crystal is rotated a small angle from the correct Bragg setting, that is to say, there is a spread of the reciprocal lattice points. By studying the diffuse reflexions near a particular point, attention is fixed on the thermal elastic waves of particular wave-length and wave-normal. From measurements of intensity the velocity of the waves can be derived and hence the elastic constants.

There are two main experimental methods : recording the reflexions on a photographic plate and using a microphotometer, or direct measurement of the intensities with a Geiger–Müller counter spectrometer. The former is less accurate, about ± 5 per cent, but has the advantage of showing the pattern of the reflexions. The Geiger–Müller method requires more elaborate equipment, namely, a highly stabilized X-ray source or a monitoring system, but can give an accuracy of about ± 3 per cent. Absolute measurements of the intensity of the X-ray beam, necessary if absolute values of the elastic constants are required, are less accurate (probably ± 10 per cent) owing to the difficulty of comparing the diffuse reflexions with a direct beam some 10^6 times stronger. The essential difference between this and all previous methods of measuring elastic constants is that the crystal is subjected to no external mechanical stress whatsoever. The constants, moreover, refer to very high frequencies, that is, wave-lengths in the region 0–200 A. There are few results yet obtained on metallic substances, the most important being those of Ohlmer on aluminium, who found marked dispersion for wave-lengths below about 10 A.

Dr. R. S. Leigh (Imperial College of Science and Technology, London) spoke on "Relations between Elastic Constants and Phase Boundaries in Alloys". Dr. Leigh explained that the free energy, F, of an alloy can be expressed as $F = E_0 + (E_v - TS_v) - TS_m$, where E_0 is the electronic energy at absolute zero ; $(E_v - TS_v)$ is the lattice vibration term, E_v being the internal energy and S_v the entropy ; and S_m is the mixing entropy in the case of a disordered solid solution. The equilibrium state of the alloy at a given temperature is, of course, that state which has the lowest free energy. An example of a theory based on the effect of lattice vibrations is that of Zener explaining the V-shaped phase boundaries of disordered body-centred cubic β-phases. This requires that the β-phase should have a lower Debye temperature than neighbouring phases. Zener has suggested that this is due to repulsive ion–ion interaction which in turn leads to a low value of $\frac{1}{2}(C_{11}-C_{12})$, a low cut-off frequency in the Debye treatment and hence a low characteristic temperature.

Considering the aluminium–zinc system, the solubility gap implies that here the mixture of the α- and α -face-centred cubic structures has a lower free energy than an equivalent homogeneous phase. Thus the free-energy curve must be such as to have a common tangent at two points. The theory put forward to explain this is based on the idea of shearing the Brillouin zone, the overlapping electrons giving a negative contribution to the shear constant. The calculation leads to phase boundaries of the gap at 275° C. of 20 and 70 atomic per cent in comparison with observed values of 16 and 59 per cent. In conclusion, Dr. Leigh stressed the value of elastic constant measurements on single crystals, in particular in this field on solid solutions of aluminium with zinc, silver, lithium and magnesium.

The afternoon opened with a paper by Prof. C. S. Barrett (University of Birmingham), in which he discussed the after-effects in metals following plastic deformation and showed that they depend on the time occupied by the stress-cycle. He explained the after-effects in terms of anchoring and release of dislocations in the material. In discussion, it was pointed out that recent work at Bristol, in which care was taken to ensure that a homogeneous stress system was obtained, confirmed Prof. Barrett's views.

In the final paper, Mr. H. L. Cox (National Physical Laboratory) referred to the general issue of stability. He stated that failure by structural instability within the elastic range is always a possibility, and that it is quite easy to devise laboratory models which would collapse in this way under any prescribed form of loading ; until the nature of the true forces of cohesion within a solid material is better understood, the possibility that the strength of the material is limited by elastic instability should not be overlooked.

After a short discussion, Dr. N. P. Allen, in closing the conference, expressed the hope that the National Physical Laboratory would have similar opportunities in the future for bringing the results of specialized research into closer relation with technological interests.

STANDARDS OF LIFE IN LESS-DEVELOPED AREAS

TWENTY years or so ago, the number of surveys of living conditions carried out each year in the 'less-developed' as well as in the 'more-developed' countries began to increase rapidly, reaching its peak just before the Second World War. This was, of course, due in the first instance to efforts on the part of administrative agencies to collect information on the basis of which action could be taken to combat the consequences of the economic depression—or sometimes, perhaps, to justify a reluctance to discharge responsibilities of this kind. A large amount of information has thus been made available as a by-product of government activity, rather than as a result of scientific research properly so called. The reports in which this information is presented have been collected by the United Nations Department of Social Affairs*, and an opportunity has now arisen to see what they amount to, and to evaluate their reliability.

The task is an important one, partly because of the urgent need for dealing with the problems of poverty and squalor in the less-developed countries, and partly because it is high time that administrative agencies so plan their work as to make available as much raw material as possible for scientific research. The range of social problems in the international field is so vast that it is unlikely that *ad hoc* researches can be undertaken to throw light on them. The proper planning of national and local surveys to secure comparability of the results is therefore an obvious necessity.

