METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

I.—PROPERTIES OF METALS

*Redetermination of the Atomic Weight of Aluminium. James I. Hoffman and G. E. F. Lundell (*J. Research Nat. Bur. Stand.*, 1937, 18, (1), 1–18; *Research Paper* No. 957).—Weighed portions of the metal were converted to the hydroxide and sulphate, respectively, and these were then heated until they were changed to the oxide, Al_2O_3, which was finally ignited at 1200°–1300° C. By this procedure the atomic weight is related directly to that of oxygen. Careful analyses showed that the metal contained only very small quantities of impurities and disclosed no gases in the highly ignited oxide. Proper corrections were made for the small amount of impurities in the metal, and special precautions were taken to prevent absorption of moisture by the ignited oxide during weighing. The value for the atomic weight based on this work is $26·974 \pm 0·002$.—S. G.

*Investigations on Bismuth Crystals. III.—Heat and Electrical Conductivity in the Transition from Transverse to Longitudinal Magnetic Fields. E. Grüneisen and J. Gielessen (*Ann. Physik*, 1937, [v], 28, (3), 225–239).— Further measurements of the effect of magnetic fields on the heat and electrical conductivity of single crystals of bismuth have been made at —190° C. (cf. *Met. Abs.*, 1936, 3, 440, 489).—v. G.

*Magnetic Analysis of Evaporated Bismuth Films. C. T. Lane (*Phys. Rev.*, 1936, [ii], 50, (11), 1094).—Abstract of a paper read before the American Physical Society. By using a compensated Gouy method in conjunction with a Sartorius micro-balance, the magnetic susceptibility of bismuth films from 0·1 to 4 μ thick was determined. The films were deposited on thin glass plates (water-cooled) from vapour in high vacuum. The susceptibility was determined as a function of film thickness for the case where the plane of the film is perpendicular to the magnetic field. For films of more than 0·5 μ the susceptibility is independent of film thickness and equal to that of a single crystal with [111] parallel to the field. At angles other than the above, for films above 0·5 μ, the susceptibility obeys the same cos^2 law as a single crystal, with its trigonal axis in the plane of the field. Below 0·5 μ the susceptibility decreases as film thickness is reduced. Bismuth films ($> 0·5$ μ thick) deposited on gold, copper, and tin are identical with those deposited on glass. On the basis of a comparison between known results for single crystals and colloidal powder, respectively, and the present work, it is suggested that these films possess fibre structure of normal particle size above 0·5 μ and show microcrystalline fibre structure below this thickness.—S. G.

*The Thermal Expansion of the Bi Lattice Between 25° and 530° abs. (Jacobs and Goetz.) See p. 146.

*Native Bismuth and Bismuthite from Ishikawa. Shin Hata (*Rikwagaku Kenkyū-jo Ihō* (*Bull. Inst. Phys. Chem. Res.*), 1936, 15, (12), 1291–1292).— [In Japanese.] Native bismuth and bismuthite were found in pegmatite dykes of Arayashiki, Ishikawa, Fukushima Prefect, Japan. *Native bismuth:* In foliated, rhombohedral crystals, cleavage parallel to *c*. H = 2·5, G = 9·84. Lustre metallic, streak and colour silver white. The analysis was: bismuth

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* Denotes a paper describing the results of original research.
† Denotes a first-class critical review.

98·0, lead 1·0, antimony 0·2, vanadium 0·2, iron 0·1, manganese + zinc 0·2, CaO 0·8, SiO$_2$ 0·3 (total 100·8%).—S. G.

*On the Magneto-Resistance Effect in Single Crystals of Cadmium. C. J. Milner (*Proc. Cambridge Phil. Soc.*, 1937, **33**, (1), 145–153).—A method is described for growing single crystal resistance specimens free, to a large extent, from strains and impurities. The magneto-resistance effect in cadmium single crystals was studied in some detail at the temperature of liquid nitrogen, using sufficiently high magnetic fields to observe the linear effect found by Kapitza. Although it proved to be impossible, in general, to determine the orientation of individual crystals, the experiments suggest that the " critical field " of the linear effect is dependent on the orientation of the crystal with respect to the current and magnetic field, and not on the perfection of the crystal lattice.
—S. G.

*The Electrical Conductivity of Thin Metallic Films. II.—Cæsium and Potassium on Pyrex Glass Surfaces. E. T. S. Appleyard and A. C. B. Lovell (*Proc. Roy. Soc.*, 1937, [A], **158**, (895), 718–728).—The electrical conductivities of thin films of cæsium and potassium on Pyrex glass surfaces were studied by the method previously used for rubidium (Lovell, *Met. Abs.*, 1936, 3, 494). The decay of conductivity after the deposition of the films decreases in the order potassium, rubidium, cæsium for a film under given conditions. At 64° K. cæsium films only a few A. thick are stable, but potassium films thinner than 30 A. are unstable. Conductivity was observed for cæsium films only 0·3 A. thick. [*Note by Abstractor:* The film thickness is calculated on the assumption that the films contain the same number of atoms per cm.^{3} as the bulk metal. A film of thickness t A. contains $t/6·05$ atomic layers of cæsium, or $t/5·20$ atomic layers of potassium. A cæsium film 0·3 A. thick implies a partially covered surface.] The previous theory (Lovell, *loc. cit.*) is confirmed.—W. H.-R.

Secondary [Electron] Emission and Fatigue Phenomena Exhibited by Photo-Sensitive Oxygen-Cæsium Electrodes. I. F. Kwarzchawa (*Physikal. Z. Sowjet-union*, 1936, **10**, (6), 809–819).—[In German.] Secondary electron emission is reduced by fatigue of an oxygen-cæsium surface. The marked secondary emission of the surface is attributable to adsorbed cæsium atoms at the cæsium oxide layer by primary and secondary electrons. The mechanism of the emission is discussed. Oxygen-cæsium surfaces possessing a large coefficient of secondary emission can be produced by the oxidation of metallic cæsium deposited upon a silver oxide (Ag$_2$O) surface.—J. S. G. T.

*The Exact Measurement of the Specific Heats of Metals at High Temperatures. XXVI.—The Specific Heats and the Electrical Resistance of Cerium. F. M. Jaeger, J. A. Bottema, and E. Rosenbohm (*Proc. K. Akad. Wet. Amsterdam*, 1936, **39**, (8), 912–920).—[In English.] Below its melting point (635° C.) cerium exists in at least 3, and probably even 4, different crystalline forms. Transformations occur at − 174°, 362°, about 503°, and probably at above 530° C. Values of the mean specific heat ($\bar{c}_p$) of cerium (purity, 98%) between about 20° and 530° C. have been determined. It is suggested that between 380° and 480° C. the true specific heat of cerium c_p, can, with a fair degree of accuracy be represented by $c_p = 0·0523 + 0·31 \times 10^{-6}(t − 380)$, and the atomic heat, C_p, by $C_p = 7·3377 + 0·43493 \times 10^{-2} (t − 380)$.
—J. S. G. T.

*The Structure and Electrical Conductivity of Thin Films of Indium. V. E. Cosslett (*Proc. Phys. Soc.*, 1937, **49**, (2), 121–131 ; discussion, 131–133).—The high electrical resistance and negative temperature coeff. of thin films of indium prepared in a moderate vacuum (10^{-4} to 10^5 mm.), without exhaustive cleaning of the substrate, are shown, by electron diffraction methods, to be in no way connected with any amorphous form of the metal. The lattice of freshly deposited films corresponds in form with that of the metal in bulk, but gives a

spacing 0·7% greater than that found by recent X-ray work. With slowly-deposited films the spacing increases and the axial ratio decreases with increase of temperature up to room conditions; this process is carried further by exposure to air until a film showing a cubic indium lattice with spacing 3·4% greater than that of the bulk metal is obtained; this change is accompanied by slow oxidation. It is suggested that the high resistance of the films is attributable to sorption of residual gas, and that the negative temperature coeff. is due to desorption and resorption processes; the change in lattice constant is due to the action of gas within the lattice.—J. S. G. T.

*Mechanism of Creep and Fatigue Limit Investigated on Lead and Lead Alloys. Klaus von Hanffstengel and Heinrich Hanemann (*Z. Metallkunde*, 1937, **29**, (2), 50–52).—Since the experiments may be conducted at room temperature, lead is a suitable metal for investigating creep phenomena. A permanent rate of creep is set up after only a short time of loading and the fatigue limit can be determined by measuring the constant rate of creep. The results obtained with pure lead support the theory that creep is the result of three processes of deformation, namely (1) elongation by place exchange processes at the grain boundaries; (2) elongation by place exchange inside the crystals by recrystallization or recovery; and (3) elongation by translation. Under small loads or low rate of creep elongation occurs chiefly by grain-boundary effects (1), whereas at high rates of creep the process is controlled by factors (2) and (3).—A. R. P.

*On the Influence of Small Additions on the Recovery Temperature, Grain-Size, and Hardness of Lead. (Jenckel and Hammes.) See p. 141.

*A Study of Old Steel Bridges [Crushing Deformation of Lead]. —— Vallette (*Ann. Ponts Chaussées*, 1936, **106**, (9), 387–412).—The latter part of the paper describes comparative tests on lead and rubber sole-plates for use in metal bridges. The investigations included a determination of the crushing deformation of lead under gradually and rapidly increased load, from which the shock-absorbing qualities of the material are then deduced.—P. M. C. R.

*Desulphurization of Manganese as Viewed from the Free Energy. Kôkiti Sano (*Kinzoku no Kenkyu (J. Study Metals)*, 1936, **13**, (10), 425–431).—[In Japanese.] The equilibrium const. of the desulphurizing reaction FeS (1) + Mn (1) = MnS (1) + Fe (1) was calculated from the free energy of formation of manganous sulphide and ferrous sulphide as 14·42 at 1600° C. This means that manganese is not such an efficient desulphurizing agent as has been supposed.—S. G.

*Spectral Energy Distribution and Light Output Associated with the [Electric] Discharge in Mercury Vapour at High Pressures. H. Krefft, K. Larché, and F. Rössler (*Z. tech. Physik*, 1936, **17**, (11), 374–377).—It is shown *inter alia* that the light output from an electric discharge in mercury vapour increases steadily with increase of vapour pressure up to 30 atm. Details concerning the spectral distribution of the radiation are given.—J. S. G. T.

*The Light Density of the Mercury [Electric] Discharge at High Pressures. R. Rompe and W. Thouret (*Z. tech. Physik*, 1936, **17**, (11), 377–380).—Characteristics of the light yield from the electric discharge in mercury vapour are investigated for pressures up to 60 atm. and for current strengths up to 8 amp. The light output and density are found to increase linearly with the current.
—J. S. G. T.

*On the Measurement of Young's Modulus of Elasticity of Iron, Nickel, and Cobalt at High Temperatures. Kiyosi Nakamura (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 146–157).—[In English.] The method of measuring Young's modulus of elasticity of ferromagnetic and non-ferromagnetic substances was improved, and the moduli of iron, nickel, and cobalt were measured at high temperatures and under a constant magnetic field. It was found that the allotropic transformation of cobalt and the magnetic trans-

formation of nickel, lying in the experimental range of temperatures, show anomalies in the modulus–temperature curves.—S. G.

*Inertia and Chemical Activity of the Rare Gases. X.—Modifications of the Density of Platinum by the Chemical and Physico-Chemical Action of Helium, and the Effect of Temperature on the Density of the Product Formed. Horacio Damianovich and Jose Piazza (*Anales Soc. cient. argentina, Sección Santa Fé*, 1936, **7**, 59–61; *C. Abs.*, 1937, **31**, 934).—When the platinum–helium product obtained by the technique previously described (*Met. Abs.*, this vol., p. 143) was decomposed by heat, 80% of the total gas was evolved at about 330° C. During expulsion of the gas (60% helium, 40% air) at this temperature and up to 450° C. the density of the product began to increase from $16 \pm 5\%$ to a maximum of 21·5. These results indicate a platinum–helium compound which, when heated, leaves platinum in an allotropic form having a lower density than ordinary platinum, into which it is reconverted at about 450° C.
—S. G.

*The Electrical Conductivity of Thin Films of the Alkali Metals Spontaneously Deposited on Glass Surfaces. A. C. B. Lovell (*Proc. Phys. Soc.*, 1937, **49**, (2), 89–94).—The resistivity of invisible thin films of three of the alkali metals, spontaneously deposited on glass *in vacuo* is found to decrease in the order potassium > rubidium > cæsium. The value of the resistivity of the rubidium film is in reasonable agreement with the value found by Ives and Johnsrud (*J. Opt. Soc. Amer.*, 1927, **15**, 374). The spontaneous deposits are of the order of thickness of monatomic layers.—J. S. G. T.

*The Effect of Orientation on Stresses in Single Crystals and of Random Orientation on Strength of Polycrystalline Aggregates. H. L. Cox and D. G. Sopwith (*Proc. Phys. Soc.*, 1937, **49**, (2), 134–151).—A method is described for tabulating resolved shear stresses for any type of slip system. Diagrams of maximum resolved shear stress for torsion and tension as functions of orientation are drawn for aluminium, with slip plane of type (111) and slip direction of type (110), and for iron with slip direction of type (111) and any slip plane. Similar diagrams of harmonic mean stress in torsion also are drawn. The effect of different criteria of failure in indicating the failure of polycrystalline specimens is investigated. If elastic failure of polycrystalline specimens is determined entirely by the maximum resolved shear stress developed locally, the ratio of the yield in torsion to the yield in tension should be 0·500; if elastic failure is determined by complete yield of all crystals of the specimen the ratio should be about 0·577.—J. S. G. T.

Theory of Creep under the Action of Combined Stresses, with Applications to High-Temperature Machinery. Folke K. G. Odqvist (*Ingeniörsvetenskapsakad. Handlingar*, 1936, (141), 31 pp.).—[In English.] The creep of solids at temperatures well above the temperature of recrystallization is discussed mathematically. The theory is such that it is unnecessary to make assumptions as to the ratio between the velocities of creep strain in tension and in torsion as is the case in Bailey's treatment of creep. The theory is applied to (1) the loosening of rivets and bolt joints; (2) a thin-walled circular tube under twist and tension; (3) creep stresses in a rotating disc; (4) the creep of turbine discs at high temperatures; (5) loosening of a shrink-fit; and (6) force fits for high-temperature service. A reliable method of fixing discs to a shaft for high-temperature work, not requiring a force fit, is described.—J. S. G. T.

*Temperature Changes in the Stretching of Metal Rods [Copper, Nickel, Steels]. Gustav Tammann and Hildegard Warrentrup (*Z. Metallkunde*, 1937, **29**, (3), 84–88).—When a metal rod is stretched its temperature decreases in the elastic region but increases rapidly during the plastic state. If an annealed rod is stretched the increase in temperature in the plastic region increases exponentially with the increase in internal stress produced by the stretching; if the rod is first stretched beyond its elastic limit and again submitted to stretching the

stress–increase in temperature curve for stresses greater than that which was first applied shows a well-marked point of inflection. These results were obtained with nickel, copper, and mild steel rods.—A. R. P.

*On the Diffusion of Gases Through Metals. Jwu-shi Wang (*Proc. Cambridge Phil. Soc.*, 1936, **32**, (4), 657–662).—The results of experiments on the diffusion of hydrogen through metals from a pressure p on one side to a vacuum on the other show that at high pressures the amount diffusing varies linearly with $p^{\frac{1}{2}}$, but that at low pressures it varies more rapidly. The difficulty usually encountered when diffusion from an adsorbed layer into the solid is considered theoretically is that the theory indicates that saturation should be reached. W. shows that this difficulty is due to the omission of an important process at the surface and that by including this process the experimental results can be explained.—S. G.

Electron Exchange in the Theory of Metals. John Bardeen (*Phys. Rev.*, 1936, [ii], **50**, (11), 1098).—Abstract of a paper read before the American Physical Society. A discussion is given of the general principles underlying the application of the Fock equations, which include the effects of electron exchange, to such problems as the specific heat of electrons, conductivity, thermionic emission, thermoelectricity, &c. The energy parameter, $E(k, T)$, of the Fock equation corresponding to the wave-function $e^{ikx}\psi_k(x)$, depends on the distribution of the remaining electrons in k space, and is thus a function of the temperature. The usual distribution formula for Fermi–Dirac statistics applies with $E(k, T)$ replacing the individual electron energy, ε_k, even though the total energy is no longer given by $\Sigma E(k, T)$. Since the exchange energy is a function of k, the distribution will be modified even if the electrons are free except for their mutual electrostatic interaction. The specific heat of free electrons goes to zero at $T = 0$ as $aT/\log(\varepsilon/kT)$. At ordinary densities and temperatures it is smaller than that predicted by the usual theory by a large factor ($\sim$ 3–7). The theoretical value of the resistivity of a metal like sodium, the electrons of which are essentially free, is reduced by the same factor. Expressions for the total current resulting from a given distribution of electrons are discussed in their relation to the problems of conductivity, thermionic emission, and thermoelectricity.—S. G.

*On the Energy States of Valency Electrons in Some Metals. I.—The Stationary States of Valency Electrons in Zn Crystal (3). Mituru Satô (*Kinzoku no Kenkyu (J. Study Metals)*, 1936, **13**, (9), 394–400).—[In Japanese.] See abstract from an English source, *Met. Abs.*, this vol., p. 95.—S. G.

*On the Energy States of Valency Electrons in Some Metals. I.—The Nature of the Electrode Potential of Zn and H$_2$ and the Mechanism of Catalytic Action of the Metal Surface (4). Mituru Satô (*Kinzoku no Kenkyu (J. Study Metals)*, 1936, **13**, (12), 486–514).—[In Japanese, with English summary.]—S. G.

*On the Energy States of Valency Electrons in Some Metals. I.—The Threshold Value of the Overpotential of Hydrogen on the Zinc Electrode (5). Mituru Satô (*Kinzoku no Kenkyu (J. Study Metals)*), 1937, **14**, (1), 35–40).—[In Japanese, with English summary.]—S. G.

Seventh Report of the Atomic Weights Committee of the International Chemical Union. G. P. Baxter, O. Hönigschmid, and P. Lebeau (*J. Amer. Chem. Soc.*, 1937, **59**, (2), 219–226; and *Ber. deut. chem. Ges.*, 1937, [A], **70**, (2), 43–55).—Revised atomic weights accepted by the Committee are : carbon, 12·01 ; rubidium, 85·48 ; gadolinium, 156·9 ; lead, 207·21 ; uranium, 238·07. Recent work on atomic weights is summarized, and a revised list of atomic weights is given.—P. M. C. R.

*On After-Effects Produced on Metal Surfaces by Cathode-Ray Bombardments or by Low-Pressure Gas Discharges. Mitio Hatoyama and Motoharu Kimura (*Rikwagaku Kenkyū-jo Ihô (Bull. Inst. Phys. Chem. Res.*), 1936, **15**,

(8), 681–691).—[In Japanese.] An English summary is given in the supplement to *Sci. Papers Inst. Phys. Chem. Res. (Tokyo)*, 1936, **29**, 642–644.—S. G.

*On the Optical and Electrical Properties of Thin Metallic Films at Low Temperatures.—I. Tadao Fukuroi (*Rikwagaku Kenkyū-jo Ihō (Bull. Inst. Phys. Chem. Res.*), 1936, **15**, (7), 411–429).—[In Japanese.] See abstract from an English source, *Met. Abs.*, this vol., p. 81.—S. G.

*On the Optical and Electrical Properties of Thin Metallic Films at Low Temperatures.—II. Tadao Fukuroi (*Rikwagaku Kenkyū-jo Ihō (Bull. Inst. Phys. Chem. Res.*), 1936, **15**, (8), 663–673).—[In Japanese.] The decreases in electrical resistance due to exposure to ultra-violet rays, *i.e.* photoconductivity, of condensed films of mercury, cadmium, and zinc were studied at low temperature.—S. G.

*Thermionic Emission into Dielectric Liquids. Edward B. Baker and Howard A. Boltz (*Phys. Rev.*, 1937, [ii], **51**, (4), 275–282).—Thermionic emission has been observed for platinum–iridium, and nickel electrodes immersed in toluene at 45° C. The current–voltage relation obeys the law $I = I_0 e^{((\epsilon FD)^{1/2}/kT)}$, where I is the current, F the field, and D the dielectric constant of the liquid. This is a modification of the Schottky law for a vacuum, and the work-function is decreased since the energy necessary to transfer an electron from the metal to a vacuum is greater than that required to transfer it to a dielectric liquid. The problem is of importance in connection with oil-insulated cables, since electrons emitted in this way may impair the insulating qualities, and cause chemical deterioration of the oil.—W. H.-R.

*On Thermal Conductivity at Low Temperatures. W. J. de Haas and Th. Biermasz (*Comm. K. Onnes Lab. Univ. Leiden*, 1937, Suppt. No. **82** to Nos. **241–252**, 13 pp.).—[In French.] Read at the 7e. Congrès international du Froid; see *Met. Abs.*, this vol., p. 2.—S. G.

†Photoelectricity. G. A. Boutry (*Rep. Prog. Physics*, 1936, **3**, 272–289).—Developments in photoelectricity during 1934–1935 are reviewed. Doubt is thrown on the existence of photoconductivity in thin layers of metals, as claimed by Majorana. The subjects reviewed include: photoemission, photoconductivity, photoelectric potential differences, and applications. A *bibliography* of 139 references is appended.—J. S. G. T.

*The Electrical Conductivity of Pure Metals. W. J. de Haas and G. J. van den Berg (*Comm. K. Onnes Lab. Univ. Leiden*, 1937, Suppt. No. **80** to Nos. **241–252**, 10 pp.).—[In French.] Read at the 7e. Congrès international du Froid; see *Met. Abs.*, this vol., p. 3.—S. G.

*On the Increase of Electrical Resistance in a Magnetic Field and on Diamagnetism. W. J. de Haas and J. W. Blom (*Comm. K. Onnes Lab. Univ. Leiden*, 1937, Suppt. No. **82** to Nos. **241–252**, 19 pp.).—[In French.] Read at the 7e. Congrès international du Froid; see *Met. Abs.*, this vol., p. 3.—S. G.

*The Nature of the Superconducting State. J. C. Slater (*Phys. Rev.*, 1937, [ii], **51**, (3), 195–202).—Theoretical. Perturbation theory is applied to Bloch's theory of metallic conduction. The excited states of a metal form a continuum of which the lower boundary is the normal state, and it is concluded that under some circumstances a few of the lowest states may be depressed below their normal positions, and that electrons in those states give rise to superconductivity. It is shown that superconductivity is not to be expected for the alkalis or for copper, silver, and gold, whilst the transition metals would be expected to show superconductivity only at very low temperatures.
—W. H.-R.

†Superconductivity and the Theory of Metals. A. H. Wilson (*Rep. Prog. Physics*, 1936, **3**, 262–271).—After a brief introduction containing a brief outline of the phenomena of superconductivity, W. discusses the thermodynamics of superconductivity, as developed by Casimir and Gorter. The treatment is limited to ideal superconductors in which the magnetic induction is zero. The

various thermodynamic relations deduced are verified by experimental data relating to tin, thallium, and indium, and are well substantiated by experiments on pure substances in the shape of rods. The influences of shape and purity of the materials are discussed. The disturbance of superconductivity in an alloy by a magnetic field shows many anomalous features. The thermal conductivity of a metal is altered when it becomes superconducting. When superconductivity is destroyed by a magnetic field the thermal resistance is decreased. No headway has been made in understanding the mechanism of superconductivity ; the existence of a transition temperature and of a threshold magnetic field lie quite outside the domain of any theory hitherto proposed.

—J. S. G. T.

*Relaxation Phenomena in Superconductivity. W. H. Keesom and P. H. van Laer (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 64–66).— [In English.] In measurements carried out for a closer study of the thermal properties of tin in connection with the transition from the superconducting to the non-superconducting state, it was observed that in the intermediate region of temperature after heating a tin ellipsoid suspended in a vacuum, a magnetic field being applied, equilibrium was attained only about 30 seconds after heating had been stopped. If on the contrary the transition from the superconducting to the non-superconducting state was realised by increasing the magnetic field by steps, the temperature immediately took its new value.—S. G.

*The Optical Reflectivity of Metals in the Superconducting State. E. Hirschlaff (*Proc. Cambridge Phil. Soc.*, 1937, **33**, (1), 140–144).—Measurements of the reflection coeff. at normal incidence on lead and tantalum mirrors in the superconducting and non-superconducting states did not reveal any change within the limits of accuracy (0·2–0·5% in R). This does not agree with a suggestion of R. de L. Kronig (*Proc. Roy Soc.*, 1935, [A], **152**, 16), according to which an increase in reflectivity of about 35% could have been expected.—S. G.

On the Category of the Carrier-Electrons Concerned in Superconduction. Robert Forrer (*J. Phys. Radium*, 1937, [vii], **8**, (2), 67–80).—The significance of certain special types of electronic distributions in the discussion of whether a metal or alloy is superconducting or not is considered at considerable length.

—J. S. G. T.

On Superconductivity. W. J. de Haas, O. A. Guinau, and J. M. Casimir-Jonker (*Comm. K. Onnes Lab. Univ. Leiden*, 1937, Suppt. No. 82 to Nos. 241–252, 19 pp.).—[In French.] Read at the 7e. Congrès international du Froid ; cf. *Met. Abs.*, 1935, **2**, 585 ; 1936, **3**, 240.—S. G.

†Magnetism. L. F. Bates (*Rep. Prog. Physics*, 1936, **3**, 175–205).—Progress in magnetism, mainly experimental, and principally during the last 7 years or so, is briefly reviewed. Amongst the subjects discussed are : the production and measurement of magnetic fields, measurements of magnetic susceptibility, magnecrystalline properties, experiments with single particles, gyromagnetic phenomena, ferromagnetism, resistance measurements in magnetic fields, and magnetostriction phenomena. Amongst interesting points may be mentioned that a magnet employing about 65 tons of metal in the magnet circuit, and using exciting coils weighing about 9 tons has been constructed (p. 175) ; the magnetic anisotropy of a bismuth crystal has been found to be $\chi_\perp/\chi_\parallel = 1\cdot425$ (p. 183) ; the magnetic anisotropy of bismuth is affected by an added impurity only when the added impurity is soluble, and is increased when the impurity is electropositive with respect to bismuth, and decreased when it is electronegative (p. 184) ; the value of the Bohr magneton has been found to be $0\cdot916 \times 10^{-20}$ erg. gauss, correct to 0·5% (p. 186) ; gyromagnetic phenomena indicate that for all ferromagnetics, with few exceptions, electron spin accounts for almost all, if not all, the observed ferromagnetism ; gadolinium metal has been found to be ferromagnetic, with a ferromagnetic Curie point at $16° \pm 2°$ C. (p. 193) ; manganese is definitely paramagnetic only (p. 193).—J. S. G. T.

†**Soft Magnetic Materials and Magnetic Measurements.** C. E. Webb (*Rep. Prog. Physics*, 1936, **3**, 227–234).—The magnetic permeability of materials is greatly affected by the presence of carbon and oxygen. By the elimination of these from iron, Yensen and Ziegler have obtained specimens of iron with max. permeabilities up to 220,000. The permeability is also largely affected by magnetostriction changes of dimensions on magnetization. Iron–nickel–copper alloys in which the magnetostriction is zero have a high initial permeability (13,500). A permeability of 610,000—the highest ever recorded—has been obtained in 65 Permalloy by cooling from 650° C. in a magnetic field of 10 oerstedts. A permeameter for the measurement of magnetic flux by means of the pressure set up in a plane helix of mercury traversed by mutually perpendicular current and flux has been described by Somaini. Other subjects discussed in the report include : magnetostriction in bismuth crystals, susceptibility measurements, hysteresis at low flux densities, and incremental permeability measurements.—J. S. G. T.

The Magnetic Properties of Elements. A Survey. Edmund C. Stoner (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 283–305).—[In English.] A survey is made of the magnetic properties of the elements. The theory of magnetic susceptibility is outlined under 6 headings—atomic, molecular and crystalline diamagnetism, atomic and molecular paramagnetism, and collective electron susceptibility. The para- and diamagnetism due to collective electrons, both free and bound, and the temperature variation, are considered in some detail as being of primary importance in connection with the susceptibility of the metals, comprising the great majority of the elements. A table is given showing the room temperature gram atomic susceptibility, variation with temperature and change at the melting point for all elements for which reasonably reliable results are available ; this table is supplemented by additional notes on some of the elements. The elements are then discussed in turn in appropriate groups corresponding either to the columns of the periodic table or, for the transition elements, the rows. Particular attention is paid to the metals. Attention is directed throughout to questions requiring further experimental or theoretical investigation.—S. G.

On the Theory of Ferromagnetism. H. A. Kramers (*7e. Congr. internat. Froid, Rapports et Communic.*, No. 29, 1936 ; and *Comm. K. Onnes Lab. Univ. Leiden*, 1937, Suppt. No. 83 to Nos. 241–252, 22 pp.).—[In German.] K. develops the thermodynamical theory of a system consisting of a very large number of particles characterized by an energy-function, or, in the language of quantum mechanics, an energy-operator, of which the eigen values are less than a finite upper limiting value, and applies it to the Heisenberg model of ferromagnetism. The respective formulæ expressing the relative magnetic saturations at very high and very low temperatures, derived by Heisenberg and Bloch are thus obtained.—J. S. G. T.

The Elastic Deformation of Ferromagnetism. Francis Bitter (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 228–234).—[In English.] The notion of elastic deformation of a vector field is introduced, and differential equations governing the behaviour of a simple model are derived. A particular solution is given and discussed in relation to the problem of ferromagnetism. It is shown that elastically distorted spontaneous magnetization can describe ferromagnetism as well as the usually assumed " regions of spontaneous magnetization," and that the regular powder patterns observed on single crystals may be due to the elastic deformations discussed.—S. G.

*An Explanation for Directions of Easy Magnetization in Ferromagnetic Cubic Crystals. R. M. Bozorth and L. W. McKeehan (*Phys. Rev.*, 1937, [ii], **51**, (3), 216).—A theoretical note. The magnetic anisotropy equation for ferromagnetic cubic crystals may be written $E = K_0 + K_1(S_2{}^2S_3{}^2 + S_3{}^2S_1{}^2 + S_1{}^2S_2{}^2) + \ldots$, where K_1 is positive for iron but negative for nickel. S_1, S_2,

and S_3 are the direction cosines of the magnetization vector at any point with respect to the cubic axes, E is the magnetic potential energy density associated with this state, and K_0 and K_1 are constants independent of the direction cosines. No satisfactory explanation of the difference in sign of K_1 in different materials has previously been advanced. If the dipoles associated with each lattice point form a small magnet of finite length, calculations show that K_1 is negative; when they form a disc equivalent to a circular current loop, K_1 is positive. The sign of K_1, and hence the direction of easy magnetization may be determined by the distribution about the atom centre of the spinning electrons ($3d$) that are associated with ferromagnetism. If this distribution approximates to that of a bar magnet, K_1 will be negative; if the distribution resembles a circular disc, K_1 will be positive. The change of sign of K_1 in some alloy series can thus be understood.—W. H.-R.

*Magnetization Discontinuities Produced by Variation of the Circular Magnetization of a Ferromagnetic Material. St. Procopiu (*Ann. Sci. Univ. Jassy*, 1937, 23, 168–176).—[In French.] P. investigates experimentally what is termed the circular Barkhausen effect. Discontinuities of magnetization are obtained when an a.c. flows in a wire of iron or nickel provided that the current intensity exceeds the value necessary to produce a circular magnetic field equal to the coercive field of the material of the wire. The same effect can be produced by variation of a continuous axial current. The effect is 3 times as marked in iron as in nickel; the saturation magnetic intensity in iron is $3\cdot6$ times that in nickel. The mechanism of the effect is discussed.—J. S. G. T.

The Theory of Hysteresis Loss in Ferromagnetic Metals Under Strong Elastic Stress. N. S. Akulov (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 271–282).—[In English.] It is shown that Becker's theory of magnetization curves for strong fields is a particular case of A.'s general theory. Becker's formula for the initial permeability can be obtained from A.'s formula for the magnetization curves by the supposition that natural anisotropy in the crystal is absent ($K = 0$; $\lambda_{100} = \lambda_{111}$). Further, a more general formula for initial permeability is given. The case of sections of a curve, where the susceptibility is negative, is also discussed and it is shown that their form may be determined from magnetization curves for single crystals under stress. The rôle of inversion, which is not dealt with by Becker, is here treated, a hysteresis loop for a twisted wire being taken as an example. Several conclusions are reached leading towards an explanation of the remarkable properties of the alloys of Honda and Mishima.—S. G.

II.—PROPERTIES OF ALLOYS

*Heat-Resisting Alloys. Eric Murphy (*Aluminium and Non-Ferrous Rev.*, 1936, 2, (2), 55–57; (3), 101–104).—The equilibrium diagram of the iron–aluminium series (the basis of the iron–aluminium–chromium type of heat-resisting alloys) is discussed critically. Additional data in the form of thermal curves and photomicrographs are given to show that alloys containing up to 30% aluminium consist of α solid solution at all temperatures up to the solidus, with the exception of a narrow region within γ and $\alpha + \gamma$ loops, which exist only between 900° and 1400° C. and extend to between $1\cdot10$ and $1\cdot15\%$ aluminium. The magnetic change is not depressed by aluminium additions up to 30%, remaining constant at 750° C. Additions of chromium to give alloys containing iron 65–75, aluminium 3–5, chromium 20, with the optional addition of cobalt up to 2%, result in the Kanthal alloys, suitable for service as heating elements for furnace temperatures up to 1350° C. Details are given of the properties of these alloys, with notes on their manipulation and use in the construction of heating elements.—J. C. C.

*The Complete Equilibrium Diagram of the System Al–Mg–Zn. Matsujiro Hamasumi (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 748–776 (in English); and *Tetsu-to-Hagane* (*J. Iron Steel Inst. Japan*), 1936, **22**, (4), 258–271 (in Japanese)).—The complete diagram of the system aluminium–magnesium–zinc was studied by thermal and X-ray analyses and microscopic examination and the diagram of Eger was thoroughly revised. In this system there exists a ternary solid solution ω in place of the ternary compound $Al_3Mg_7Zn_6$ found by Eger, which has considerable extension at various temperatures. If V is taken as the basal compound of the solid solution ω the system may be divided into 4 fields: $Al–Zn–MgZn_2$, $Al–Al_3Mg_2–MgZn_2$, $Mg–V–Al_3Mg_2$, and $Mg–V–MgZn_2$; each may be treated as a pseudo-ternary system. The systems $Al–MgZn_2$ and $Al_3Mg_2–MgZn_2$ can each be treated as an independent binary system. Special consideration was given to the solution of the relationship arising from the λ-phase in the aluminium–zinc system and the η-phase in the magnesium–zinc system.—S. G.

*On the Age-Hardening Mechanism in Al–MgZn$_2$ Alloys. Sadajirô Kokubo (*Kinzoku no Kenkyu* (*J. Study Metals*), 1937, **14**, (1), 1–10).—[In Japanese.] See abstract from English source, *Met. Abs.*, this vol., p. 85.—S. G.

*On the Question of the Age-Hardening of Silicon–Aluminium Alloys. Werner Helling (*Z. Metallkunde*, 1937, **29**, (1), 25–28).—The hardening effect obtained by ageing at 200° C. silicon–aluminium alloys which have been quenched from 570° C. increases with the silicon content to a maximum at 1·6% silicon, and then decreases sharply with increasing silicon content; with increasing iron content the hardening effect appreciably decreases. On ageing the 1·54% silicon alloy at 400° C. the hardness increases rapidly to a maximum in 1 minute then decreases rapidly to a minimum in 10 minutes; at 250° C. there is a rapid increase in hardness during 30 minutes followed by a further small increase during the next 90 minutes, and at 200° C. the hardness curve has a parabolic form with a maximum hardness in 5 hrs. The maximum tensile strength is obtained by ageing for 1 hr. at 218° C. (19·3 kg./mm.²), but if the alloy is cold-drawn before ageing a strength of 25·3 kg./mm.² is obtained in 4 minutes at 218° C. Some corrosion tests in various solutions indicate that the behaviour of the alloy varies considerably with the amount of graphitic silicon present and with the nature and concentration of the corrosive medium.—A. R. P.

*The Influence of Hydrostatic Pressure on the Age-Hardening of Duralumin. Gustav Tammann and Hans Hartmann (*Z. Metallkunde*, 1937, **29**, (3), 88–89). —Hydrostatic pressure retards the age-hardening of Duralumin, the effect increasing with increase in pressure above 3000 kg./mm.².—A. R. P.

*Influence of Mechanical Vibrations on the Tensile Properties of Constructional Materials [Aluminium, Duralumin, Brass, Elektron, Steel]. Georg Welter (*Z. Metallkunde*, 1937, **29**, (2), 60–62).—Comparative tensile tests were made on 3–4 mm. test-pieces of steel, brass, aluminium, Duralumin, and Elektron with and without vibrations produced by drawing a violin bow across the specimen. The results show that vibrations cause a considerable decrease in the values of the tensile properties, the strength being reduced by 3·7–8·6%, the elongation by 7·5–47%, and the work absorption by 18·1–54·7%. In structures built up of these metals the effect of vibrations is the greater the higher is the temperature, the greater is the relative loading, and the more unfavourable is the critical vibration frequency of the material.—A. R. P.

*On Free-Cutting Aluminium Alloys. H. Kästner (*Metallwirtschaft*, 1936, **15**, (52), 1217–1221).—The opinion is expressed that aluminium alloys are free-cutting only when they contain a constituent which is incompletely soluble in the molten alloy, *e.g.* lead, cadmium, thallium, or Mg_3Bi_2. The alloys WJ301 (Duralumin basis) and WA301 (Pantal basis) have such additions; the former has a high tensile strength and the latter, being free from

copper, a high resistance to corrosion. The exact compositions of these alloys are not stated, but examples are given of their use as substitutes for 58% copper brass.—v. G.

Albondur—Bondur—Bondurplat. —— (*Apparatebau*, 1936, **48**, (22), 243–246).—An account is given of the heat-treatment and ageing of Bondur, with graphical summaries of its principal mechanical properties in relation to annealing temperature and period of storage. The properties of Bondur sheet, strip, rod, pressed sections, tubing, and wire are tabulated, the necessary corrections in the case of Albondur and Bondurplat being indicated.—P. R.

Pantal. —— (*Apparatebau*, 1936, **48**, (24), 265–266).—An account of the properties, working, welding, surface treatment, and uses of Pantal. A table is given of the mechanical properties produced by various types of thermal and mechanical treatment.—P. M. C. R.

K.S.–Seewasser—B.S.–Seewasser. —— (*Apparatebau*, 1936, **48**, (26), 289–290).—The influence of heat-treatment on the mechanical properties of K.S.– and B.S.–Seewasser is shown graphically; the properties of K.S.– and of 3 grades of B.S.–Seewasser are tabulated, and a brief account is given of both types of alloy.—P. M. C. R.

*****The Curie Ferromagnetic Points of Some Cobalt Alloys.** Toma Farcaş (*Ann. Sci. Univ. Jassy*, 1937, **23**, 125–149).—[In French.] Values were determined of the Curie ferromagnetic points of electrolytic cobalt and of binary alloys of cobalt with chromium, tungsten, manganese, molybdenum, and aluminium. The Curie point (θ) for cobalt is found to be $1145°$ C. ($1418°$ K.). Values of θ for the various series of alloys containing the respective percentages (atomic) of the metal added to cobalt were found as follows : chromium–cobalt alloys : $5·6\%$, $1190°$ K. ; $10·6\%$, $983°$ K. and $943°$ K. ; $16·6\%$, $719°$ K. ; $22·1\%$, $466°$ K. and $461°$ K. ; $24·2\%$, $227°$ K., after heat-treatment at $1000°$ C. ; manganese–cobalt alloys : $1·6\%$, $1371°$ K. and $1400°$ K. ; $3·2\%$, $1338°$ K. ; $4·2\%$, $1284°$ K. ; $10·60\%$, $1058°$ K. ; $10·65\%$, $1145°$ K. ; $15·9\%$, $915°$ K. and $923°$ K. ; $18·6\%$, $799°$ K. and $787°$ K. ; $21·6\%$, $673°$ K. and $618°$ K. ; tungsten–cobalt alloys : $1·6\%$, $1325°$ K. ; $3·4\%$, $1253°$ K. ; $5·3\%$, $1187°–1245°$ K. ; $6·6\%$, $1110°–1241°$ K. ; $8·3\%$, $1036°–1239°$ K. ; $12·1\%$, $781°–1233°$ K. ; $17·6\%$, $643°–1213°$ K. ; $24·3\%$, $458°–1246°$ K. ; 50%, $543°–1123°$ K. ; molybdenum–cobalt alloys : $1·9\%$, $1333°$ K. ; $3·1\%$, $1283°$ K. ; $5·1\%$, $1283°$ K. ; $6·4\%$, $1189°$ and $1227°$ K. ; $9·8\%$, 1138 and $1188°$ K. ; $13·3\%$, $873°$ and $1239°$ K. ; $20·8\%$, $808°$ and $1263°$ K. ; $29·1\%$, $1130°$ K. ; aluminium–cobalt alloys : $6·4\%$, $1260°$ K. ; $8·2\%$, $1221°$ and $1233°$ K. ; $10·3\%$, $1143°$ and $1166°$ K. ; $19·5\%$, $1119°$ and $1200°$ K. ; $22·9\%$, $1141°$ and $1163°$ K. Where two values of θ are given, the second relates to the respective alloys after subjection to heat-treatment. Alloys of cobalt with the following respective atomic percentages of alloying metal have a Curie point at absolute zero : $32·4\%$ chromium, $41·2\%$ manganese, 27% tungsten, $32·2\%$ molybdenum, and 57% aluminium. The results do not confirm the ferromagnetism of the compounds CoW and CoMo. The alloys can be grouped in three categories according to the mode of variation of θ with composition.—J. S. G. T.

*****The Reaction Between Molten Copper Alloys and Sulphur Dioxide.** Ernst Raub and Alice Schall (*Z. Metallkunde*, 1937, **29**, (1), 16–20).—Tin reacts with sulphur dioxide at high temperature forming stannic oxide and sulphur and the reaction is not reversible. On bubbling sulphur dioxide through molten bronze tin dioxide and cuprous sulphide are formed, but at higher temperatures this reaction is reversible ; equilibrium curves are given for 5 and 10% tin bronzes with sulphur dioxide between $1100°$ and $1250°$ C. Sulphur dioxide reacts with molten nickel–copper alloys forming nickel oxide and a nickel sulphide, the reaction also reaching an equilibrium. Aluminium bronze absorbs sulphur dioxide to form alumina, which rises to the top as

slag, and aluminium sulphide part of which remains in homogeneous solution in the melt. With molten brass zinc oxide and zinc or copper sulphide or both (according to the composition of the alloy) are formed; the oxide volatilizes or is slagged off while the sulphides dissolve to some extent in the metal and to some extent pass into the slag.—A. R. P.

*On Some Strong, Anticorrosive Wrought Aluminium Bronzes. Tomojiro Tanabe and Goro Koiso (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1937, **2**, (9), 833–857).—[In Japanese.] The effects of iron on ordinary two-phase aluminium bronzes was examined, and it is concluded that Asado's theory of grain-refinement by peritectic reaction does not apply in wrought $\alpha + \delta$ aluminium bronze. A study was also made of the mechanical and chemical properties of some well-known and some new special wrought aluminium bronzes—H.B., Ha7, D.T.D. 135, F.A., and silicon–aluminium bronze. The properties of the strongest of these (H.B.-4, a proprietary Japanese alloy) are set forth, with composition, in a table (in English).—S. G.

*On the Course of Precipitation in Beryllium–Copper Alloys. Helmut Bumm (*Z. Metallkunde*, 1937, **29**, (1), 30–32).—Microscopic and X-ray investigations were made of the course of precipitation of CuBe from quenched copper alloys with 2·3% beryllium at 250° and 350° C. after and without previous mechanical treatment. Precipitation may occur in two different ways; it may begin in the grain boundaries and spread inward with autocatalytic acceleration or precipitation may occur simultaneously throughout the grain at a uniform rate in such a way that no visible effect is seen under the microscope until the lattice constants inside the grains are sufficiently changed. This "microscopically homogeneous" precipitation has a definite period of induction, then proceeds rapidly almost to completion and finally completes itself very slowly. The "autocatalytically accelerated" precipitation process becomes more and more pronounced the higher the ageing temperature until at 500° C. it entirely governs the precipitation.—A. R. P.

†Cast Tin–Copper Alloys [Bronzes]. Felix Hoehne (*Maschinenbau*, 1936, **15**, (21/22), 623–626).—The properties of cast bronzes and the German standards therefor are reviewed.—v. G.

†On the Question of Lead–Bronzes. Willi Claus (*Metallwirtschaft*, 1937, **16**, (5), 109–114).—A review of the various types of leaded bronzes used for bearings and of their performance in use.—v. G.

*On the Precipitation-Hardening of Gold–Nickel Alloys. Walther Gerlach (*Z. Metallkunde*, 1937, **29**, (3), 102–103).—Supersaturated gold–nickel alloys, obtained by quenching from 950° C., decompose on heating at 400° C. into a nickel-rich phase of great magnetic hardness and a non-magnetic gold-rich phase; this takes place by microscopically non-homogeneous precipitation. Simultaneously a small fraction of the alloy undergoes a microscopically homogeneous hardening characterized by a slight displacement of the Curie point of the undecomposed supersaturated solid solution. Thus, for the 50 : 50 nickel–gold alloy the Curie point of the quenched alloy is 90°–100° C., but after ageing at 410° C. the lower Curie point is about 25° C. higher while the upper Curie point (due to the nickel-rich phase) is about 340° C. The coercivity and remanence of the aged alloy still containing undecomposed solid solution increase with increase in temperature to about 120° C. and then decrease sharply; in the completely decomposed alloy both properties decrease almost linearly with increase in temperature.—A. R. P.

*The Decomposition of Gold–Nickel Single Crystals. Werner Köster and Armin Schneider (*Z. Metallkunde*, 1937, **29**, (3), 103–104).—Single crystals of gold–nickel alloys behave like polycrystalline aggregates on ageing, the nickel-rich phase being precipitated directly with only a slight contraction of the original lattice.—A. R. P.

*Rate of Crystallization of, and Number of Crystallites in Lead Containing Small Additions of Tellurium, Lithium, and Magnesium. Ernst Jenckel and Christian Thierer (*Z. Metallkunde*, 1937, **29**, (1), 21–24).—The rate of crystallization of lead reaches a maximum at 324° C. (150 mm./minute); the number of crystallites formed increases almost linearly with fall in temperature between 320° and 290° C. Addition of tellurium displaces the temperature–rate of recrystallization curve by 5°–6° C. (lower) and the maximum rate is reduced. Lithium has a similar effect, but the curve is only 1° C. lower. Magnesium makes the curve much flatter with a maximum at 314° C. The crystallite number–temperature curves for alloys with 0·043–0·85 atomic-% magnesium show a maximum at 308°–310° C. and a minimum at 315°–317° C.—A. R. P.

*On the Influence of Small Additions on the Recovery Temperature, Grain-Size, and Hardness of Lead. Ernst Jenckel and Heinrich Hammes (*Z. Metallkunde*, 1937, **29**, (3), 89–94).—The effect of 0·1% of numerous metals on the hardness, recovery temperature, and grain-size of lead was determined. The results show that an appreciable increase in recovery temperature is brought about only by metals which form intermetallic compounds with lead, the most effective being tellurium, calcium, and lithium which increase the recovery temperature to 120°–160° C. Increase in the concentration of the added element up to a definite, rather low limit, still further increases the recovery temperature, but further additions are without effect. Elements which increase the recovery temperature also decrease the grain-size, but, except in the cases of potassium, calcium, and lithium, have relatively little effect on the hardness of the cast alloy.—A. R. P.

*Hardening, Deformation, and Recrystallization of Lead–Antimony Alloys. Wilhelm Hofmann, Angelika Schrader, and Heinrich Hanemann (*Z. Metallkunde*, 1937, **29**, (2), 39–48).—Alloys of lead with 1–2% antimony harden during storage at room temperature after prolonged homogenization at 250°–270° C. followed by quenching. The degree of hardening which occurs is considerably affected by the presence of minute amounts of impurity in the lead (cf. following abstract); practically no hardening takes place with very pure lead containing 1% antimony even after 6 months' storage, whereas the hardness of a similar alloy made from commercial lead is nearly trebled in 25 days. Ageing at 100° C. results in an initial rapid increase in hardness followed by a slow decrease in the case of the 2% antimony alloy, and in only a very slight progressive increase in hardness in the case of the 1% antimony alloy. Whereas the antimony separates in a submicroscopic form on ageing at room temperature the particles which separate on ageing at 100° C. or on prolonged storage at room temperature after deformation consist of small rod-like crystals having a definite orientation to the crystal from which they have been precipitated; this effect is due to the fact that the lead itself recrystallizes after these latter treatments. A stable hard state of the 2% antimony alloy is obtained by ageing for a short time at 100° C. after rolling; the hardness is only slightly below the maximum cold-work hardness.—A. R. P.

*The Influence of Arsenic and Copper on the Hardening of Lead–Antimony Alloys. Margarete Bluth and Heinrich Hanemann (*Z. Metallkunde*, 1937, **29**, (2), 48–50).—The presence of very small amounts of copper and arsenic in lead containing 0·5–2% antimony considerably improves its age-hardening capacity. With the 1% antimony alloy the maximum hardening effect (Brinell hardness 13 compared with 4·9 for the annealed alloy) is obtained with 0·005% of copper and 0·05% of arsenic; further additions of these metals appreciably reduce the hardening effects obtainable. Curves are given showing the age-hardness obtainable with varying amounts of arsenic and copper.—A. R. P.

*Mechanism of Creep and Fatigue Limit Investigated on Lead and Lead Alloys. (v. Hanffstengel and Hanemann.)

*The Hexagonal Structure of Magnesium. G. Boehme (*Dissertation, Tech. Hochschule, Hannover*, 1934 and (in abstract) *Z.V.d.I.*, 1937, **81**, (5), 126).— Owing to the peculiar crystallographic structure of magnesium, its alloys behave differently to those of other metals, *e.g.* the yield-point of normally extruded alloys is twice as great under tensile as under compression stresses. Slow extrusion or quenching as the metal leaves the die prevents this. Forging should be done in different directions alternately. To produce sheet with a better elongation repeated dressing is useful.—v. G.

*On the Shrinkage of Magnesium Alloys. (Spitaler.) See p. 159.

Fires in Light Metal Alloys. —— (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (2), 70–72).—An account of a debate at the Llandudno Congress of the Institution of Fire Engineers. Concern was expressed at the danger of fires from light alloys of unknown compositions, and the need for experimental work urged. Sodium chloride (which may generate chlorine), dry sand, chalk and sodium bicarbonate, and a mixture of oil and sand were among the extinguishing agents proposed. Carbon tetrachloride and methyl bromide appear unsuitable.—J. C. C.

*Microscopic and X-Ray Investigation of Precipitation in Beryllium–Nickel Alloys. Hans Lay (*Z. Metallkunde*, 1937, **29**, (1), 32–33).—When a cold-rolled sheet of 1·9% beryllium–nickel alloy is quenched from 1100° C. and aged at 350° C. the hardness begins to increase immediately (from 150 to 250 in 6 hrs.), then decreases slightly and finally increases linearly reaching 350 in 65 hrs.; no change occurs in the lattice constants, however, during the first 10 hrs., but thereafter there is a continuous and progressive change in these constants. If the metal is aged at 500° C. both hardness and lattice constants increase rapidly from the beginning, the former reaching 500 in 5 hrs. and then increasing slowly to nearly 600 in 30 hrs., and the latter reaching a maximum in 2·5 hrs. and then decreasing slowly. If the specimens are etched with cold concentrated nitric acid black areas appear round the grain boundaries and gradually spread over the grains as ageing proceeds, complete blackening being obtained in 60 hrs.; at 350° C. blackening appears only after 150 hrs. and spreads very slowly. These results indicate that the mechanism of precipitation is similar to that which occurs in Duralumin, *i.e.* there is an induction period in which hardening occurs by the formation of internal complexes in the lattice.—A. R. P.

Two New Nickel Alloys : Inconel and Ceralumin. P. Régnauld (*J. Marine marchande*, 1936, **18**, (895), 956).—An account of the properties and composition of Inconel and Ceralumin, with a table of the mechanical properties of chill- and sand-castings of the latter alloy, the heat-treatment of which is described.—P. M. C. R.

*The Paramagnetism of Copper–Nickel Alloys. Gotthard Gustafsson (*Ann. Physik*, 1937, [v], **28**, (2), 121–131).—The magnetic susceptibilities of carefully tempered copper–nickel wires were measured at temperatures above the Curie point; the results are shown in tables and graphs.—v. G.

*X-Ray Investigation of Pure Iron–Nickel Alloys. II.—Thermal Expansion of Some Further Alloys. E. A. Owen and E. L. Yates (*Proc. Phys. Soc.*, 1937, **49**, (2), 178–188).—The lattice parameters of three iron–nickel alloys containing, respectively, 42·7, 32·2, and 24·2% nickel by weight were measured at 0° to about 600° C. Details are given of the preliminary heat-treatment to which the alloys had to be subjected. From the relations between lattice parameter value and temperature, curves were obtained showing how the coeff. of thermal expansion (ε) of the alloys varied with temperature. The two alloys containing 42·7 and 32·2% nickel yielded curves which showed that ε had a rather low value at low temperatures. At mean temperature ranges at about 375° and 150° C. the value of α of these two alloys increased suddenly and thereafter remained constant with further increase of tempera-

ture, as found by other observers. The expansion curve of the alloy containing 24·2% nickel showed the ordinary thermal-hysteresis effect found with irreversible alloys. The mean atomic volume in the α phase is greater than that in the γ phase at the same temperature. The contraction of a rod occurring when the α-phase transforms to the γ-phase is thus explained. The coeff. (ε) of the body-centred α-phase is approximately $8·2 \times 10^{-6}$ at 0° C., and $14·0 \times 10^{-6}$ at 200° C., and that of the face-centred γ and γ' phases is $17·5 \times 10^{-6}$ between 0° and 630° C.—J. S. G. T.

*The Formation of Martensite in Nickel–Iron Alloys. Helmut Bumm and Ulrich Dehlinger (*Z. Metallkunde*, 1937, **29**, (1), 29).—The transformation from a face-centred to a body-centred lattice proceeds to completion with the 29% nickel–iron alloy below about $-$ 180° C. and with the 26% nickel–iron alloy below about 20° C. if the alloys are in the single-crystal state originally. If the crystal has once undergone the transformation a certain amount of residual austenite remains after the second transformation. When transformation is complete the structure of the alloy consists of plate-like martensite, but, when incomplete, of pointed needles of martensite.—A. R. P.

*Ferromagnetic Anisotropy in Alpha Iron and in Gamma Nickel–Iron and Nickel–Cobalt–Iron At and Above Room Temperature. L. W. McKeehan, R. G. Piety, and J. D. Kleis (*Phys. Rev.*, 1936, [ii], **50**, (11), 1093).—Abstract of a paper read before the American Physical Society. Oblate spheroids cut from single crystals were examined by the pendulum magnetometer method. Magnetization curves along 4-, 3-, and 2-fold axes have been obtained at room temperature and two or more higher temperatures below the Curie points. In α-iron (of exceptional purity) and in γ-nickel–iron the results are qualitatively similar to previous results of others. In iron the anisotropy vanished just above 600° C. In the nickel–iron series the anisotropy changes its type at 76% nickel. In γ nickel–cobalt–iron with from 40 to 80% nickel there is evidence supporting the finding of J. W. Shih (*Met. Abs.*, 1936, **3**, 456) that in γ nickel–cobalt the anisotropy changes type twice between 80 and 97% nickel.
—S. G.

*On the Dependence of the Magnetic After-Effect on Internal Stresses [Iron–Nickel and Heusler's Alloys]. Heinrich Kindler (*Ann. Physik*, 1937, [v], **28**, (4), 375–384).—The magnetic hysteresis of a 50 : 50 iron–nickel alloy increases at first under tensile stress but decreases again when the elastic limit is exceeded. The magnetic properties of Heusler alloys are likewise considerably affected by the internal stresses produced by prior thermal treatment.—v. G.

*Inertia and Chemical Activity of the Rare Gases. IX.—Thermal Decomposition of the Platino–Helium Compounds. Horacio Damianovich and Jose Piazza (*Anales Soc. cient. argentina, Sección Santa Fé*, 1936, **7**, 57–59; *C. Abs.*, 1937, **31**, 934).—Cf. *Met. Abs.*, this vol., p. 132. Platinum–helium compounds were prepared by subjecting helium at 1·18–1·8 mm. and at 0·28–0·5 mm. to the action of a current of 10–15 ma. at 1000–600 v. in the presence of platinum at 24°–27° C.; the volume of helium fixed was 21·65–20·87 ml. per grm. of product. On heating, the platinum–helium product shows 2 points of decomposition, one at 90°–100° C., the other at 300°–320° C., indicating 2 platinum–helium compounds.—S. G.

*Thermal Expansion of Cemented Tungsten Carbide. Peter Hidnert (*J. Research Nat. Bur. Stand.*, 1937, **18**, (1), 47–52; *Research Paper* No. **960**).— Data are given for the linear thermal expansion of tungsten carbide–cobalt mixtures containing about 6 and 13% cobalt; these products are known as " cemented tungsten carbide " and Carboloy in the U.S.A., and as Widia in Germany. The average coeff. of expansion of cemented tungsten carbide containing 5·9% cobalt increases from $4·4 \times 10^{-6}$ for the range 20°–60° C. to $5·9 \times 10^{-6}$ for the range 300°–400° C. The average coeffs. of expansion of samples containing from 12·9 to 13·2% cobalt increase from $5·0 \times 10^{-6}$ for

the range 20°–60° C. to 6·7 × 10⁻⁶ for the range 300°–400° C. For the range 20°–400° C. the average coeffs. of expansion of the samples containing about 13% cobalt are 15% greater than the coeff. of expansion of the alloy containing about 6% cobalt. The rates of expansion of the samples of cemented tungsten carbide increase linearly with temperature. The rates of expansion of those containing 13% cobalt are greater than the rates for the carbide containing 5·9% cobalt. The rates of expansion of the samples of cemented tungsten carbide are greater than those of tungsten, and considerably less than those of cobalt.—S. G.

*On the Heat of Formation of Some Metallic Systems Calculated from A. Olander's Electrochemical Measurements. Friedrich Weibke (*Z. Metallkunde*, 1937, **29**, (3), 79–84).—The heats of formation of the compounds in the cadmium–antimony, bismuth–thallium, silver–cadmium, gold–cadmium, and copper–zinc systems are calculated thermodynamically from the electrochemical data of A. Ölander.—A. R. P.

†On the Heat of Formation of Intermetallic Compounds. Wilhelm Biltz (*Z. Metallkunde*, 1937, **29**, (3), 73–79).—Recent work on this subject and on the affinity of metals for one another is collated and critically discussed. All the available numerical data are collected in tables and the theoretical relationships explained on the basis of the modern conception of affinity.—A. R. P.

Steels of French Manufacture : Non-Forging Steels and Alloys. —— (*Mécanique*, 1937, **21**, (270), 45–49).—This review includes an account of the composition and properties of alloys of the Stellite group and of tungsten, titanium, and tantalum carbides. Working speeds for rough-machining and finishing are suggested for the cutting of bronze and aluminium.—P. M. C. R.

*On the Phenomenon of Incubation of Alloys. Kotarô Honda and Kanzi Tamaru (*Rikwagaku Kenkyū-jo Ihô* (*Bull. Inst. Phys. Chem. Res.*), 1936, **15**, (6), 315–319 ; and *Kinzoku no Kenkyu* (*J. Study Metals*), 1937, **14**, (2), 41–45).—[In Japanese.] See abstract from an English source, *Met. Abs.*, this vol., p. 90.—S. G.

†Alloys for Permanent Magnets. D. A. Oliver (*Rep. Prog. Physics*, 1936, **3**, 224–227).—The development of magnet steels from 1920 to the present time is briefly reviewed. Among steels now available, in addition to the older tungsten, and cobalt and chromium steels are the following, introduced since 1931 ; alloys of iron containing nickel 17–34 and aluminium 8–14%, discovered by Nishima, and possessing abnormal mechanical hardness and brittleness and very large coercive force. Special alloys of this class are known as Alni and Nial ; the alloy Alnico containing nickel 18, aluminium 10, cobalt 12, copper 6, and iron 54%, discovered by Horsburgh and Tetley, and now firmly established as the best permanent magnet alloy possessing high remanence and energy content per unit volume ; a carbon-free ternary alloy of iron and cobalt with either tungsten or molybdenum can be heat-treated so as to possess magnetic properties rivalling those of the Nishima alloys ; a ferrous alloy of cobalt, nickel, and titanium discovered by Honda, Masumoto, and Shirakawa ; powdered-alloy magnets made of mixed compressed oxides of iron and ferro-cobalt, and magnets made of powdered alloys mixed with a binder (Bakelite) and compressed in dies.—J. S. G. T.

Use of [the] Centrifuge for Investigating Metallic Alloys. G. Komovsky (*Physikal. Z. Sowjetunion*, 1936, **10**, (6), 840–842).—[In English.] The design and use of a centrifuge which is capable of effecting complete separation of phases in copper–lithium alloys are briefly described ; by X-ray analysis, a definite orientation of the crystals was established. Al_3Ti has been separated from an Al_3Ti–Al alloy. With pseudo-binary alloys, Pb + AlLi and Pb + ZnLi, the destruction of the intermetallic compounds AlLi and ZnLi and the probable formation of the alloys Pb + PbLi and the separate formation of Al and Zn is established.—J. S. G. T.

III.—STRUCTURE

(Metallography ; Macrography ; Crystal Structure.)

(Continued from pp. 92–95.)

*The Micrography of Metals in Ultra-Violet Light. J. Smiles and H. Wrighton (*Proc. Roy. Soc.*, 1937, [A], **158**, (895), 671–681).—An apparatus for the photomicrography of metals in ultra-violet light is described with full details of the method of adjustment. Monochromatic radiation of wavelength 2750 A. is obtained from a condensed spark between cadmium electrodes. Difficulties of focussing are overcome by the use of Barnard's interchangeable objective holding plates. Photographs of ferrous and non-ferrous alloys are reproduced at a magnification of $\times$ 2500 ; these show the same area of the specimen photographed with an ordinary 2 mm. apochromat, N.A. 1.30, a 2 mm. monochromat, N.A. 1.60, λ 4395, and with the 1.7 mm. quartz monochromat N.A. 1.25, λ 2750. Structural markings in free ferrite, not shown under the apochromat, N.A. 1.30, and only faintly under the monochromat, N.A. 1.60, are more clearly seen in the ultra-violet photographs which generally show greater resolution and sharpness of detail. Instructions are given for the preparation and etching of specimens.—W. H.-R.

*On the Microscopic Examination of Lead and Lead Alloys. Angelika Schrader and Heinrich Hanemann (*Z. Metallkunde*, 1937, **29**, (2), 37–39).—The specimens are polished by hand successively on emery papers : No. 2, 1F, 00, and 0000, using the liquid wax " Bohnofix " as lubricant to prevent particles of emery being forced into the surface of the metal. The final polishing is done first on a rotating disc (600–800 r.p.m.) covered with a soft cloth and impregnated with a suspension of alumina in 0.2% nitric acid, and then by hand on a chamois leather moistened with a thick aqueous suspension of alumina. During the last operation the specimen is frequently lightly etched and the etched surface polished away. The best etching reagent for developing the structure is a mixture of 15 c.c. of glacial acetic acid, 15 c.c. of concentrated nitric acid, and 60 c.c. of glycerin ; a lighter etch is obtained by diluting 1 volume of this mixture with 2 volumes of glycerin. The method has been used for the examination of the changes which occur in the structure of antimonial lead on annealing and on storing at room temperature after quenching and cold-working ; the decomposition of the supersaturated solid solution of antimony in lead can readily be followed.—A. R. P.

Glide in Metal Single Crystals. E. N. da C. Andrade and R. Roscoe (*Proc. Phys. Soc.*, 1937, **49**, (2), 152–176 ; discussion, 176–177).—A method is described wherein crystallization is effected by means of a travelling temperature gradient, for producing single crystals of cadmium and of lead, which are not affected by annealing, and which, in general, show great regularity of regular behaviour. A simple method is also described for recording photographically the stress–strain relationship of the crystals. Experiments on the hardening and recovery of the cadmium crystals, and on the spacing of glide planes in lead crystals indicate that the results relating to hardening can be explained by a hardening on individual glide lamellæ which is proportional to the glide, and it is suggested that the mechanism of permanent hardening is mainly a rotation of crystallites in the lamellæ. A *bibliography* of 30 references is given.—J. S. G. T.

On the Determination of the Grain-Size of Fine Crystalline Powder. Mituo Yamada, Yutake Abe, and Iturô Tesima (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 67–71).—[In English.] The influence of lattice distortion in crystal grains on the breadth of the Debye–Hull lines is discussed.—S. G.

M

†**The Constitution of Alloys.** Kent R. Van Horn (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 230–283). —A comprehensive review of the application of X-ray diffraction methods to the investigation of the constitution of alloys, the determination of crystallographic structures and equilibrium diagrams. A *bibliography* of 53 references is appended.—J. S. G. T.

†**Application of X-Ray Methods to Problems of Cold-Work, Preferred Orientation, and Recrystallization.** John T. Norton (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 302–323).— The application of X-ray diffraction methods to the investigation of structural changes effected in metals by cold-working or by reheating after cold-working is discussed. Three changes are produced in polygrained materials by cold-working : (1) distortion of the crystal lattice ; (2) fragmentation of the grains ; and (3) preferred orientation. Each of these effects has its characteristic X-ray evidence. The various effects are illustrated. Industrial illustrations include : the determination of the depth of cold-working produced by machining ; changes in structure by cold-drawing a Monel metal rod ; the structure of cold-drawn tubes ; recrystallization of cold-worked Monel metal ; deep-drawing operations ; effect of crystal orientation on bending qualities of cold-rolled zinc. A *bibliography* of 20 references is given.—J. S. G. T.

†**The X-Ray Determination of Particle Size.** G. Harvey Cameron and A. L. Patterson (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 324–338).—The X-ray method (not yet fully developed) is applicable to determine the sizes of particles from about 0·00001 cm. in diameter down to the smallest having crystalline structure. These particles produce X-ray diffraction lines which are broader than those ordinarily found in " powder " X-ray photographs. Measurements of particle size are based on a theoretical formula connecting the breadths of the lines with particle size. Various formulæ proposed are reviewed critically. Relative values of particle size can be obtained with an accuracy of about 10% ; absolute values may not be reliable owing to the imperfect state of the theory. A *bibliography* of 33 references is included.—J. S. G. T.

*Intensities of X-Ray Reflections from Bismuth Crystals Between 25° and 530° Abs. [Allotropy and Mosaic Structure of Bismuth].** Alexander Goetz and Robert B. Jacobs (*Phys. Rev.*, 1937, [ii], **51**, (3), 151–159).—The temperature variation of the integrated intensities of reflections of Mo K_a radiation from the (111) planes of bismuth crystals was studied in the range 25°–530° abs. The relative values of the integrated intensities (J_T/J_N) follow the Debye–Waller relation at the lower temperatures, but deviations occur from about 80° below the melting point upwards. In this region hysteresis effects are observed which depend on the previous thermal treatment of the crystal ; these effects are explained on the basis of the mosaic theory. The intensity measurements give no indication of a transformation at 75° C. (see, however, following abstract).—W. H.-R.

*The Thermal Expansion of the Bi Lattice Between 25° and 530° Abs.** Robert B. Jacobs and Alexander Goetz (*Phys. Rev.*, 1937, [ii], **51**, (3), 159–164).—The thermal expansion of bismuth crystals parallel to the (111) axis, $\alpha_{||}$, was measured by the Bragg spectrometer method between 25° and 530° abs. With increasing temperature, $\alpha_{||}$ at first increases comparatively rapidly from $8\cdot3 \times 10^{-6}$ at 25° abs. to $17\cdot4 \times 10^{-6}$ at 120° abs. ; $\alpha_{||}$ then remains constant at the latter value in the ranges 120°–258° abs. ($-15°$ C.), and 348° abs. (75° C.) to 530° abs. (257° C.). From $-15°$ to $+75°$ C., $\alpha_{||}$ has a constant value of only $13\cdot8 \times 10^{-6}$, suggesting that a separate " phase " exists in this region, but there is no change in lattice configuration, and no sudden change in (111) spacing, although the change in $\alpha_{||}$ is definite. Discrepancies between the results of different investigators are discussed. The values of $\alpha_{||}$ obtained

by X-ray lattice spacing measurements, and by macroscopic methods show a definite divergence beginning about 30° C. below the melting point; this effect may be due to traces of impurity. The Grüneisen relation $\alpha/c_p =$ const. ($c_p =$ specific heat) is a valid approximation except in the range $- 15°$ to $+ 75°$ C.—W. H.-R.

*The Atomic Rearrangement Process in the Copper–Gold Alloy Cu_3Au. C. Sykes and F. W. Jones (*Proc. Roy. Soc.*, 1936, [A], **157**, (890), 213–233).— The order–disorder transformation of the copper–gold Cu_3Au alloy was investigated by measurements of specific heat, and electrical resistance, together with X-ray diffraction photographs. The results are compared with the theories of Bragg and Williams (*Met. Abs.*, 1934, 1, 384), and of Bethe (*Met. Abs.*, 1935, 2, 425) and Peierls (*Proc. Roy. Soc.*, 1936, [A], in print). Neither theory is confirmed exactly, but the theory of Bethe and Peierls gives the better agreement, and the basic assumption of Bethe that the energy of any atom is determined by the identity of its immediate neighbours is a good approximation. The transformation from disorder to order at a given temperature takes place by rearrangement round small atomic configurations having a high degree of order of nearest neighbours. The energy of any one atom is fixed only by the identity of its neighbours within two atomic distances, and consequently a large proportion of the energy of the ordinary process is released by the time the ordered regions attain a length of 5×10^{-7} cm. The electrical resistance, on the other hand, starts to diminish when the ordered regions are about 5×10^{-7} cm. long, and has not reached the equilibrium value when these regions are 3×10^{-7} cm. long. Considerable atomic rearrangement can take place before either the diffraction pattern or electrical resistance is affected, and hence caution is needed in interpreting experimental results unless supplemented by energy measurements.—W. H.-R.

*The Crystal Structure and the Composition of the Intermediate Iron–Tungsten and Iron–Molybdenum Phases. Arne Westgren (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 852–863).—[In English.] The crystal structures of the intermediate phases present in these systems have been determined, using the data of Arnfelt (*J. Inst. Metals*, 1929, 42, 516). The unit cell of the hexagonal phase Fe_2W has $a = 4.727$; $c = 7.704$ A.; space group D_{6h}^4; 12 atoms to the unit cell. The phases usually denoted by the formulæ Fe_3W_2 and Fe_3Mo_2 are rhombohedral. The elementary rhombohedron of the iron–tungsten phase saturated with iron is defined by the edge 9·02 A. and the angle 30° 30·5'; the corresponding data of the iron–molybdenum phase are 8·97 A. and 30° 38·6'. As there are in both cases 13 atoms in the unit cell, the formulæ Fe_3W_2 and Fe_3Mo_2 are excluded. If the two atomic kinds are not statistically distributed on the lattice points, the only possible division of them falling within the homogeneous ranges (about 40–46 atomic-% tungsten or molybdenum) is that corresponding to the formulæ Fe_7W_6 and Fe_7Mo_6. The determination of the atomic grouping verifies this conclusion. Technical tungsten with about 85% tungsten has been found to consist of Fe_2W and tungsten. Fe_7W_6 is accordingly not stable at low temperatures. Its decomposition rate is, however, evidently very low. Even if iron–molybdenum alloys are annealed for 1 month at 500° or 700° C. they contain no other intermediate phase than Fe_7Mo_6.—S. G.

†Crystal Structure of Metals and Inorganic Substances. W. A. Wood (*Rep. Prog. Physics*, 1936, 3, 356–361).—Very briefly reviews matters relating to developments in the application of X-rays to the investigation of crystal structure during the period 1934–1936 : the rôle of atomic size in conditioning the entry of an atom A into the structure of the phase A/B, and the resulting lattice distortion ; the tendency to chemical combination between A and B ; the effect of structures of pure components upon lattice distortion ; Hume-Rothery's rule ; application of Bloch's theory to alloys ; super-lattices.—J. S. G. T.

IV.—CORROSION

*Experiments with Various Cleansers for Use in Can-Washing Machines [Action on Aluminium, Tinned Iron, and Copper]. W. Mohr and —— Wullhorst (*Molkerei-Zeit.* (*Hildesheim*), 1936, 50, 2490-2492, 2525-2528; *C. Abs.*, 1937, 31, 1507).—The authors studied the corrosive action of (1) " alte P_3-zinnfest "; (2) " neue P_3-zinnfest "; (3) calcined soda (95-100% Na_2CO_3); and (4) caustic soda, on aluminium, tinned iron, and copper—materials used in milk-transport cans. As in actual practice in can-washing machines, the temperature was 85° C. and the time 12 seconds. The concentration of reagents was 0·25%. The compositions of the reagents (1) and (2), sold by a German firm, are not given. Reagent (1) caused more corrosion on tinned surfaces than on aluminium, and is not recommended; (3) and (4) were found to be corrosive and are not recommended unless silicate is added as a corrosion preventative. Reagent (2) was found to be satisfactory.—S. G.

The Resistance of Light Alloys [to Corrosion]. —— (*Apparatebau*, 1936, 48, (5), 49-52).—The principal light alloys of considerable corrosion-resistance are briefly discussed. A table is given of the mechanical properties of pure aluminium and 5 light alloys in sheet form and in different conditions of heat-treatment. A list of about 200 materials frequently handled in bulk indicates the solubility of pure aluminium, and copper-free or copper-containing light alloys as material for containers in each case.—P. M. C. R.

*Hollander Knives of Aluminium Bronze. Friedrich Ostermann (*Z. Metallkunde*, 1937, 29, (2), 67).—An 8-9% aluminium bronze heat-treated to produce an α-structure containing uniformly-distributed α + δ areas (resulting from decomposition of β) is much more resistant to corrosion by hot and cold 5% sulphuric or hydrochloric acid, considerably more resistant to wear in bisulphite solutions, and has somewhat more regular tensile properties than the ordinary phosphor–bronze knives used in hollanders in the paper-making industry. Large-scale works tests over a prolonged period have shown the superiority and economy of aluminium bronze over the usual tin bronze for this purpose.
—A. R. P.

Multitude of Alloys Aid in Fighting Refinery Corrosion. N. W. Mitchell (*Nat. Petrol. News*, 1937, 29, (5), 65-72).—Failures in Admiralty brass condenser tubing used in oil refineries are due partly to dezincification on the water side and partly to attack by acid or sulphur compounds in the oil vapours; the latter type of attack is more frequent when alloys with a higher copper content are used. The incidence of " galvanic corrosion," deposit attack, dezincification, and stress–corrosion attack is reviewed, and an account is given of the results of service tests on a large variety of tube materials. The best results were obtained with cupro-nickel. The effect of antimony on the strength and corrosion-resistance of brass is considered, and a brief note refers to the use of duplex tubes having 90% copper–zinc alloy on the water side, Admiralty brass being exposed to the oil vapours.—P. M. C. R.

Corrosion of Metals. II.—Lead and Lead Alloy Cable-Sheathing. R. M. Burns (*Bell System Tech. J.*, 1936, 15, 603-625; and *Bell Telephone System Tech. Publ., Chemistry, Monograph* B-955, 1936, 23 pp.).—Discusses the corrosion of cable-sheathing in aerial and underground cable plants. Corrosion does not appear to be a primary factor affecting the life of aerial cables; failure of these cables usually occurs from intergranular embrittlement and is minimized by the use of alloy sheathing. It is shown that corrosion of cable-sheathing in conduit occurs by means of the operation of small corrosion cells on the surface of the sheaths or by the leakage of current from the sheath to the ground. The driving force of these corrosion cells arises

from some chemical inhomogeneity in either the metal or the surrounding environment. The course and the character of corrosion is determined chiefly by the influence of the constituents of the environment on the operation of these cells. These constituents may be classed as corroding or protective, the corroding including oxygen, nitrates, alkalis, and organic acids, while the protective are silicates, sulphates, carbonates, soil colloids, and certain organic compounds. Cable-sheathing buried directly in soils is seriously corroded by differential aeration–cell action resulting from physical contact of relatively large soil particles and metal. In general, it is concluded that corrosion of cable-sheathing is influenced more by the nature of the environment than by the chemical composition of the metallic material. The incidence of corrosion of cable-sheathing is small owing to the maintenance of non-corrosive chemical and electrical environments in the cable plant.—S. G.

*Corrosion of Lead Pipes and a New Alloy for the Conduction of Water. E. Sorrentino and R. Intonti (*Annali chim. applicata*, 1936, **26**, 385–398; *C. Abs.*, 1937, **31**, 1751).—An alloy containing lead 99·05, cadmium 0·75, and arsenic 0·09% has been found to withstand almost twice the hydraulic pressure of ordinary lead pipes. Corrosion experiments show that the alloy as well as ordinary lead becomes more soluble in waters containing carbon dioxide and oxygen. When large amounts of salts are also present, the solubility of lead is decreased, even with carbon dioxide and oxygen present. The amount of arsenic dissolved is below the minimum permissible, and is about the same in both cases, as ordinary lead also contains arsenic.—S. G.

*Some Experiments on Tinned Copper Water Tubing. Kenzo Inamura and Hidekichi Ohashi (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1937, **2**, (9), 858–864).—[In Japanese.] The investigation was undertaken to study the corrosion-resistance of tinned copper tube to tap-water. Preliminary tests were made of the corrosion of tin and copper plates by various waters, and then a study was made of the corrosion by tap-water of copper tubes coated with tin or with paints. It is concluded that even in the presence of oxygen and carbon dioxide, the corrosion of tinplate by distilled water is very slight; in tap-water, however, corrosion is increased by an addition of carbon dioxide and oxygen. The rate of corrosion of copper plate in distilled water is greatly accelerated if it contains carbon dioxide and oxygen. Tinning or painting either with Bakelite paint or Japanese lacquer prevents the dissolution of copper tubes by tap-water. Painting, however, is undesirable as it colours or affects the odour of the water.—S. G.

Refrigeration and Corrosion Problems in the Canning Industry. T. N. Morris (*Ice and Cold Storage*, 1936, **39**, 181; *C. Abs.*, 1937, **31**, 1111).—Some fruits corrode the cans in which they are packed and their flavour is injured. Packing such fruits in lacquered cans or holding the cans at low temperature, *e.g.* at 32° F., reduces corrosion and prevents deterioration of the fruit.—S. G.

Use of the Spectrograph to Detect Metal Contamination. A. H. Staud (*Glass Packer*, 1936, **15**, 731–732; *C. Abs.*, 1937, **31**, 1106).—Laboratory tests showed 5–15 p.p.m. of tin in canned beer, but none in bottled beer. One sample of canned beer contained 2·0 p.p.m. of lead. The copper content varied from 0·1 to 0·7 p.p.m. and the iron content from 1·0 to 6·0 p.p.m.—S. G.

*The Destruction of Metals by Cavitation. H. N. Bötcher (*Z. V.d.I.*, 1936, **80**, (50), 1499–1503).—Examination of various bronzes and of Duralumin which had been destroyed by cavitation revealed the presence of a hardened surface layer which had been broken up by deformation, and an inner layer which had failed by typical fatigue fracture. Chemical action appears to be of little importance in this type of erosive attack. Compressing the surface affords no protection and can even produce deleterious effects.—v. G.

*On the Theory of Corrosion Phenomena. V.—The Application of the Pore Theory of Corrosion to the Balance Effect of Thiel and Eckell. W. J. Müller and E. Löw (*Anz. Akad. Wiss. Wien, Math.-naturw. Klasse*, 1936, **73**, 184–185).—For a full account of this work see *Met Abs.*, this vol., p. 49.—S. G.

*The Theory of Corrosion Phenomena. VI.—On the Experimental Determination of the Metal Potential of a Working Cathode and the Experimental Determination of Voltage and Resistance Values for Local Elements. W. J. Müller (*Z. Elektrochem.*, 1936, **42**, (11), 830–833; and (summary) *Anzeiger Akad. Wiss. Wien, Math.-naturw. Klasse*, 1936, **73**, 185).—Describes a method of measuring the pore resistance, due to the presence of a coating on the metal, by determining the voltage of two different current intensities through the pores. The correction coefficient, $K = \dfrac{W}{W_p + W_s}$, of Thiel and Eckell's balance effect was obtained from these measurements. The results obtained by Thiel and Eckell on zinc combined with platinum were in good agreement with the value determined for W_p (the pore resistance), which is very small at a mean value of $0\cdot0908$ ω. In particular, a high concentration of zinc ions occurs at the boundary layer of such an electrode, so that the variation of the current intensity from the smallest local current of $0\cdot188$ amp. to the largest combined current of $0\cdot265$ amp. practically does not alter the polarization, ε_{me}.
—J. H. W.

Corrosion and Refrigeration. U. R. Evans (*Ice and Cold Storage*, 1936, **39**, 180; *C. Abs.*, 1937, **31**, 989.)—Methods for rendering the brine non-corrosive are discussed.—S. G.

Some Aspects of Brine Corrosion. A. S. White (*Ice and Cold-Storage*, 1936, **39**, 182; *C. Abs.*, 1937, **31**, 990.)—To prevent corrosion by sodium chloride brine it is important to avoid (1) the presence of anodic spots (such as scale or inclusions); (2) dissimilar metals in contact; (3) the use of two-phase alloys unless one alloy is of small area and cathodic to the other; and (4) the use of jointing methods tending to promote local salt concentration differences, such as rivets, &c.—S. G.

V.—PROTECTION

(Continued from pp. 99–102.)

†The Electrolytic Oxidation of Aluminium in Patent Literature. Kurt Nischk and Fritz Markhoff (*Metallwirtschaft*, 1936, **15**, (50), 1170–1172; (51), 1196–1199).—A review of the German, British, Austrian, Swiss, French, American, and part of the Russian patent literature on electrolytic oxidation of aluminium and its alloys, methods of after-treatment, and colouring of oxidized surfaces. Only a few patents about the application of the treated metals are mentioned.—v. G.

*Deterioration of Chromic Acid Baths Used for Anodic Oxidation of Aluminium Alloys. R. W. Buzzard and J. H. Wilson (*J. Research Nat. Bur. Stand.*, 1937, **18**, (1), 53–58; *Research Paper* No. 961).—Commercial practice has shown that chromic acid baths for anodizing aluminium eventually fail. This failure, which had been attributed to other causes, is now shown to be caused by dissolved aluminium. The addition of chromic acid to the bath at regular intervals to maintain a constant p_H is suggested as a means to improve bath control.—S. G.

*Anodic Coating of Magnesium Alloys. R. W. Buzzard and J. H. Wilson (*J. Research Nat. Bur. Stand.*, 1937, **18**, (1), 83–87; *Research Paper* No. 964; and *Met. Ind.* (*Lond.*), 1937, **50**, 403–404).—Magnesium alloys may be anodized in a bath of sodium phosphate ($NaH_2PO_4 \cdot H_2O$) and sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$). The film obtained combines both corrosion-

resistant and paint-holding properties, without serious change of dimensions of the treated piece, even on machined surfaces.—S. G.

Tinplate and Tin Cans in the United States. —— (*Bull. Internat. Tin Res. Develop. Council*, No. 4, 1936, 142 pp.).—An account is given of the historical development and present applications and future of tinplate, together with a detailed description of the manufacture of sheet steel, tinplate, terne plate, and tin cans. A statistical review is given of the tinplate industry of America, together with some description of the decoration of tinplate and the manufacture of bottle caps and closures.—W. D. J.

Influence of Foreign Metals in Zinc for Galvanizing. E. T. Richards (*Illust. Zeit. Blechindustrie*, 1937, **66**, (4), 45–47; (5), 118–119).—A review of the influence and permissible content of lead, tin, aluminium, arsenic, antimony, iron, and cadmium.—P. M. C. R.

*****Metallic Cementation. X.—Cementation of Tungsten on Some Metals.** Tsutomu Kase (*Kinzoku no Kenkyu (J. Study Metals)*, 1937, **14**, (1), 22–34).— [In Japanese.] The cementation of iron, nickel, and copper by tungsten at various temperatures between 800° and 1350° C. for 1–5 hrs. was studied, using powdered tungsten containing tungsten 98·84, iron 0·25, and carbon 0·08%. Measurements of the depth of penetration, microscopic examinations, chemical analyses, and tests of corrosion by some acids were carried out. It was found that tungsten diffuses into iron, nickel, and copper at a temperature of less than 800° C., the rate of diffusion increasing with increase of temperature. The relation between the increase in weight of the specimen (ΔW) or the depth of penetration (P) and the absolute temperature of cementation (T) or the time (0) required for the treatment is given by the exponential function $\Delta W = ae^{-b/T}$ or $\Delta W = ae^{b0}$, where a and b are different constants in each case. The cemented surfaces are harder than the original material. Although nickel cemented with tungsten has a sturdy resistance to hydrochloric acid, there is little advantage in the case of the other materials as regards corrosion-resistance.—S. G.

Some Recent Applications of Metallization. —— (*Soudeur-Coupeur*, 1936, **15**, (8), 1–8).—The Lépine bridge in Paris was sprayed with lead to protect the steelwork from the action of the sulphurous fumes from locomotives passing underneath. Other applications described and illustrated are towers and vats for petroleum treatment, brewery vessels, and sugar vats, all aluminium sprayed; zinc spraying of the ventilation system, refrigerating system, fire-protection devices, condensers, and funnels of the liner *Normandie*; zinc-sprayed street signs; and ornamental doors sprayed with Monel metal.
—H. W. G. H.

*****The Adherence of Sprayed Metal Coatings of Zinc, Steel, and V2A [Stainless Steel].** Theo Everts (*Z. Metallkunde*, 1937, **29**, (2), 63–66).—The adherence of sprayed zinc coatings on steel is a maximum when the steel surface is prepared by sand-blasting with a coarse, sharp quartz sand and subsequently pickled for 1 minute in hydrochloric acid, when the air-pressure in the pistol is 2·6 atm., and when a slightly reducing flame is used; under these conditions the best rate of feed of the zinc wire to the pistol is about 4·2 m./minute.—A. R. P.

Protection of Underground Pipes of Metal from Electrolytic Corrosion by Means of the Electronic Filter. James Borel (*Bull. Assoc. Suisse Élect.*, 1937, **28**, (3), 54–57).—A review is given of methods of protecting metal pipes from attack due to stray currents in the soil. The " electronic filter," which transmits electric currents but is impervious to electrolytically active ions, is described. The material employed is rubber impregnated with graphite. The results of corrosion tests on lead and iron samples are discussed and illustrated.—P. M. C. R.

VI.—ELECTRODEPOSITION

†**The Cyanide Cadmium Plating Solution.** Gustaf Soderberg (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 12 pp.).—A critical review of recent work and a summary of the results obtained by numerous investigators on the nature of the cadmium cyanide complex, the resistivity of various cadmium plating baths, the cathode conditions (deposition potentials, current efficiencies, throwing power, and appearance and properties of the plate), and the anode conditions (potentials, current efficiency, and carbonate formation).—A. R. P.

Insulators Salvaged by Cadmium Plating. J. B. Bowen (*Elect. World*, 1936, **106**, (37), 41–42, 110, 112).—Corroded caps and pins from insulators exposed to salt fogs have been cleaned by sand-blasting and returned to satisfactory service after plating with cadmium in a cyanide bath at 25–30 amp./ft.^{2} for 35 minutes.—J. C. C.

Economy in Tools and Machine Construction by Hard Chromium Plating. W. Pfanhauser (*Metallwirtschaft*, 1936, **15**, (50), 1173).—The production of wear-resistant chromium surfaces finds application in many kinds of tools and machine parts.—v. G.

.***The Etching of Copper by Ferric Chloride Solutions.** B. Baars and L. S. Ornstein (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 8 pp.).—Electrolytic copper plates are widely used in intaglio printing processes, for which purpose they are etched in ferric chloride solutions ; the effect of the concentration of this reagent on the results obtained was investigated. In solutions of $d < 1.48$ the rate of dissolution of the copper is regular and the attack uniform, but in more concentrated solutions the rate decreases at first with time and then increases ; in some cases etching figures in the shape of quadrilateral pyramids are formed. Potential measurements indicate that the peculiar behaviour of the concentrated solutions is due to the formation of a layer of cuprous chloride on the copper surface owing to the slow rate of diffusion of the reaction products from the surface and of fresh solution towards the surface caused by the high viscosity of the solution. Metal deposited at high current density dissolves more rapidly than that deposited at low current density owing to its finer crystal structure.—A. R. P.

Modern Developments in the Electrodeposition of Gold. H. W. J. Pope (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 4 pp.; and (summary) *Chem. Age*, 1937, **36**, (923), Met. Section, 15–16).—The colour of gold plate can be reddened by addition of small amounts of copper to the cyanide electrolyte, rendered greenish by addition of cadmium, and made lighter in colour by addition of zinc. An 18-carat green gold plate can be obtained from the following bath : gold (as $NaAu(CN)_2$) 2, silver (as $NaAg(CN)_2$) 0.75, free sodium cyanide 4, sodium carbonate 5, trisodium phosphate 20, and potassium sulphite 5 grm./litre. The bath is worked hot at a low current density and gives deposits which require little buffing to produce a brilliant lustre.—A. R. P.

***The Adhesion of Electrodeposited Nickel to Nickel.** A. W. Hothersall (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 8 pp.).—The presence of an oxide film on nickel surfaces may be demonstrated by plating with copper in an acid sulphate bath at 0.1 v. for 30 seconds, when a deposit of copper is obtained only on film-free parts. Since the presence of such a film causes poor adhesion of nickel in the building-up of worn parts, an investigation was made to discover a convenient method of removing the film. Abrasion with coarse emery tended to make adhesion poorer and the only method found of removing the film involved removal of the surface layer of nickel by etching. This is preferably done by anodic etching in 30% sulph-

uric acid for 10 minutes at 15°–25° C., with a current density of 20 amp./ft.^{2}, then at 200 amp./ft.^{2} for 2–3 minutes; the current is then reversed for 1 second, the article washed and immersed immediately in the nickel-plating solution. The acid must be free from depositable impurities and from ferric salts. The process is applicable to composite nickel and iron surfaces.

—A. R. P.

†**Electrodeposition of Platinum. Historical and General Review.** R. H. Atkinson (*1st Internat. Electrodeposition Conf. (London), Advance Copy,* **1937,** 14 pp.).—The methods which have been proposed for the electrodeposition of platinum from 1840 to the present day are critically reviewed. The only plating processes of any commercial importance are those using the phosphate bath, the alkali platinate bath, and the ammino-nitrite bath. Information is also given on the hardness, wearing properties, and corrosion-resistance of platinum plate.—A. R. P.

Developments in the Electrodeposition of the Platinum Metals. K. Schumpelt (*1st Internat. Electrodeposition Conf. (London), Advance Copy,* **1937,** 6 pp. ; and (abridged) *Met. Ind. (Lond.),* 1937, **50,** (14), 416–417).—Amminonitrite platinum plating baths contain ammonium nitrate and sodium nitrite as conducting salts and are operated at 82°–93° C. with 4–5 v. No accumulation of salts occurs despite the use of insoluble anodes since the residue of the salt after deposition of the platinum decomposes into nitrogen and water ; the cathode current efficiency is, however, low and variable. The most satisfactory rhodium plating baths are those containing rhodium sulphate or phosphate or both in the presence of a small amount of either or both acids ; for plating tin and similar white metals an all-phosphate bath is recommended. A nickel undercoat is advised, however, in all cases ; when this is used sulphate rhodium baths give the best results.—A. R. P.

****Platinum Plating from Alkaline Solutions.** E. C. Davies and A. R. Powell (*1st Internat. Electrodeposition Conf. (London), Advance Copy,* **1937,** 7 pp.).—The recommended bath contains sodium hexahydroxyplatinate, $(Na_2Pt(OH)_6,2H_2O)$ 2·7, sodium hydroxide 0·75, sodium oxalate 0·75, and anhydrous sodium sulphate 4·5 oz./gall., and is operated at 65°–80° C. with 7·5 amp./dm.^{2}. The cathode current efficiency is almost 100%, so that a layer of metal 0·00003 in. thick is deposited in 6 minutes, the normal time required for producing a tarnish and wear-resistant coating on silver or silver-plated articles. Insoluble anodes are used ; these may be of pure platinum, but are preferably of thickly platinum-plated copper. The plate produced is perfectly bright and smooth provided that the surface of the article plated has been previously highly polished ; no polishing is required after plating, but only a light buffing to remove " water stains." Replenishment of the bath is effected by adding more of the platinum salt when the platinum content falls to about 0·7 oz./gall. ; in addition about 1 grm. of sodium hydroxide per gall. should be added daily commencing 14 days after the bath has been put into use in order to keep the hydroxide alkalinity at the correct value.—A. R. P.

Surface Protection by Rhodium Plating. F. Kuech (*Z.V.d.I.,* 1936, **80,** (46), 1388–1389).—The advantages and uses of rhodium-plating are described.

—v. G.

Zinc and Cadmium Plating in the U.S.S.R. N. A. Isgarischev (*1st Internat. Electrodeposition Conf. (London), Advance Copy,* **1937,** 6 pp. ; and (abstract) *Met. Ind. (Lond.),* 1937, **50,** (10), 307.—The compositions of two zinc sulphate baths, two cadmium sulphate baths, and one cadmium cyanide plating bath used in Russia are given, and the effect of various factors on the behaviour of the sulphate baths is discussed. In general, polarization is reduced with increase in the velocity of the cathode process which is chiefly determined by the rate of discharge of hydrated ions in the more dilute solutions or by the

rate of dissociation of the hydrated sulphate in the more concentrated solutions. Polarization is also influenced by the nature of the hydrated ions and molecules present, by complex formation, by double salt formation, and by the effect of inter-ionic forces. The unexpected increase of polarization in concentrated cadmium salt solutions is accounted for on the assumption that complex ions of the type $[Cd_2SO_4(H_2O)_n]^{++}$ and $[SO_4(H_2O)_m]^{--}$ are formed.

—A. R. P.

†**Electrodeposited Coatings on Aluminium and Its Alloys.** Karl Altmannsberger (*Metallwirtschaft*, 1937, **16**, (7), 161–162). **Methods of Preparing Aluminium and Aluminium Alloys for Electroplating.** Hugo Krause (*Ibid.*, 162–164).—Both articles review the " Fixal " and " Elytal " methods for plating aluminium-base metals with copper and nickel or chromium.—v. G.

*****A Method of Obtaining Adherent Electrodeposits on Chromium and Stainless Steel.** G. E. Gardam (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 8 pp. ; and (condensed) *Met. Ind. (Lond.)*, 1937, **50**, (14), 415–416).—The difficulty of plating chromium or chromium alloy articles may be overcome by removing the oxide film by cathodic polarization for 5 minutes at 35° C. and at 150 amp./ft.² in a solution of nickel sulphate 240, and sulphuric acid 50 grm./litre followed by copper-plating in an acid copper sulphate bath. The method has been used for testing the adhesion of chromium to various basis metals by a modified form of the Ollard test. The acid nickel sulphate treatment also serves to produce a surface on chromium-plated articles which can be soft-soldered using a zinc chloride flux.—A. R. P.

Comments on the Electrolysis of Solutions of Complex Salts. A. Glazunov and M. Schlötter (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 8 pp.).—The results of recent work on electrolysis of complex salt solutions are critically reviewed and their theoretical implications discussed. Complex cations which are a product of the dissociation of the complex anions are always present and their presence results in the production of a particularly fine-grained cathode deposit. Discharge of the complex cations at the cathode results in their decomposition with the deposition of the metal by secondary precipitation (*i.e.* by chemical reaction), but small quantities of the complex cation remain undecomposed within the lattice structure of the deposit, *e.g.* Ag_2I^+ in the deposition of silver from double iodide solutions.—A. R. P.

†**British Electroplating Practice.** E. J. Dobbs (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 6 pp. ; and (abridged) *Met. Ind. (Lond.)*, 1937, **50**, (10), 305–307).—Nickel is the most widely used plating metal in Great Britain not only as a finishing coating but also as an undercoat for chromium. The baths generally used contain total nickel 50–55, boric acid 12–15, and nickel chloride 25–30 grm./litre and are operated at 32°–40° C. with continuous filtration and air agitation, the current density being kept at 20–24 amp./ft.². Details are given of the preliminary cleaning treatment usually adopted, and of various types of automatic plating plant, with some notes on British practice in chromium-, copper-, cadmium-, tin-, zinc-, and rhodium-plating.—A. R. P.

†**American Practice in Electroplating.** George B. Hogaboom (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, **1937**, 9 pp. ; and (considerably abridged) *Met. Ind. (Lond.)*, 1937, **50**, (10), 313–314).—Some hints are given on the cleaning of steel and brass by electrolytic degreasing and modern American procedure in plating nickel, copper, brass, zinc, and tin is described. The cold nickel bath contains nickel 22·5 and boric acid 15–30 grm./litre with sufficient chloride (as nickel or ammonium chloride) to give good anodic corrosion of the high-purity nickel anodes used ; the bath is operated at p_H 5·8–6·0, 20°–33° C., and 2–10 amp./ft.². The hot nickel bath is now operated at 50–60 amp./ft.² at 65°–70° C. and contains nickel (total) 75, nickel chloride 67·5, and boric acid 37·5 grm./litre. For nickel plating zinc-base alloys the

solution must contain sodium sulphate and must be purified from zinc when the amount present exceeds 0·075 grm./litre. Good results on zinc alloys are being obtained with a cyanide copper bath containing Rochelle salt 45–60, copper 15–37·5, and free cyanide 3·75 grm./litre operated at up to 40 amp./ft.^{2} at 60°–65° C.; the p_H must be kept at about 11·3 at which the cathode efficiency is 80%.—A. R. P.

Advances in Industrial Electro-Plating. C. F. J. Francis-Carter (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (3), 123–124).—A general review. Condensed from a paper read before the British Association.—J. C. C.

Electrodeposition. Production of Bright Plating. —— (*Electrician*, 1937, **118**, (3064), 240).—Characteristics which are desirable in a process for producing bright deposits of nickel are briefly discussed.—J. C. C.

Modern Electroplating Machinery. John Kronsbein (*1st Internat. Electrodeposition Conf. (London), Advance Copy*, 1937, 8 pp.; and *Met. Ind. (Lond.)*, 1937, **50**, (10), 315–318).—A description is given of the following typical modern plating installations: automatic nickel plating plant, automatic chromium plating machine, semi-automatic cadmium plating barrel, and metal rectifiers for plating plant. Curves are given for the power factor characteristics, output voltage, and efficiency of British metal rectifiers.—A. R. P.

Modern Electroplating Plant. J. Loiseau (*Pratique Indust. mécaniques*, 1937, **19**, (11), 444–448).—The plating and finishing practice in a modern factory producing automobile headlights and reflectors are described, and the arrangement of the factory is shown in plan. Nickel, copper, chromium, cadmium, and silver plating, and cleaning and polishing methods are dealt with.—P. M. C. R.

IX.—ANALYSIS

(Continued from pp. 105–108.)

†**Contributions to Applied Spectrography in Metal-Working Industries.** G. Heidhausen (*Metallwirtschaft*, 1937, **16**, (2), 37–45).—An exhaustive report on the use of spectrographic analysis in works laboratories and the accuracy of the methods.—v. G.

†**Chemical Analysis by X-Ray Diffraction Methods.** Wheeler P. Davey (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 284–296; discussion, 297–301).—The salient advantages of the X-ray crystal structure method for the identification of crystalline materials are pointed out in non-technical language. It is inherent in the method that the results show the state of chemical combination of the crystalline components of the substance. The crystal structure is a valuable tool in determining phase diagrams of crystalline materials, and in tracing the course of certain chemical reactions. Illustrative examples of the method include: the effect of traces of impurity in solution on metallic Pb; Hanawalts card index for identifying chemicals from their three strongest X-ray diffraction lines; the evaluation of sands used in casting Mg alloys (now regarded as the standard method); the cause of blistering of Mg alloy sheets; the cause of small corrosion pits on Mg alloys; the determination of the percentage of Au in a " nugget " weighing only 0·0001 grm.—J. S. G. T.

***On the Detection and Separation of Rhenium.** Isaburo Wada and Raizo Ishii (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, 1937, **31**, (674), 55–84).— [In English.]—W. H.-R.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

(See also " Testing " and " Temperature Measurement and Control.")

†**Development of Measuring Methods in Metallurgy.** Erich Scheil (*Z.V.d.I.*, 1936, **80**, (48), 1466–1468).—Microscopic, acoustic, physical, and X-ray methods are discussed.—v. G.

†**The Importance of the Microscope for Investigating the Structure of Metals.** Werner Köster (*Metallwirtschaft*, 1937, **16**, (6), 129–137).—The subject is discussed with especial reference to the equilibria in aluminium–magnesium–zinc alloys.—v. G.

On the Resolving Powers of the Infinity Objectives of N.A. 1.40 and N.A. 1.60 Used With a Precision High-Power Metallographic Apparatus. Francis F. Lucas (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 614–635).— [In English.] L. discusses a new precision-type metallographic apparatus using infinity corrected objectives of N.A. 1.40 and N.A. 1.60. The latter are the mono-brom-naphthalene objectives which represent the highest order of achievement in optics for the metallographic microscope. For the first time, many comparisons are shown and discussed as photographed with the apochromats of N.A. 1.40 and the mono-brom-naphthalene objective of N.A. 1.60. Details of structure of the order of magnitude of 200 atom diameters may now be clearly and sharply resolved. The necessary technique is discussed.—S. G.

†**X-Ray Diffraction Equipment and Methods.** Charles S. Barrett (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 193–225; discussion, 226–229).—Apparatus for X-ray diffraction work is described, and suggestions are made regarding suitable instruments for various practical applications, *e.g.* a camera for study of preferred orientation in sheet material, a camera for examining cold-worked layers, and a universal camera. The choice of camera for a definite problem is discussed. The paper includes examples of the method of determining the depth of cold-working from a machining operation, and the amount of cold-work occurring as the result of alternating stresses in a fatigue specimen. Diffraction patterns do not afford direct indication of impending fatigue failure. The determination of internal and external stresses in the surface fibres of a metal by means of back-reflection cameras is explained. Illustrative examples include the determination of the solubility of copper in iron, effect of quenching stresses on the lattice parameters of aluminium–magnesium alloys, and X-ray study of age-hardening.—J. S. G. T.

*On the Method of Measuring the Oxidation Equilibrium of a Metal by Carbon Dioxide. Kôkiti Sano (*Kinzoku no Kenkyu (J. Study Metals)*, 1936, **13**, (12), 483–485).—[In Japanese.] A simple device was constructed for the determination of the oxidation equilibrium of metals and carbon dioxide, and was applied to the reaction $Fe + CO_2 = FeO + CO$. The equilibrium constants obtained were in good agreement with those of Eastman (*U.S. Bur. Mines Circular* No. **6125**, 1929).—S. G.

XI.—PHYSICAL AND MECHANICAL TESTING, INSPECTION AND RADIOLOGY

Studies on Metallic Wear. P. Régnauld (*J. Marine marchande*, 1936, **18**, (909), 1505–1507).—An historical survey of the development of tests for wear in metals.—P. M. C. R.

†**Testing Machines for Determining Endurance Strength.** H. Oschatz (*Z.V.d.I.*, 1936, **80**, (48), 1433–1439).—A review of methods for determining the fatigue limit of metals, with an extensive *bibliography*.—v. G.

Hardness and Hardness Measurements. S. R. Williams (*Instruments*, 1937, **10**, (1), 12–14). **Theories and Definitions of Hardness.** S. R. Williams (*Ibid.*, (2), 41–44, 58).—The need for an absolute method for measuring hardness, if such a property exists, is emphasized. As a preliminary definition, it is suggested that hardness may be regarded as the resistance to penetration by another body. In commencing a detailed review of the subject, an outline is given of modern views on crystal structure as revealed by X-ray and other methods.—J. C. C.

Optical Investigations on Thin Films of Silver and Silver Iodide. Georg Essers-Rheindorf (*Ann. Physik*, 1937, [v], **28**, (4), 279–318).—A new optical method for measuring the thickness of very thin metal films is described.

—v. G.

RADIOLOGY.

†**The Principles of the Radiographic Process.** John T. Norton (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, **1936**, 3–20 ; discussion, 21–24).—Various factors—contrast, latitude, speed and definition of the photographic film or paper used, the X-ray source, shielding —entering into the production of a successful radiograph are interestingly discussed. In recent years, intensifying screens of metal foil have been used with considerable success for radiography at high voltages. Fixed-type, semi-portable, and portable X-ray units are described. For the detection of small defects, a long tube-to-film distance is desirable. Higher voltage means lower contrast and greater latitude. The principles discussed, correctly applied, enable one to produce a radiograph which reproduces satisfactorily the interior of the object being examined, while ensuring that defects larger than a certain minimum size, if present, are detected.—J. S. G. T.

†**Foundry Applications of Radiography.** Earnshaw Cook (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, **1936**, 25–47 ; discussion, 48–52).—Foundry applications of radiography for the metallurgical control and inspection of simple and alloy steels and aluminium, as practised by five American organizations, are described and illustrated. In one case, the lay-out of plant for use with a 300 kv. tube is briefly described. The discussion turned largely on the value of the inspection of a pilot-casting in full scale production of castings. Foundry practice is corrected by results obtained with radiography of a pilot-casting, with the result that 75–90% of routine castings are found to be satisfactory. A method for the detection of cracks occurring in a fillet is suggested.—J. S. G. T.

†**Radiography in the Welding Shop.** J. C. Hodge (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, **1936**, 53–85 ; discussion, 86–91).—The necessity for non-destructively testing welds in certain engineering structures, *e.g.* pressure vessels, is pointed out, and the superiority of the radiographic method for this purpose is stressed. Forty-eight industrial X-ray equipments for this purpose have been installed in America since 1931. The method is also used for random checking of weld quality, and for the examination of critically stressed parts in welds which are not completely radiographed. The development of X-ray technique for production weld testing is outlined. Technique for weld examination both in the workshop and under conditions of use is outlined. The nature of weld defects and their detection are considered with special reference to the limitations in the detection of certain types of defects such as incomplete fusion and small cracks. Majority opinion indicates the necessity of radiographic testing of welds in boiler drums and pressure vessels. A *bibliography* of 11 references

and a form of questionnaire submitted to 45 individuals or corporations are given.—J. S. G. T.

†**Miscellaneous Applications of Radiography and Fluoroscopy.** Herman E. Seemann (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 92–111; discussion, 112–115).—Applications of radiography and fluoroscopy (eye observation of X-ray images on a fluorescent screen) are described. If high-percentage inspection of articles or packages of light materials is necessary, rapid inspection by the fluoroscope is very practicable. General conditions for the application of both methods are discussed. Illustrative examples comprise the examination of a copper-jacketed transmitter tube, Bourdon gauges, stamped sheets brazed together, a reinforced concrete floor, canned goods, distortion of embedded coils of wire, silver-impregnated carbon contacts. A *bibliography* of 21 references is given.—J. T.

†**Gamma-Ray Radiography and Its Relation to X-Ray Radiography.** Norman L. Mochel (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 116–151; discussion, 152–155).—The present status, and the extent and manner of application of γ-ray radiography are briefly outlined, practical aspects of the subject being stressed. The materials examined by γ-ray radiography include cast and wrought steel, welded metals, nickel–chromium alloys, copper-base alloys, zinc and zinc alloys, aluminium, cast iron, Babbitt metal, die-castings, lead, copper and submarine-cable. Reasons for and against the adoption of γ-ray radiography are summarized. X-ray and γ-ray radiography are both necessary methods of investigation. A *bibliography* of 31 references is given, and an appendix gives instructions and precautions to be taken in radium radiography.—J. S. G. T.

†**The Problem of Radiographic Inspection.** H. H. Lester (*Amer. Soc. Test. Mat. Symposium on Radiography and X-Ray Diffraction Methods*, 1936, 156–179; discussion, 180–190).—Radiographic tests, much used abroad, particularly in Germany, set standards of metal soundness that are usually higher than those set by other methods of testing. This fact has not been appreciated by some manufacturers. Uncertainties of testing arise from lack of familiarity with the tests, lack of information regarding the physical significance of observed unsoundness, and from other causes. The percentage of doubtful interpretations of casting defects is probably less than 1%. Doubtful cases in weld defects are much higher. It is difficult to manufacture to standards required by radiographic acceptance tests unless radiography is used in developing the manufacturing technique. There is need for better understanding of the tests and of their significance, by producers and consumers.—J. S. G. T.

Practical Applications of X-Rays for the Examination of Materials.—I–VII. W. G. Burgers (*Philips Tech. Rev.*, 1936, 1, (1), 29–31; (2), 60–61; (3), 95; (5), 158–159; (6), 188–190; (7), 220–222; (8), 253–254).—The apparatus used for examining materials by the X-ray diffraction method is described. Some practical applications are then discussed; these include identification of the surface film formed on some steel balls which had been in rolling contact with brass bushes; examination of the texture of electrolytically deposited nickel; detection of compounds in a mixture of chemical products; identification of a modification of aluminium oxide as Corundum; identification of metallic carbides, such as those of zirconium, titanium, tantalum, &c.; detection of thorium oxide and metallic thorium in tungsten wire; distinction between α- and β-tungsten in electrolytic deposits; investigation of the degree of solid solution in the " oxide layer " of oxide cathodes; detection of excess tantalum in solid solution in tantalum carbide; detection of hydrogen absorbed by tantalum.—H. W. G. H.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

Production of Nickel–Brass Castings. Anon. (*Apparatebau*, 1936, **48**, (8), 81–82).—The composition range and composition, melting-point, and casting range are tabulated, and directions are given for melting and casting.—P. R.

*****On the Shrinkage of Magnesium Alloys.** P. Spitaler (*Metallwirtschaft*, 1936, **15**, (52), 1221–1227).—The shrinkage coeff. in the solid state of binary alloys of magnesium with cadmium, copper, nickel, aluminium, zinc, and silicon and of aluminium–zinc–magnesium alloys were measured by Wüst and Schitzkowski's method. The values obtained were, irrespective of the alloying constituent, slightly lower than the value (2%) for pure magnesium, reaching 1·5% for 5% alloys. Further addition of other metals has little effect. Only cadmium has no effect on the shrinkage.—v. G.

†**The Centrifugal Casting Process as Applied to Non-Ferrous Metals and Alloys.** J. E. Hurst (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (2), 73–76; (3), 115–117).—Centrifugal casting results in a fine-grained product, free from gases and shrinkage cavities. Applications of the process are described for producing long tubular castings in brass and bronze; worm wheel blanks in bronze; valve inserts in aluminium bronze; shell bands in cupro–nickel; liners, sleeves, and bushes in Monel and silicon–Monel metal; bearings in white metals and leaded bronze; and tuyeres and ornamental vases in copper. Typical values are tabulated for the mechanical properties of centrifugal castings of these materials, and numerous photomicrographs of their structures are reproduced.—J. C. C.

*****On the Effect of the Chemical Composition of the Colloids of Moulding Sand.** A. Glazunov (*Metallwirtschaft*, 1937, **16**, (1), 13–19).—The effect of additions of colloidal alumina, silica, kaolin, and ferric oxide on the bonded strength of dry moulding sand was investigated. Silica has no binding power and reduces that of other additions. G. concludes that the binding power is due to chemical reactions.—v. G.

Position of Casting Machine Technique in Germany. U. Lohse (*Z.V.d.I.*, 1937, **81**, (2), 39–42).—A report on the machines for preparing moulding sand, for making moulds and for baking them as shown at the Düsseldorf Exhibition, 1936.—v. G.

*****Pressure-Casting Methods for the Production of Thin Railway Bearings.** S. Beilfuss (*Z.V.d.I.*, 1936, **80**, (49), 1475–1477).—An apparatus is described for casting thin white metal bearings having a lead or tin base. Both the mould and the melting kettle are adapted to receive nitrogen under 10–15 atm. pressure. The metal solidifies rapidly in a fine-grained homogeneous form free from porosity. The surface of the bearing is smoothed and strengthened by rolling so that boring out is not necessary.—v. G.

†**Recent Advances in Die and Pressure Castings of Zinc [Alloys] with Especial Reference to American Practice.** Josef Dornauf (*Z. Metallkunde*, 1937, **29**, (2), 53–60).—The structure, properties, and uses of Zamak zinc-base alloys with about 4% aluminium, 0·03–3% copper, and 0·02–0·06% magnesium are discussed and numerous examples of die-castings produced from them are described.—A. R. P.

†**Die-Casting.** Martin Storch (*Z.V.d.I.*, 1937, **81**, (5), 119–125).—A review of the alloys used for die-casting, some modern machines, and the principles of mould construction.—v. G.

†**Foundry Applications of Radiography.** (Cook.)

XV.—FURNACES AND FUELS

Gas-Fired Heat-Treatment Furnaces. —— (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (2), 65).—The need for efficient mixing of gas and air before and during combustion is emphasized, and an account given of the " Gako " turbulent burners.—J. C. C.

Electric Furnaces. E. P. Barfield (*Electrician*, 1937, **118**, (3061), 134–135). —A brief review of recent developments in electrically heated controlled-atmosphere, continuous, and forced-air circulation furnaces for heat-treatment purposes.—J. C. C.

Electrical Characteristics of the Electric Arc Furnace. Tatsuo Hayashi and Hiroshi Noda (*Tetsu to Hagane (J. Iron Steel Inst. Japan)*, 1937, **23**, (1), 1–10). —[In Japanese.]—S. G.

Buys Electric Furnaces for Treating Aeroplane Parts. E. P. Dean (*Elect. World*, 1936, **106**, (39), 51–52).—A brief illustrated account of a heat-treatment plant installed by the Boeing Aircraft Co. for handling steel and aluminium parts up to $4 \times 10 \times 2$ ft. in size.—J. C. C.

An Automatic Furnace Temperature Regulator. H. Smethurst and W. L. Lothian (*Metropolitan-Vickers Gaz.*, 1936, **16**, (281), 216–217).—The regulator consists of a bridge system, one arm of which is formed by a platinum resistance thermometer installed in the furnace ; variations in temperature are controlled through two relays. The working range is $20°$–$600°$ C., and the regulator is designed to operate on alternating current. Circuit diagrams are given.

—P. M. C. R.

Fuels and Their Application. Emil Vierow (*Blast-Fur. and Steel Plant*, 1937, **25**, (1), 76–78, 84).—Reviews the progress made in 1936, and outlines the production of " reformed gas " which is made by burning in a converter natural or manufactured gas with 60% of theoretical combustion air, and refrigerating the water vapour formed.—R. Gr.

[Discussion on a Paper by H. A. Humphrey on the] History and Development of Mond Gas for Industrial Purposes in South Staffordshire. —— (*J. Inst. Fuel*, 1937, **10**, (51), 178–182).—Discussion on a paper by H. A. Humphrey ; see *Met. Abs.*, this vol., p. 113.—S. G.

[Discussion on a Paper by V. Binns and S. Bairstow on] Combustion Control by Means of Electrical Meters. —— (*J. Inst. Fuel*, 1937, **10**, (51), 183–188).— Discussion on a paper by V. Binns and S. Bairstow ; see *Met. Abs.*, this vol., p. 113.—S. G.

XVIII.—WORKING

*****Improving the Durability of Constructional Materials (Formelemente) by Cold-Working.** A. Thum and W. Bautz (*Mitt. Material. Tech. Hochschule Darmstadt*, 1936, (8), 91 pp.).—Fatigue failure is attributable to the continued strain exceeding a certain plastic deformation, the so-called limiting creep strain. The fatigue limit of rolled constructional materials, which from the purely constructional point of view, could not be further improved, is effected by a special cold-working process which produces localized cold strengthening of the material and a useful internal strain system. This system must be such that the dangers of external loading strains are minimized, and must produce with these latter strains a total strain of greater polyaxiality and homogeneity. A suitable process has been devised which, while retaining the rolling strains, superimposes effects of cold-working so that there is an increase of 100% in the fatigue limit of rolled and hollow beams. Laboratory tests have

been satisfactorily applied to large-scale constructional materials. Details of the process of cold-working and of the tests are given. A valuable *bibliography* of 125 references is appended.—J. S. G. T.

*The Resistance to Deformation of Copper in Hot-Rolling. Otto Emicke and Karl-Heinz Lucas (*Z. Metallkunde*, 1937, **29**, (1), 10–16).—A method for determining the power required in the hot-rolling of copper is described ; from the results obtained the following expression is deduced : $N_w = (\sigma + k_{h/D} + k_v) \Delta h . b . v$, where N_w is the power consumption in m.-kg./second, σ is the static flow pressure in kg./cm.², $k_{h/D}$ and k_v are additional characteristics for the resistance to deformation, v is the rate of rolling in m./second, b is the width of the material rolled, and Δh is the reduction in height in passing through the rolls.—A. R. P.

†Recent Experience in the Properties and Working Possibilities of Clad Sheet [Steel]. Wilhelm Radeker (*Z. Metallkunde*, 1937, **29**, (1), 1–8 ; discussion, 9). —The adhesion of rolled-on coatings of nickel, Monel metal, and stainless steel to steel was investigated by torsion and bending tests and by micrographic examination. To obtain good adhesion the cladding metal must be securely locked into the crystal boundaries of the steel ; a zone of mutual diffusion on either side of the weld assists in securing good adhesion providing that only solid solutions or workable new phases are formed without any brittle intermetallic compound. When the clad product fulfils these requirements the cladding does not part from the basis metal even under prolonged alternate bending or during sudden sharp changes of temperature. Methods of making welded joints in clad metals are described and the properties of such joints in copper- and nickel-clad steels are tabulated.—A. R. P.

Lubrication of Modern Rolling Mills. L. Ballard (*Blast-Fur. and Steel Plant*, 1937, **25**, (2), 191–194, 226).—A general review.—R. Gr.

*Mechanism of Flow in the Cold-Drawing of Profile Rods of Various Metals. Hermann Unckel (*Z. Metallkunde*, 1937, **29**, (3), 95–101).—The mechanism of flow in the drawing of square and rectangular rods of metals was investigated in a similar way to that used in the case of rolled sheet. The results obtained which varied with the nature of the metal are shown in photographs for copper, aluminium, and brass.—A. R. P.

Manufacture of Sporting Cartridges and Copper Tubes. H. O. Smaldon (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (2), 85–86).—Brief report of a paper read before the Canterbury and District Ironmongers' Assistants Association.—J. C. C.

*Studies of the Wire-Drawing Process. IX.—Does the Phenomenon Known as the " Alkins Effect " Occur in Certain Ferrous Alloys ? Edgar L. Francis (*Carnegie Schol. Mem.*, Iron Steel Inst., 1936, **25**, 69–79).—The mechanical properties of a number of cold-drawn steels were carefully investigated. No evidence was obtained that any of these materials show the " Alkins effect " which has been found to be of fairly general occurrence amongst metals and alloys belonging to the face-centred cubic system.—S. G.

Drilling of Aluminium Sheet with Reference to the Quality of the Hole. W. Walbersdorf (*Maschinenbau*, 1936, **15**, (21/22), 599–602).—To obtain smooth holes in drilling aluminium sheet without using a liquid lubricant special tools are required, and the initial drilling speed must be high while the final speed (for the last 0·3–0·4 mm.) must be low.—v. G.

Steels and Tools for Working Aluminium and Other Non-Ferrous Metals. —— (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (3), 129–130).—Workshop notes on the machining of aluminium.—J. C. C.

†Capability of Cutting as Part of Material Testing. H. Schallbroch (*Maschinenbau*, 1936, **15**, (21/22), 605–610).—The various methods by which the suitability of a metal for working by cutting tools may be evaluated are reviewed.—v. G.

N

A Speed-Increment Test as a Short-Time Testing Method for Estimating the Machinability of Steels. P. Clausing (*Philips Tech. Rev.*, 1936, 1, (6), 183–187 ; (7), 200–204).—In the usual type of test, the time, during which a standardized tool holds, is measured at different cutting speeds when making a cut of definite dimensions. From such tests, F. W. Taylor obtained a formula relating tool-life and linear cutting speed. The method is tedious and wasteful, and results can be obtained more rapidly by increasing the speed to such a rate that the tool becomes blunted in a short time. A convenient method of accomplishing this on an ordinary lathe is to machine the face of a disc, beginning at the centre and moving outwards. The relation between this disc test and the Taylor test is analyzed and the results of correlating experiments on various steels are described.—H. W. G. H.

XIX.—CLEANING AND FINISHING

†Chemical Colouring of Metals. H. Krause (*Z. V.d.I.*, 1937, 81, (5), 127–131). —Practical chemical and electrochemical methods of colouring metals are reviewed ; the films produced are often corrosion-resistant.—v. G.

Fresh-Air System Expedites Work in Cleaning and Plating Departments. W. W. Boone (*Products Finishing*, 1936, 1, (1), 20–23 ; *C. Abs.*, 1937, 31, 987). —A description of a blower system in a modern cleaning and plating department, which produces a complete change of air in the whole department every 2 minutes. The fumes are exhausted and fresh air is blown into the department, simultaneously necessitating two complete sets of ducts. As the steam is the most difficult to exhaust, the exhaust vents from the washing machines and hot-water tanks are slightly larger in size than the exhaust vents for removing the acid fumes. Any possible corrosion by the acid fumes is precluded by lining the exhaust ducts with a light coating of lead.—S. G.

Cleaning of Tantalum Jets by Induced Flow. Joseph Brandwood (*Silk and Rayon*, 1936, 10, 878–883 ; *C. Abs.*, 1936, 31, 1608).—Tantalum jets are cleaned with a mixture of equal volumes of concentrated sulphuric and nitric acids at 100° C. An apparatus for cleaning tantalum and precious metal jets is illustrated and described.—S. G.

Organic Coatings for Metal Products.—I. M. H. Corbin (*Products Finishing*, 1936, 1, (3), 10–14).—S. G.

The Growing Importance of Metal Finish. Herbert R. Simonds (*Products Finishing*, 1936, 1, (2), 5–10 ; *C. Abs.*, 1937, 31, 987).—A survey, dealing with the knowledge of available finishes, finishing characteristics (base metal, plating and coating), polishing and buffing, and the value of finish.—S. G.

Finishing Automobile Bumpers in Modern Plant. C. L Halladay (*Products. Finishing*, 1936, 1, (2), 12–16, 37).—A detailed description.—S. G.

XX.—JOINING

*Are Tin Solders Replaceable by Other Soft Solders ? Alex. Schaefer (*Metallwirtschaft*, 1937, 16, (3), 61–63).—Tests were carried out on zinc–cadmium alloys with a composition near to that of the eutectic (17·4% zinc). Addition of 0·1% of copper, 0·5% of silver, or 1% of lead to this solder improves the strength of the joints made with it on steel sheets ; the plain binary eutectic alloy has the best wetting power.—v. G.

The Hard-Soldering of Stainless and Acid-Proof Steels with Silver Solder. Robert J. Snelling (*Illust. Zeit. Blechindustrie*, 1937, 66, (4), 94–95 ; (5), 120–122).—Unsatisfactory results in the silver-soldering of stainless steels are

attributed to the selection of too high a silver content : the optimum composition range is silver 10–15, zinc 25–40, and copper 50–60%. The results of salt-spray corrosion tests on soldered 18 : 8 steel are summarized, and an account is given of the influence of additions of cadmium, iron, and lead to the solder. The choice of flux and the optimum soldering temperature are discussed and special compositions of solder are recommended for the joining of stainless steel to pure nickel or to Monel metal.—P. M. C. R.

Phosphorus-Brazed Joints. —— (*Soudeur-Coupeur*, 1936, **15**, (9), 1–5).—The low melting point phosphor–copper alloy, Alphos, is described and its applications for jointing copper in architectural, electrical, and chemical work are illustrated. It is stated to be a satisfactory alternative in cases where soft solder, ordinary brazing, or silver soldering is unsuitable.—H. W. G. H.

A List of Fundamental Research Problems in Welding and Reviews of Recent Welding Literature. —— (*J. Amer. Weld. Soc.*, 1936, 15, (11), 1–40 (Supplement)).—This impressive classification of welding problems is compiled by a sub-committee of the Welding Research Committee sponsored jointly by the American Welding Society and the American Institute of Electrical Engineers. The problems are divided into 7 groups : tests of mechanical properties, metallurgical, physics, welding procedure, structural studies, chemistry, and personnel. Reviews of recent literature are given in the form of 12 appendices, of which those interesting the non-ferrous welder are : welding non-ferrous metals, resistance welding electrodes, metal transfer in welding and allied topics, X-ray testing, weld shrinkage, stress distribution in welded joints, and corrosion of welds. A *bibliography* is given with each review, which covers papers published in 1935 and 1936.—H. W. G. H.

*****The Jointing of Materials by Welding.** R. H. Dobson and R. F. Taylor (*J. Roy. Aeronaut. Soc.*, 1936, **40**, (309), 647–657 ; discussion, 657–662).—The technique of torch welding aluminium, aluminium alloys, and magnesium alloys is described. Spot-welding is described and attention is directed to the scope of this method of making joints in aircraft parts. Results are given of shear tests of spot welds in Alclad.—H. S.

The Bronze-Welding of Copper Piping. W. L. Kilburn (*J. Inst. Heating Ventilating Eng.*, 1936, **4**, (40), 172–180 ; and *Aluminium and Non-Ferrous Rev.*, 1936, 1, (10), 489–491 ; (11), 511).—The advantages of copper for sanitary purposes, and of welding as a jointing method, are enumerated. For fusion welding, the copper should be deoxidized, skilled technique is required, and the finished joint needs careful hammering. Bronze-welding, on the other hand, can be carried out on copper which is not deoxidized, the parent metal never attaining fusion temperature. The fluidity of the filler-rod and its low melting-point simplify the technique and enable joints to be made in awkward places. The correct technique is described for typical joints, such as the short bell and built-up tee joints. A neutral flame is used in such cases, but an oxidizing flame is recommended for bronze-welding brass fittings to copper pipe.—H. H.

*****The Electric Welding of Lead.** T. Okamoto, H. Nishimura, and I. Onishi (*Yosetsu-Kyokwai-Shi*, 1936, **6**, 256–261 ; *C. Abs.*, 1937, **31**, 1340).—[In Japanese.] Lead could be welded easily by the electric arc or by the resistance welding process. Lead plates were welded by the ordinary d.c. metallic arc process, with or without flux, and also by the d.c. or a.c. carbon arc process, and the mechanical properties of the joints, the corrosion-resistance to sulphuric acid, and various other properties of the deposited metal were tested and found very satisfactory. Lead plates were also welded easily by resistance spot welding with good results. Bars and plates can be welded successfully by ordinary resistance butt-welding if proper attention is given to the current, the pressure, and the time. Plates can be welded by the electric arc process with much greater speed and economy than by the gas and other welding processes.—S. G.

Technique for Resistance Welding Ferrous and Non-Ferrous Sheet Metals.
E. I. Larsen (*J. Amer. Weld. Soc.*, 1936, **15**, (12), 9–16).—After a general discussion of the principle factors involved in resistance welding—electrical and thermal conductivity, current timing devices, electrode pressure, electrode design and properties—the following materials are considered in more detail : mild steel, tin- and terne-plate, galvanized iron, aluminium, nickel, Monel metal, copper, brass, bronze, and special copper alloys. In several cases, recommended current values, welding times, and electrode pressures are given.
—H. W. G. H.

How Should Small Parts be [Resistance] Welded ? A. Mayerhofer (*Werkstatt u. Betrieb*, 1937, **70**, (5/6), 64–66).—An illustrated account of butt-, spot-, and seam-welding as applied to small parts, especially of sheet.—P. M. C. R.

*Stress Distribution in Welded Joints Subjected to Tension or Bending (Measured by Photoelastic Methods).** Hirosi Yamanouti, Masahiko Fuziwara, and Seiichirô Sakezawa (*Trans. Soc. Mech. Eng. Japan*, 1936, **2**, (8), 316–327). —[In Japanese, with English summary in suppt., pp. 89–90.] Tests were made on about 37 test-pieces of every standard and other forms of arc welded joints, in which the parent metal and the arc fused metal were prepared from a plate of celluloid and jointed together by film cement. The data obtained from about 80 cases subjected to tensile, shearing, and bending stresses are given and the results obtained are discussed.—J. W. D.

†**Radiography in the Welding Shop.** (Hodge.) See p. 157.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 118–119.)

Conditions of Acceptance for Light Alloys Used in Naval Construction.
P. Régnauld (*J. Marine marchande*, 1936, **18**, (877), 144–145).—The use of aluminium or light alloys is forbidden by the French authorities in many parts of a ship, a list of which is given. Methods of protection and precautions to be taken in storage are summarized. Limits of composition, tensile strength, elongation, heat-treatment (if any), and permissible loss of weight under corrosion testing in the absence of protective treatment are specified for cast alloys. Minimum requirements are also stated for medium and high-strength rolled alloys containing 1% magnesium (max.) ; a recently admitted class contains magnesium up to 5·7%.—P. M. C. R.

Notes on the Construction of Integral Fuel Tanks for Airplanes. Horace J. Alter (*J. Aeronaut. Sci.*, 1937, **4**, (3), 100–106).—The success of the built-in fuel tank depends mainly on the seams. Methods for preventing seam leakage are reviewed. Directions are given regarding the size, spacing, and number of rivets, for the application of sealing compounds and strip, for tank testing, and for clearing. Since dichromate solution is frequently used in the latter process, the tanks should be of Alclad, with or without anodic protection.
—P. M. C. R.

Alloy Tubes for Aeroplanes. Gilbert Evans (*Aircraft Eng.*, 1936, **8**, (90), 224–226).—A practical description of processes of manufacture.—H. S.

Aluminium Wrapping for Electric Cables. —— (*J. Marine marchande*, 1936, **18**, (898), 1098–1099).—Aluminium or light alloy wrapping for electric cables is recommended on the grounds of resistance to corrosion, reduction in weight, absorption of stray currents, relatively low melting point, non-magnetic character, and rapid cooling of cables. The material is used in the form of ribbon or flat wire.—P. M. C. R.

Copper in Chemical Plant. —— (*Copper Develop. Assoc. Publ.* No. 23, 1936, 68 pp.).—The properties of copper and its alloys with zinc, tin, nickel, and aluminium are reviewed. Coatings of tin, silver, nickel, and chromium on copper are also briefly considered. Copper in chemical plant being mainly in

the wrought form, the working of sheet and tube, and jointing methods receive considerable attention. The high thermal conductivity of copper and its resistance to corrosion account for its extensive use in heat transfer apparatus, and applications in evaporation and distillation are described. Finally, miscellaneous applications in fermentation, food, paper, textile, oil, and paint industries are indicated. Many excellent illustrations and an adequate index complete an interesting and useful booklet.—H. W. G. H.

Lining Vessels for Steaming Wood. —— Hoyer (*Wochbl. Papierfabr.*, 1936, **67**, 798–800 ; *C. Abs.*, 1937, **31**, 1202).—A discussion of the advantages of using sheet metal (steel) plated with copper, nickel, or copper–nickel alloys, in the construction of wood-steaming autoclaves.—S. G.

*Influence of [Copper]Water Pipes on the Iodine Content of Water. W. P. M. Matla (*Chem. Weekblad*, 1936, **33**, 570–574 ; *C. Abs.*, 1937, **31**, 1130).— Experiments indicate that copper pipes, especially when they have accumulated a coating of copper decomposition products, may remove iodine from water. There are also indications that inner asphalt coatings may act similarly. Tinned copper and lead pipes are apparently without action.—S. G.

The Behaviour and Maintenance of [Brass and Copper] Boiler Tubes and [Steel] Superheater Elements on the Western Australian Government Railways. G. W. Blackwood (*J. Inst. Locomotive Eng.*, 1936, **26**, (132), 510–547).—Details are given of the procedure in repairing 70 : 30 brass boiler tubes by rumbling, cutting off damaged ends, and " piecing " to length, the joints being butt-welded by oxy-acetylene, using a brass welding stick and borax as a flux. " Dezincification " is discussed, and details given of trials with arsenical copper, cupro–nickel, and leaded 60 : 40 brass tubes. The repair of copper and steel flue-tubes by stretching to length after trimming away the damaged ends is described in detail.—J. C. C.

Pantograph Construction and Operation. H. W. Beckering (*Elect. Rail. Traction* (Suppt. to *Railway Gaz.*), 1936, **64**, (26), 1230–1236).—An account of the wear experienced on overhead contact wires of bronze against copper and carbon pantograph shoes. Graphical records, structural details, estimated installation and maintenance costs, and an account of development in shoe design are given.—P. M. C. R.

The Effect of Cylinder Walls on the Performance of Explosion Engines. Boris Rabinovitch (*Mécanique*, 1937, **21**, (270), 28–35).—Combustion conditions within the cylinder are analyzed, and a review is given of the work of Veron, Gillett, and others on the influence of cylinder-head materials on engine performance and carbonization. A copper–cast-iron cylinder head is compared with one of light alloy, graphs showing power and fuel consumption at different loads and with two types of fuel. The relative unimportance of thermal conductivity as compared with heat exchange coeff. is emphasized.

—P. M. C. R.

Note on the Capping of Cables for Suspension Bridges. —— Grelot (*Ann. Ponts Chaussées*, 1936, **106**, (11), 583–591).—As a basis for future specifications, recommendations are made for the various operations of the capping process, the form of the cap, the preparation of the cable, and the melting and pouring of the alloy.—P. M. C. R.

Molybdenum—A Metal for Vacuum Tubes. T. G. Troxel (*Radio Eng.*, 1936, **16**, (Dec.), 8–9 ; *C. Abs.*, 1937, **31**, 952).—A brief outline of the means of obtaining molybdenum for radio receiving valve construction.—S. G.

Monel in the Soap Factory and in the Cosmetic Industry. Rudolf Müller (*Seifenseider-Zeit.*, 1936, **63**, 813–816).—Discusses the properties of Monel metal, and its possible applications in these industries.—S. G.

The Use of Monel Metal in Steam Fittings. —— (*J. Marine marchande*, 1936, **18**, (918), 1859–1860).—A review of the applications of Monel metal in boiler and superheater fittings, condensers, and turbines.—P. M. C. R.

High-Duty Valves. B. Trautmann (*Apparatebau*, 1936, **48**, (25), 282–284). —A discussion of the desirable properties of materials for high-duty valves and valve seats. A table gives the chief mechanical properties of pure nickel, Monel metal, K-Monel, and 3 ferrous nickel alloys.—P. M. C. R.

