasts having only 8-9 per cent trehalose were more active than stored yeast containing 16 per cent trehalose.

Storage studies — The results of studies on the effect of temperature of storage on the viability of yeast cells in a sample of A.D.Y. are recorded in Table 2. The results show that storage at lower temperatures prolongs the life of the yeast.

The results of experiments on the effect of storing the samples for different periods on the viability of yeast (Table 3) show that the baking strength of the yeast is directly proportional to the number of viable cells and gradually deteriorates during storage.

Yeast samples packed in screw-cap jars and vacuum-sealed containers were analysed. The baking strength was 3·5 for the samples stored in screw-cap jars and 1·5 for the samples in vacuum-sealed containers. The percentage of dead cells in the two cases was 76 and 35 respectively. Thus, vacuum packing definitely prolongs the life of yeast.

Factors influencing the production of good quality yeast — The activity of active dry yeast, which is dependent on (1) the initial enzyme activity of the yeast and (2) the ability of yeast cells to elaborate more of the enzymes and thereby increasing the total enzyme concentration of the final product, is markedly influenced by the conditions obtaining during its culture, drying and packing, and careful process control during these stages is, therefore, essential.

Top yeast is preferable to bottom yeast in the preparation of A.D.Y., since the former has higher fermenting power than the latter.

TABLE 2 — EFFECT OF TEMPERATURE OF STORAGE ON THE VIABILITY OF A.D.Y.

(*Storage period*, 6 *months*)

Temp. °C.	Plate count *viable cells/g.*	Viability count (M.B. strain) *cells/g.*	Dead cells %
4	$5 \cdot 1 \times 10^{10}$	$1 \cdot 2 \times 10^{10}$	50
30	$1 \cdot 8 \times 10^{10}$	$1 \cdot 0 \times 10^{10}$	62
37	$1 \cdot 2 \times 10^{10}$	$3 \cdot 0 \times 10^{9}$	90
50	$1 \cdot 0 \times 10^{10}$	$3 \cdot 5 \times 10^{8}$	98

TABLE 3 — EFFECT OF STORAGE ON THE QUALITY OF A.D.Y.

Storage period *months*	Plate count *viable cells/g.*	Baking strength *hr.*
0	$2 \cdot 3 \times 10^{10}$	0·75
1	$2 \cdot 2 \times 10^{10}$	1·00
3	$1 \cdot 2 \times 10^{10}$	1·00
5	$2 \cdot 0 \times 10^{9}$	1·50
7	$2 \cdot 3 \times 10^{8}$	2·50
9	$8 \cdot 0 \times 10^{7}$	3·50

Top yeast also has more trehalase and the corresponding enzyme trehalose[6]. Vigorous aeration and feeding of sugar-nutrient solution at a very slow rate promote complete oxidation of glucose to carbon dioxide and water and suppress alcohol formation[7]; also, high yields of yeast possessing high concentration of enzymes are obtained. Thin spirit brews give better A.D.Y. than strong spirit brews from the point of view of activity and shelf-life[8].

Since certain metallic ions, viz. Cu, Fe, etc., act as enzyme poisons, contamination by these has to be avoided. When using molasses for the cultivation of yeast, it has to be carefully clarified for the same reason and also to obtain a light coloured product.

The amount of water left in the dried yeast is important. If it is high, the endoenzymes in it autolyse the cells rapidly and the yeast which is active in the beginning becomes inactive rapidly. If the drying is carried out too far, a large number of cells die and the activity of the product suffers. The optimum moisture content, therefore, appears to be 8·5-10·0 per cent.

The total concentration of enzymes in the yeast depends considerably on the number of viable cells present. If the number is initially high, the activity of yeast increases rapidly because of the multiplication of cells.

The shelf-life of dried yeast depends on culture conditions. Yeast cells from strongly aerated thin spirit brews remain in good condition longer (up to 6 months) than those from strong spirit brews. Yeast cultivated by non-alcoholic fermentation in worts derived solely from grain and culms yield dried yeast which remains active for 12 months if stored under cool and dry conditions. The lower the temperature of storage, the longer the life of yeast[9]. The shelf-life of samples stored at 40°, 70°, 90° and 120°F. was found to be 24, 21 and 6 months and 8 days respectively.

Acknowledgement

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Letters to the Editor

A COMPOSITE APPARATUS FOR REFLUXING & DISTILLATION

DRYING AND PURIFICATION OF ORGANIC solvents, frequently carried out in a preparative or research laboratory, involve refluxing of the solvent with some drying material prior to distillation, and this entails dismantling of the assembly for refluxing and refitting it for distillation. In order to save time, a composite reflux-cum-distillation apparatus (Fig. 1) has been fabricated which is described in this note.

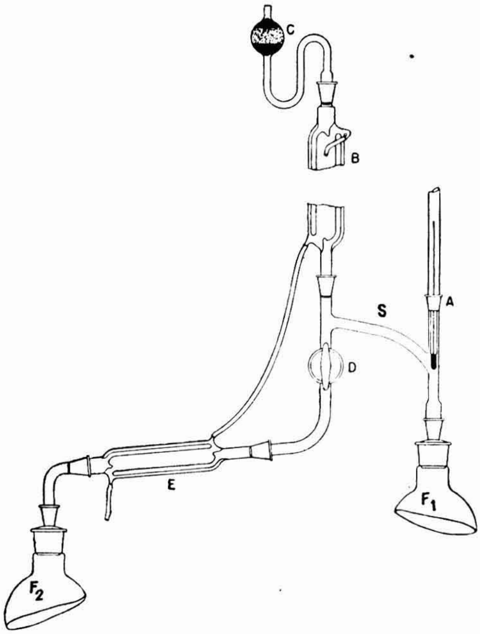

FIG. 1 — COMPOSITE APPARATUS FOR REFLUXING AND DISTILLATION

An essential item in the apparatus is a modified still-head (S) provided with a stopcock (D) to check or regulate the flow of distillate. This still-head has two outer and two inner members of standard joints. The entire assembly consists of a distilling flask (F_1), two condensers (B and E), a drying tube (C), two adapters, a receiving flask (F_2) and a still-head (S), all fitted with interchangeable joints. To set the apparatus for refluxing the solvent, the stopcock D is closed when the solvent condensing in condenser B flows back to the distilling flask. When it is desired to collect the distillate, the stopcock D is opened to allow the condensing solvent to flow into the receiving flask via condenser E. If during the collection of the distillate, additional cooling is needed, it is achieved with the help of the condenser E. The type and size of the condensers B and E may be changed depending on the nature of the solvents to be purified. Thus, this composite apparatus allows a quick change-over from the refluxing operation to the distillation operation by simply opening a stopcock, and no dismantling the assembly is called for. The assembly is compact and there is a saving of space because the condenser E, which is auxiliary to the main cooling condenser, need not be long.

I am thankful to Shri M. R. Verma for helpful suggestions and to Shri Devinder Singh for the fabrication of the apparatus.

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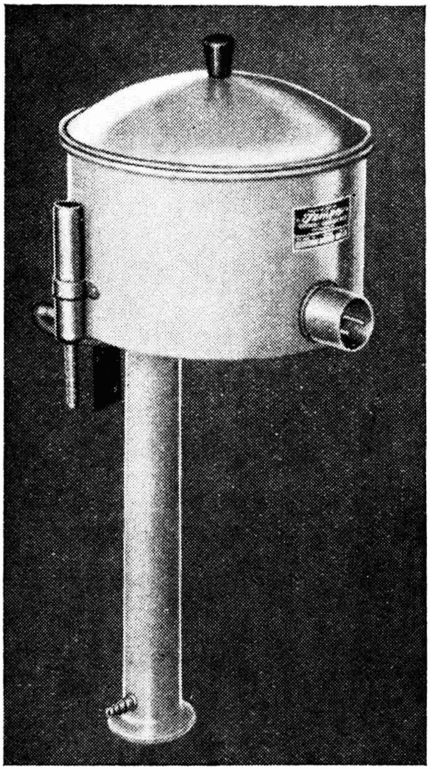
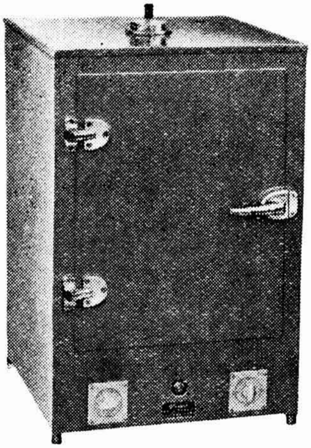
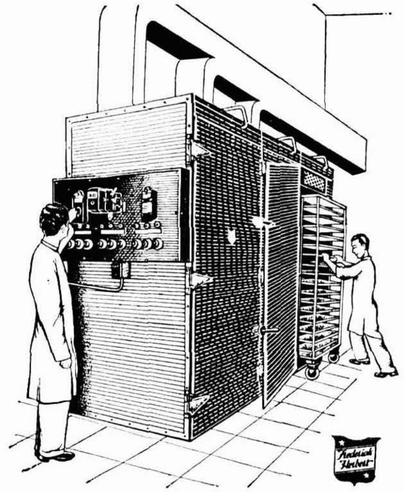
17 *February* 1958





HOT AIR OVEN



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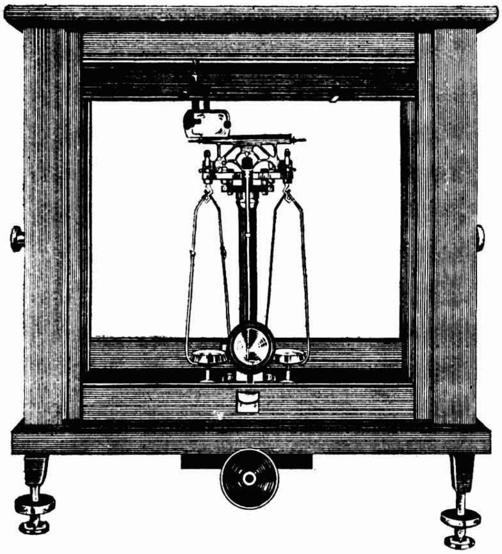

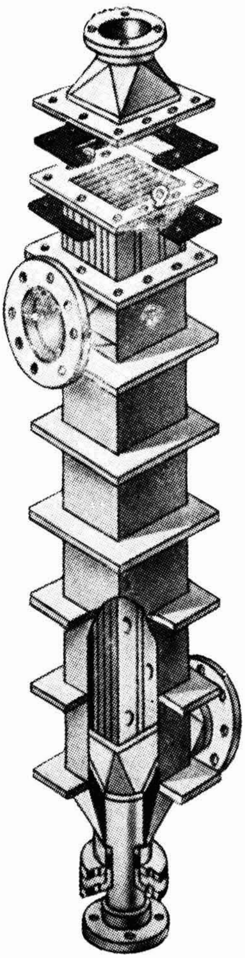

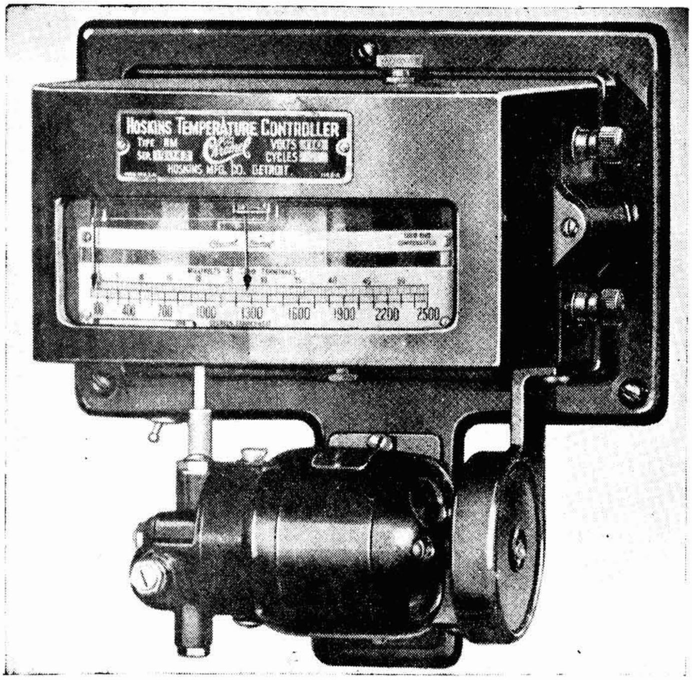
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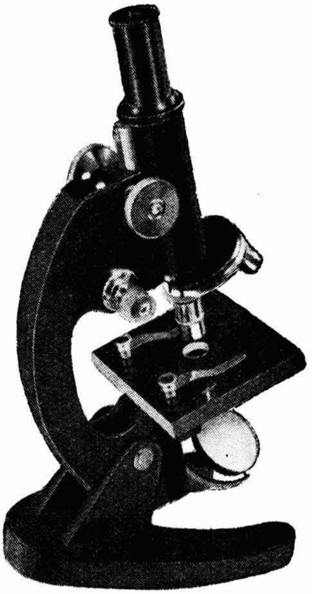