The first report which the Department of Social Affairs has published in the series dealing with inquiries into household standards of living in less-developed areas surveys the organization and geographic and demographic range of field-investiga-

* United Nations. Enquiries into Household Standards of Living in Less-Developed Areas : a Survey of the Organization and Geographic and Demographic Range of Field Investigations of the Income, Expenditure and Food Consumption of Selected Households in Africa, Asia, the Caribbean, Latin America and the Pacific. Pp. viii+191. (New York : United Nations ; London : H.M. Stationery Office, 1951.) 2 dollars ; 15*s*.

tions of the income, expenditure and food consumption of households in Africa, Asia, the Caribbean, Latin America, and the Pacific. It is issued as the first part of a Survey of which the ultimate aim is "to provide a critical commentary on such information on standards of living in the less-developed areas of the world as is at present available". This is a task that is as ambitious as it is praiseworthy, for as the information available from the inquiries that are surveyed is narrow both in its range and its scope, the Survey will perforce "constitute a study of the limitations rather than of the extensiveness of the data now available".

This statement must be somewhat depressing to those whose interest in living conditions is administrative rather than scientific; something more might have been hoped from a study of twenty years of work in this field, because the aspects of the conditions which are dealt with by the Survey (consumer income and expenditure and domestic food consumption) are those concerning which it is most easy to produce quantitative data. The first volume of the Survey, however, makes it plain that the inquiries so far conducted are seriously defective in many respects. In the first place, the households which are the subjects of the investigations have almost invariably been selected from the members of social, economic or occupational population groups, the majority living in single localities. As a result, the geographical range of the strict applicability of the findings is narrow, often being confined to the locality concerned; few instances of comparability between inquiries conducted within the same territory have been found, and virtually no instances at all of direct comparability between inquiries conducted in different countries or territories. The general conclusion on this score is that, although the areas in which the inquiries were conducted are widely dispersed, they constitute "a relatively insignificant fraction of the total inhabited surface of the less-developed portion of the world", and, "in most cases, of particular less-developed countries or territories".

The inquiries are also defective in a rather more technical sense. Few even of the relatively small number of inquiries which, it is claimed, deal with an adequate representative sample of the relevant statistical universe, appear to be free from faulty selection procedures, or from a failure to apply the sampling procedures originally decided on when a survey was being planned. "In many cases," it is said, "the methods applied to the choice of the units of investigation either deviated from the target standards of selection, or were not calculated to secure an unbiased choice." The final conclusion embodied in the first volume of the Survey is therefore that "both in respect of the less-developed countries and territories as a whole, and in respect of them individually, the total amount of information available on household income and expenditure and domestic food consumption is, if not negligible, at any rate meagre".

This is not to say, of course, that the work carried out hitherto has been a waste of time for administrative purposes. The statistician may be very sceptical about the results of numerous surveys of the condition of half a dozen or even single households. It is obviously dangerous to base sweeping generalizations on the circumstances, for example, of five families who are thought to be "more or less typical of the average run of Punjab cultivators working between seven and sixteen acres of land each", or on those of two families at San Antonio Huichimal, Mexico. Nevertheless, crude information such as this may be found to vary from case to case only within narrow margins, and to present a picture of basic poverty which is of great political and administrative significance. As is said in the first volume of the Survey, therefore, "in a socially and economically homogeneous environment, data on the living conditions of a small number of judiciously, albeit not statistically, selected households, or even of a single typical household, cannot but be an expression of the domestic economies and material circumstances of life of the community as a whole".

In sum, then, even though the Survey demonstrates the need for greatly improved techniques in social surveys conducted in underdeveloped countries, the information elucidated in this way is of great interest, and the "critical commentary" on it which the Survey will produce will be received with gratitude both by social scientists and by administrators.

ELECTROMETRIC DETERMINATION OF OZONE AT HIGH DILUTIONS

By DR. J. N. PRING, M.B.E., and G. M. WESTRIP

Royal Institution, Albemarle Street, London, W.1

THE chemical reactions which were formerly mainly employed for the estimation of ozone were based on the liberation of iodine from a neutral potassium iodide solution[1]. In the absence of any more accurate or sensitive method, a check on the assumed reaction was lacking, and it is now apparent that this simple procedure is of value only for conducting comparative measurements. On the other hand, the precise spectrophotometric technique[2] which has now been developed and extensively employed in atmospheric tests is difficult to apply in isolated districts and is limited to the measurement of a column of air several kilometres in length.

Extended laboratory trials by us have shown that an electrometric technique provides a highly sensitive method which could be applied to the determination of local atmospheric concentrations by means of a readily portable apparatus. For this purpose a measurement is made of the E.M.F. of a suitable oxidation-reduction system which is determined by the well-known relation:

$$E = \frac{RT}{nF} \ln\left(k \frac{[\text{oxidant}]}{[\text{reductant}]}\right) = E_0 + \frac{RT}{nF} \ln\left(\frac{[\text{oxidant}]}{[\text{reductant}]}\right),$$

where k is the equilibrium constant of the reaction, E the potential with a given solution, and E_0 the potential with a solution containing equal concentrations of oxidant and reductant.

Of different reactions which were investigated, the one most suitable and specific for ozone was found to consist of the oxidation of hydrobromic acid with liberation of bromine in accordance with the reaction: $O_3 + 2\ H^{\cdot} + 2\ Br' \rightarrow Br_2 + H_2O + O_2$. (At atmospheric pressure and a temperature of 18° C. the E.M.F. of ozone against hydrogen is estimated at 1·9 volts, and that of bromine in a normal solution of bromine ions at 1·066 V.)

The electromotive equation with this reaction takes the form: