layer of the average profile and the lower zone lies within the "gabbroic" layer.

As to causes, Ocola and Meyer also point to the question of electric resistivity (or its reciprocal, conductivity). It transpires that as a result of the "exceptional" attenuation of body waves under the Andes in southern Peru and northern Chile, discovered in 1958, various conductivity studies were actually carried out in Bolivia and Peru between 1963 and 1966 in an attempt to discover high temperature material. For example, on the basis of analyses of induced fields from both daytime and night-time magnetic variations, Schmucker *et al.* (*Carnegie Inst. Wash. Yearbook*, **65**, 11 ; 1966) concluded that a "large-scale induced subterranean jet current is guided into a high conductivity channel under the crust of the Andes", and from this and other evidence, suggested that "a highly conductive sub-stratum comes close to the surface". Later, Schmucker (in *The Application of Modern Physics to the Earth and Planetary Interiors*, Wiley, 1969) noted that the depth of this high conductivity zone would have to be less than 50 km. These findings are clearly consistent with previously discovered associations between high conductivity (low resistivity) and velocity inversions.

The low velocity zones are apparently also consistent with various geochemical-petrological conclusions drawn by Pichler and Zeil (1970, quoted by Ocola and Meyer), who suggested that the acidic and basic lavas in northern Chile and southern Bolivia derive from different parent magmas at different depths. Ocola and Meyer point out, for example, that if each low velocity layer has the same composition as its corresponding host rock but is at a higher temperature, it would be "logical" to regard the shallow low velocity zone as the source of the acidic lavas and the deeper zone as the source of the basic lavas. Thus petrochemical studies, as electrical conductivity studies, imply a higher temperature origin for the low velocity zones.

Finally, in a quite different part of the world, Bamford (*Geophys. J.*, **30**, 101 ; 1972) has also used record sections, to obtain the first evidence for a low velocity zone in the crust beneath the British Isles. The basic data in this case were obtained in the 1969 Continental Margin Refraction Experiment between Wales and Ireland ; and first arrivals have already been interpreted by Bamford (*Geophys. J.*, **24**, 213 ; 1971) in terms of a single-layer crust. But a new analysis of later refractions and reflexions indicates a 4–5 km thick low velocity layer beginning at less than 12 km and having an average P wave velocity of 5.9 km s^{-1}. Immediately below the low velocity zone the P wave velocity is 6.4 km s^{-1}, and immediately above it is 6.2–6.3 km s^{-1}. Bamford is concerned to point out, however, that these figures were obtained assuming horizontal layering and are thus only approximate.

PHYSICAL METALLURGY

How to Design an Alloy

from our Materials Science Correspondent

METALLURGISTS have dreamed of sitting down with paper, pencil and slide-rule to design an alloy ever since Henry Sorby first used the microscope to examine the fine structure of metals and alloys more than a century ago. That episode signalled the beginning of the science of physical metallurgy and more generally (for Sorby also pioneered the use of the microscope in geology) of the scientific study of microstructure.

Real life has, however, been singularly resistant to this dream. Part of the difficulty has been that so much of the really interesting detail of microstructure is below the level of resolution of the optical microscope; this objection has been removed now that the electron microscopy of thin metal films is a fully mature technique. The problem now is a theoretical one; microstructures are only statistically determinate: they cannot be described by a set of precise drawings, as can a car or a bridge. Correspondingly, the statistical theories relating, in particular, mechanical properties at different temperatures to microstructure are subtle and necessarily inexact. Overall, the physical metallurgist, as he gains in knowledge and insight, can predict the kind of alloy and the kind of treatment that will approach the desired outcome: the empirical component can never be totally exorcised.

Several case histories to illustrate the gradual improvement in the design/empiricism ratio have been assembled and analysed by Cahn (*J. Metals*, February 1973). In particular, he analyses the stages by which the Nimonics and other high-temperature alloys for jet engines came to be improved: these stages involved, alternately, advances in theory and purely experimental leaps forward. Almost simultaneously with this survey, an account has appeared of the invention (there is no other word for it) of a high temperature alloy. Berghezan and Fourdeux (*Metallography*, **5**, 485; 1972) entitled their article "The Design of Specific Microstructures in Order to Obtain Materials with Desired Properties"—an ambitious but justified title.

Briefly, what these Belgian investigators have done is to formulate a design philosophy for producing an alloy with good mechanical properties over an exceptionally wide temperature range, based partly on an accumulation of empirical knowledge concerning dispersion-hardened alloys and partly on established theory. They specify the microstructural features called for by this design philosophy, and then predict how they may be achieved. The alloy is simple enough: a 90 per cent Ni/10 per cent Al matrix is made by sintering the constituent powders, slightly oxidized. The alloy contains both some γ' phase (ordered Ni_3Al) and some finely dispersed alumina. The achievement of the desired structure is confirmed not only by conventional electron microscopy but also by the new photoemission electron microscope.

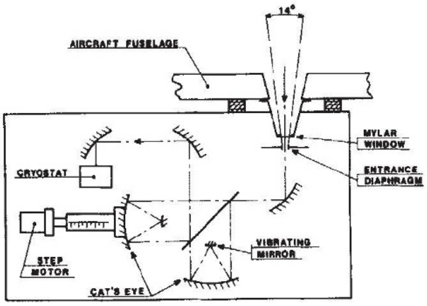
This article is not written with all the clarity one might desire, but nevertheless is both instructive and enjoyable.

Infrared Observations of the Stratosphere

OBSERVATIONS from a Caravelle aircraft which extend spectroscopic observations of the Earth's upper atmosphere to the range 25 to 200 cm^{-1} are reported in next Monday's *Nature Physical Science* (February 5). Previous studies of this kind have been restricted chiefly to the region 5 to 125 cm^{-1}.

The instrument—shown schematically in the figure—scans the sky through a 40 μm mylar window, and contains a detection element consisting of a germanium-doped bolometer at a working temperature of about 2 K. The spectra obtained show good consistency on different flights ; the most prominent features are due to H_2O rotational lines, O_2 triplets and the Q_R head branches of O_3.

Baluteau and Bussoletti, reporting this work, have also made assignments corresponding to CO, N_2O and NO transitions, because these are among the more common of the atmospheric trace gases. Some of these assignments are tentative, but there is good agreement with studies carried out at other frequencies.



Plan of the experimental system flown on the Caravelle to obtain high resolution spectra of the stratosphere between 30 and 200 cm^{-1}.