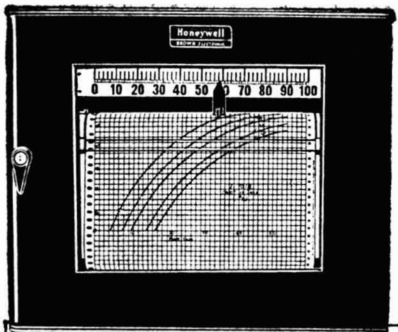

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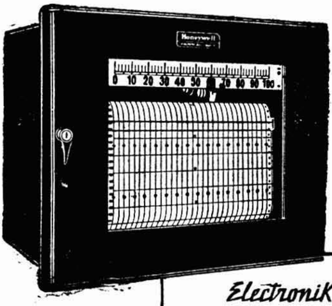

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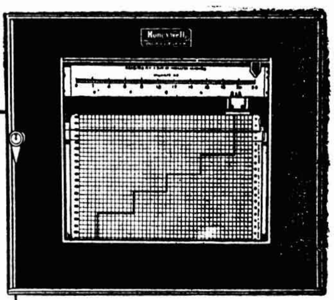

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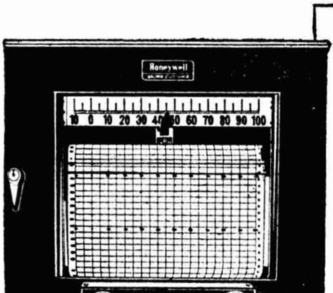

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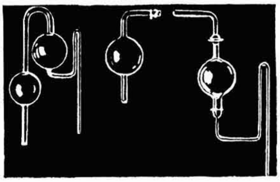

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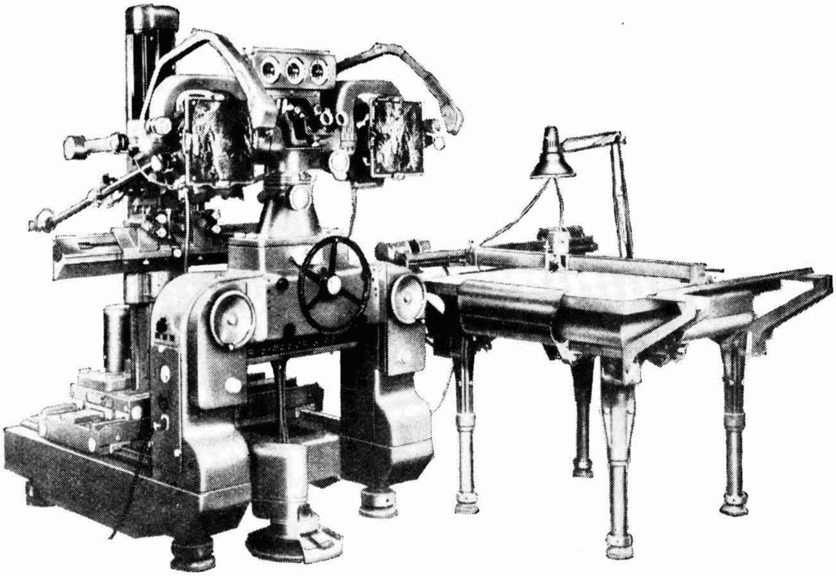

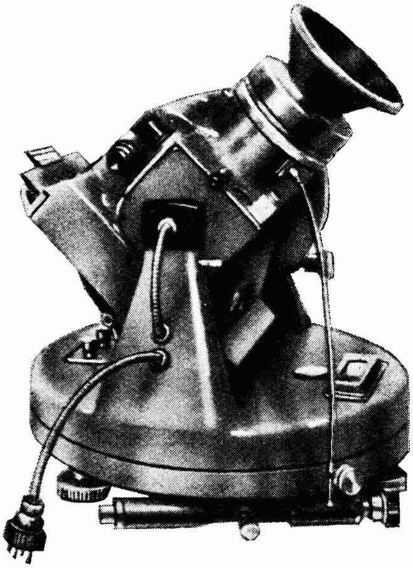

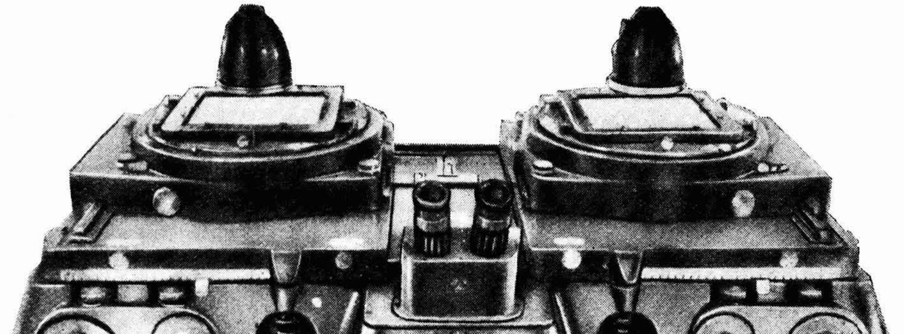

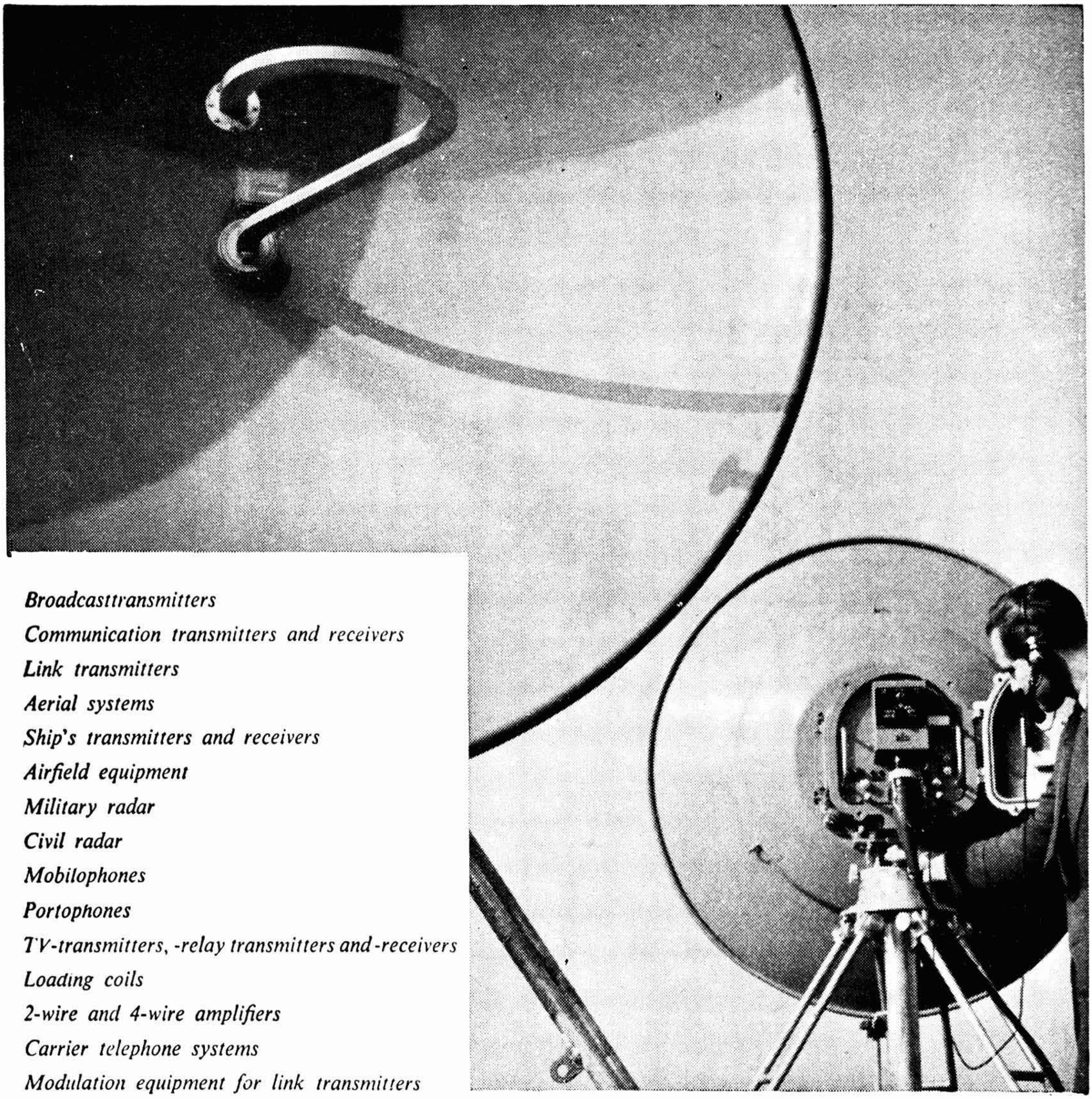

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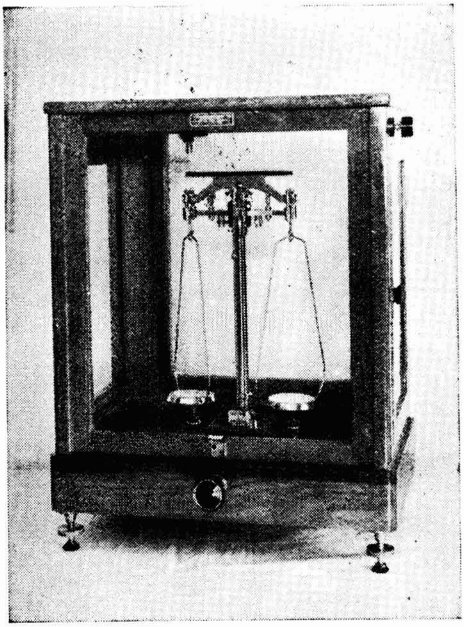

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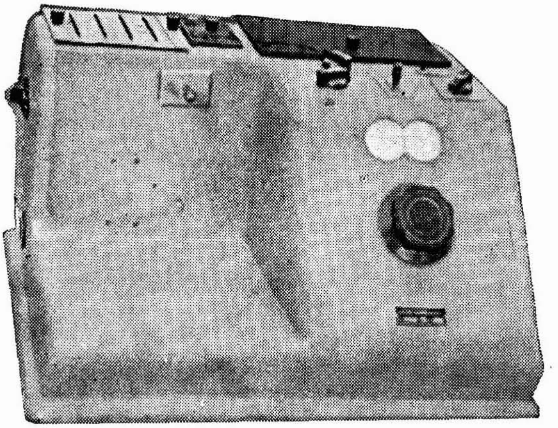

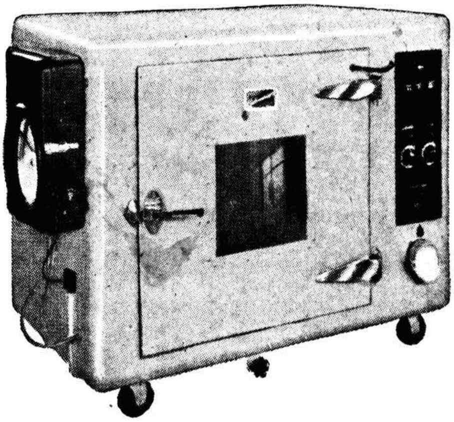

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