Electrical [Precious Metal] Contacts. Edmund Downs (*Elect. Rev.*, 1937, **120**, (3088), 168–169).—Silver, being resistant to oxidation at all temperatures below its melting point, is widely used for electrical contacts. Silver alloys, graphite blocks impregnated with silver powder, copper blocks having a thin inlay or facing of silver, platinum, and platinum alloys are also used. Applications of these materials are briefly discussed.—J. C. C.

The Use of Tin in Refrigerating Equipment. E. J. Daniels (*Ice and Cold Storage*, 1936, **39**, 182).—S. G.

Modern Applications of Rare and Recently Developed Metals. G. Guzzoni (*Industria meccanica*, 1936, **18**, 679–683; *C. Abs.*, 1937, **31**, 1332).—The properties of Dow metal, Elektron, beryllium alloys, and the fields of application of titanium, bismuth, cerium, cobalt, tantalum, tungsten, osmium, thorium, and uranium are discussed in general.—S. G.

Alloys and Alloy Steels in 1936. James C. Vignos (*Blast-Fur. and Steel Plant*, 1937, **25**, (1), 74–75).—Summarizes the advancements made in 1936 in the use of alloying elements in steel.—R. Gr.

The Leipzig Fair—Metallic Constructional Materials and Semi-Products. A. Kessner (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (3), 127–128).— Abstracted from a technical report issued by the Leipzig Fair authorities. The use of aluminium and its alloys as a substitute for copper, brasses, or bronzes is discussed. Figures are included for the German consumption of the important non-ferrous metals.—J. C. C.

Non-Sparking Tools Help Make Process Industries Safe. —— (*Chem. and Met. Eng.*, 1936, **43**, (11), 604–605).—The views are summarized of plant safety engineers in a number of different process industries on the use of non-sparking tools—especially in dangerous applications where inflammable vapours or gases are handled. With only a few exceptions, the views indicate that a wide variety of problems are being solved by the use of such alloys as beryllium–copper and aluminium bronze, wherever there is a possible explosion hazard from inflammable vapours. Such articles as machinists' hammers, sledge hammers, chisels, wrenches, pinch bars, spatulas, picks, shovels, &c., are made for this kind of service, the extra cost being judged to be justified by the lessened risk to human life. An aluminium bronze hammer is almost twice the cost of a steel one, whilst one of beryllium–copper is about twice that of an aluminium bronze one.—F. J.

XXII.—MISCELLANEOUS

(Continued from pp. 120–121.)

The Work of Henry Le Chatelier. G. Charpy (*Chim. et Ind.*, 1936, **36**, 669–672).—S. G.

Metallurgical Progress : A Broad Survey of the Vast Non-Ferrous Field Shows Many Changes. Ernest A. Hersam (*Eng. and Min. J.*, 1937, **138**, (2), 90–93).—A broad survey of the progress made in the non-ferrous field.—R. Gr.

The Literature of Aluminium. A. D. Roberts (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (3), 104–105).—A selected bibliography of books on aluminium and its alloys.—J. C. C.

A Film about Aluminium. —— (*Aluminium and Non-Ferrous Rev.*, 1936, **2**, (3), 106–110).—The text of a French film, dealing with the production of aluminium and its applications in road, rail, air, and marine transport, in the electrical industry, in building, and for domestic purposes.—J. C. C.

Development of the Technische Hochschule, Darmstadt. A Review on the Occasion of the 100-Year Jubilee. F. List and C. Rau (*Beton u. Eisen*, 1936, 35, 157–159).—S. G.

Working of Polymerized Resins into Pipes. Hans Lutz (*Z.V.d.I.*, 1937, 81, (2), 47–51).—Vinyl resins have been used for making pipes which have proved satisfactory substitutes for and sometimes superior to metal tubes as regards working and stability towards corrosion.—v. G.

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[The papers in this volume (with discussions) are : J. T. Norton : " The Principles of the Radiographic Process "; E. Cook : " Foundry Applications of Radiography "; J. C. Hodge : " Radiography in the Welding Shop "; H. E. Seemann : " Miscellaneous Applications of Radiography and Fluoroscopy "; N. L. Mochel : " Gamma-Ray Radiography and its Relation to X-Ray Radiography "; H. H. Lester : " The Problem of Radiographic Inspection "; C. E. Barrett : " X-Ray Diffraction Equipment and Methods "; K. R. Van Horn : " The Constitution of Alloys "; W. P. Davey : " Chemical Analysis by X-Ray Diffraction Methods "; J. T. Norton : " Application of X-Ray Methods to Problems of Cold-Work, Preferred Orientation, and Recrystallization "; G. H. Cameron and A. L. Patterson : " The X-Ray Determination of Particle Size "; G. L. Clark : " The Applications of the X-Ray Diffraction Method to Non-Metallic Materials."

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[See *Met. Abs.*, this vol., p. 150.]

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[See *Met. Abs.*, this vol., p. 129.]

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Jaeger, F. M., J. A. Bottema, and **E. Rosenbohm.** *The Exact Measurement of the Specific Heats of Metals at High Temperature. XXVI.—The Specific Heats and the Electrical Resistance of Cerium.* Pp. 9, with 4 illustrations. 1936. Amsterdam : N.V. Noord-Hollandsche Uitgeversmij. (Fl. 0.80.)

[In English. From *Proc. K. Akad. Wet. Amsterdam*, 1936, **39**, (8), 912–920; see *Met. Abs.*, this vol., p. 130.]

Jaeger, F. M., J. A. Bottema, and **E. Rosenbohm.** *The Exact Measurement of the Specific Heats of Metals at High Temperatures. XXVII.— The Specific Heats and the Electrical Resistance of Lanthanum.* Pp. 7, with 3 illustrations. 1936. Amsterdam: N.V. Noord-Hollandsche Uitgeversmij. (Fl. 0.50.)

[In English. From *Proc. K. Akad. Wet. Amsterdam*, 1936, **39**, (8), 921–927.]

Japan **Nickel Information Bureau. *Nickel and Monel in the Chemical Industries.* (Technical Information, B–16.) Second Edition, Revised. 18 × 25 cm. Pp. 95, with 28 illustrations. 1936. Tokyo: The Bureau, Municipal Research Building, Hibiya Park.

[In English and Japanese.]

*Japan **Nickel Information Bureau.** *Nickel–Copper Alloys.* (Technical Information B–11.) 18 × 25 cm. Pp. 70, with 27 illustrations. Tokyo: The Bureau, Municipal Research Building, Hibiya Park.

[In English and Japanese. Reprinted from Bureau of Information on Nickel Publications R1 and R2.]

Johnson, S., and **J. Warby.** *Drop Forging Practice.* Ex. Cr. 8vo. Pp. 108. 1937. London: Charles Griffin and Co., Ltd. (4s. net.)

*Krause, Johannes.** *Fehlernachweis in ferromagnetischen Werkstoffen nach dem Feilspäneverfahren.* (Forschungsarbeiten über Metallkunde und Röntgenmetallographie, Folge 16.) Med. 8vo. Pp. 54, with 57 illustrations. 1935. München: Carl Hanser. (R.M. 4.50; Foreign price, R.M. 3.38.)

de Lattre, G. *Le décapage des métaux et alliages.* Pp. viii + 189. Paris: Dunod. (Broché, 30 francs; relié, 53 francs.)

Lintschewski, W. P. *Metallurgical Furnaces.* [In Russian.] Pp. 643. 1936. Moscow and Leningrad: Onti. (Rbl. 11.50.)

Loesche, Adolf. Bearb. von. *Patentregister zum Jahresbericht über die Leistungen der chemischen Technologie.* 1925–1935. Pp. 190. 1936. Leipzig: J. A. Barth. (M. 25; Lw., M. 27.)

Lyssjakow, G. J., and **S. W. Kassatkin.** *Special Technology of Metals.* [In Russian.] Pp. 248. 1936. Moscow and Leningrad: Gosstransisdad. (Rbl. 4.90.)

Masstriukow, A. W. *The Technology of Metals.* [In Russian.] Pp. 531. 1936. Moscow and Leningrad: Onti. (Rbl. 6.00.)

*Maucher, Herbert.** *Beiträge zur Kenntnis der Systeme Kupfer–Germanium, Silber–Germanium.* (Forschungsarbeiten über Metallkunde und Röntgenmetallographie, Folge 20.) Med. 8vo. Pp. 32, with 30 illustrations. 1936. München: Carl Hanser. (R.M. 3; Foreign price, R.M. 1.69.)

*Meaker Company.** *Meaker Process Galvanizing, including Practical Plating Pointers.* Fourth Edition. Med. 8vo. Pp. 40, illustrated. Chicago, Ill.: The Company, 1629–1641 South 55th Ave. (Gratis.)

*Mengeringhausen, M.** *Heimische Werkstoffe für Warmwasserbereiter für Einzelheizung mit Kohle, Gas, Elektrizität.* 15 × 21 cm. Pp. iii + 73, with 55 illustrations. 1937. Berlin: V.D.I.-Verlag G.m.b.H.

*Metal Statistics.** *Quin's Metal Handbook and Statistics, 1937.* Twenty-Fourth Year of Publication. Pott 8vo. Pp. 327. 1937. London: Metal Information Bureau, Ltd., 79 Mark Lane, E.C.3. (5s. net, post free.)

[Contains statistics regarding exports, imports, prices, &c., of: Aluminium; Antimony; Arsenic; Bauxite; Beryllium; Bismuth; Black Plates; Black Sheets;

Brass; Cadmium; Chrome Ore; Chromium Metal; Cobalt; Copper; Ferro Alloys; Galvanized Sheets; Gold; Iron Ore; Iron and Steel; Lead; Magnesium; Manganese Ore; Molybdenum Ore; Nickel; Precious Metals; Pyrites; Quicksilver; Scrap; Secondary Metals; Selenium; Silver; Spelter; Tellurium; Tin; Tinplates; Tungsten; Tungsten Ore; Vanadium Ore; Zinc Sheets. Information is given regarding Extreme Price Records, and London Metal Exchange Dealings. Conversion Tables are also included.]

*Panseri, Carlo. *Metallografia dei Bronzi d'Alluminio.* Studio critico delle possibilità industriali del bronzo d'alluminio attraverso le sue caratteristiche fisico-chimiche, meccaniche e tecnologiche. 17×25 cm. Pp. xvi + 614, with frontispiece and 750 illustrations. 1937. Milano: Ulrico Hoepli. (Lire 90.)

Piwowarski, J. *General Metallography.* [In Russian.] Pp. 531. 1936. Moscow and Leningrad: Onti. (Rbl. 6.00.)

Pogodin, S. A. *Alloys for Electric Cables and Rheostats.* [In Russian.] Pp. iii + 291. 1936. Moscow and Leningrad: Onti. (Rbl. 5.00.)

Pokrowski, J. N. *Outline of the History of Metallurgy.* Volume I. [In Russian.] Pp. 198. 1936. Moscow and Leningrad: Onti. (Rbl. 4.00.)

Rimarski, Walter. Herausgegeben von. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen.* Folge 11. 21×30 cm. Pp. 123. 1936. Halle a. S.: Carl Marhold. (M. 5.)

Roush, G. A. *The Mineral Industry: Its Statistics, Technology, and Trade.* Volume 44, 1935. Pp. 754. 1936. New York: McGraw-Hill Book Co., Inc. ($12.00); London: McGraw-Hill Publishing Co., Ltd. (70s.).

Sarazin, R. *La soudure électrique à l'arc.* Pp. 490. 1937. Paris: Caffin. (40 francs.)

Schied, Max. Bearbeitet von. *Giesserei-Taschenbuch.* Jahrgang 11. Pp. 430. 1936. Berlin: Elsner. (M. 3.)

*Schulz, W., H. Louis, und E. Goethe. *Bergtechnisches Taschenwörterbuch.* 2 Teil: *Deutsch–Englisch.* 12×16.5 cm. Pp. 76. 1936. Essen: Verlag Glückauf G.m.b.H.

*Sisco, Frank C. *The Alloys of Iron and Carbon.* Volume II.—*Properties.* (Alloys of Iron Research Monograph Series.) Med. 8vo. Pp. xiii + 777, with 250 illustrations. 1937. New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd. (45s.)
[A bibliography of 822 references is included—covering the years 1880 to 1935.]

Ssimkin, A. G., S. W. Iwanow, and A. E. Saidman. *Metallic Wastes* (Scrap). [In Russian.] Pp. vi + 346. 1936. Moscow and Leningrad: Standardgis. (Rbl. 7.00.)

*Thum, A., und H. Ochs. *Korrosion und Dauerfestigkeit.* (Mitteilungen der Materialprüfungsanstalt an der Technischen Hochschule, Darmstadt. Herausgegeben von A. Thum. Heft 9.) 15×22 cm. Pp. vi + 109, with 45 illustrations. 1937. Berlin: V.D.I.-Verlag G.m.b.H. (Br., R.M. 9; V.D.I.-Mitgl., R.M. 8.10.)

*United States Department of Labor, Bureau of Labor Statistics. *Occupational Disease Legislation in the United States, 1936.* Prepared by the Labor Law Information Service. (Bulletin No. 625.) Med. 8vo. Pp. 58. 1937. Washington, D.C.: Government Printing Office. (10 cents.)

*U.S. Department of Commerce, National Bureau of Standards.   *Temperature Interconversion Tables* (° C.⟵⟶ ° F.) and *Melting Points of the Chemical Elements*.   (Miscellaneous Publication No. 126.)   20 × 26 cm.   Pp. 4 1937.   Washington, D.C.:   Superintendent of Documents.   (5 cents.)

*United Steel Companies, Ltd.   *Standard Methods of Analysis of Iron, Steel, and Ferro-Alloys*.   Revised and Enlarged Edition.   Med. 8vo.   Pp. 81. 1936.   Sheffield: The Company, 17 Westbourne Rd.   (4s. 6d. net.)

*Zimmer, Reinhard.   *Abnützungsversuche an Hartmetallen, Gusseisen und Leichtmetallen auf der Abnützungsprüfmaschine von O. Nieberding*. (Forschungsarbeiten über Metallkunde und Röntgenmetallographie, Folge 18.)   Med. 8vo.   Pp. 68, with 41 illustrations.   1935.   München: Carl Hanser.   (R.M. 6 ; Foreign price, R.M. 4.50.)

THESIS.

*Walter, J.   *Beitrag zur Technik der anodischen Oxydation von Aluminium unter besonderer Berücksichtigung des Alumilite-Verfahrens*.   Dissertation: Eidgenössischen Technischen Hochschule, Zürich.   Demy 8vo. Pp. 100, with 23 illustrations.   1936.   Zürich: Eidgenössischen Technischen Hochschule.

XXIV.—BOOK REVIEWS

Duralumin and Its Heat-Treatment.   By P. Litherland Teed.   Med. 8vo.   Pp. xi + 116, with 20 illustrations.   1937.   London: Charles Griffin and Co., Ltd.   (12s. 6d.)

After a brief note, the author gives the main features of Duralumin as supplied to British specifications.   The influence of forging and heat-treatment on the properties of the originally cast material are described and illustrated by data on the strength properties in the conditions concerned.   Reference is made to the effect of the metallic impurities present on the properties and response to heat-treatment.   One chapter of 16 pages, with a few diagrams and tables, is devoted to age-hardening, and the main results of age-hardening are presented authoritatively. A complete survey of research on age-hardening would be indeed a difficult task and the author's treatment of the subject should prove both interesting and helpful to the engineers for whom the book is written.   The rest of this little manual is devoted to the various forms of heat-treatment to which Duralumin is subjected and their effect on the more commonly observed mechanical properties.   The effects described are illustrated by comprehensive tables of test results obtained in the author's own extensive investigations.

The book should prove of high value to users of Duralumin.—H. SUTTON.

Die Bearbeitung des Aluminiums.   Von E. Herrmann und E. Zurbrügg. Zweite vermehrte und verbesserte Auflage.   Demy 8vo.   Pp. viii + 117, with 70 illustrations.   1936.   Leipzig: Akademische Verlagsgesellschaft m.b.H.   (M. 4.)

Both authors of this booklet are on the staff of a well-known Swiss firm of aluminium producers; hence the text may be regarded as authoritative.   It has been written chiefly for the benefit of foremen or works managers and much care has evidently been taken to keep it "low-brow" with avoidance both of scientific jargon and unnecessary figures.

The title "The Working of Aluminium" (which is intended to include the light alloys) sufficiently explains the contents, subject to the omission of aluminium founding, which is regarded as a subject on its own; otherwise practically every branch of aluminium working finds some mention, and though the treatment gives quite a good general idea of what can be done, it is very much too brief for use as a workshop manual.

The book is nicely produced with excellent diagrams, but the language difficulty will bar many English readers, also the fact that most of the alloys have unrecognizable German names. Books of this type already exist in English.—H. W. L. PHILLIPS.

Aluminium Paint and Powder. By Junius D. Edwards. Second Edition, Revised and Enlarged. Med. 8vo. Pp. 216, with 78 illustrations. 1936. New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd. (22s. 6d. net.)

This is an authoritative book dealing with the preparation and applications of aluminium powder and paint. It contains a mass of information derived from many sources, of which not the least important are the records of the Aluminum Company of America, and each chapter concludes with an up-to-date bibliography.

The first three chapters deal with the powder itself, its preparation, handling, properties, and testing. Chapter 4 gives a critical description of the vehicles used in the manufacture of aluminium paints, and the subsequent chapters are devoted to the properties and uses of the paint on metal and wood, including the results of tests of long duration under various conditions. The book concludes with a brief account of other uses of aluminium powder, such as in printing, pyrotechnics, Thermit, and aero concrete.

The book is well produced and can be confidently recommended, particularly to those responsible for the erection and maintenance of chemical plant or engineering or architectural structures.—H. W. L. PHILLIPS.

Zinn. Wandlungen in der Erzeugung und Verwendung des Zinns nach dem Weltkrieg. Von Josef Wollnik. (Wandlungen in der Weltwirtschaft, Heft 6. Herausgegeben von H. Schumacher.) 16×23 cm. Pp. 224. 1936. Leipzig: Bibliographisches Institut A.-G. (Br., R.M. 10.)

Although this book contains nothing of purely scientific or metallurgical interest, metallurgists who are interested in the broader aspects of the tin industry will find in it a useful survey of the economic problems involved. The changes in the spheres of application of tin that have occurred during the past 20 years are ascribed mainly to the growth of the canning industry, the popularization of the motor-car, and the increase in electrical equipment and machinery generally. Both loss and gain of markets have occurred. The economic aspects of tin production and consumption in the principal producing and industrial countries are reviewed and the problems of adjusting supply and demand discussed with special reference to international control of the industry. The book is enriched with statistical tables.

—E. S. HEDGES.

Widia-Handbuch. 15×21 cm. Pp. 230, with 213 illustrations. 1936. Essen: Fried. Krupp A.G.

For an example of trade literature this book is quite extraordinary. If it were marketed at half a guinea it would represent good value.

The book opens with a short and elementary account of the development and manufacture of Widia together with some remarks concerning the physical properties. The greater portion of the book consists of a description of the various forms in which Widia is marketed, data on tool preparation, and a profuse collection of information on operating conditions and results. The concluding section deals with miscellaneous uses of tungsten carbide.

The whole book is most lavishly illustrated with scale drawings and very excellent photographs. As an example of this type of really useful practical literature it is without parallel.—W. D. JONES.

The Theory of Metals. By A. H. Wilson. Based on an Essay awarded the Adams Prize in the University of Cambridge, 1931–1932. Demy 8vo. Pp. viii + 272, with 31 illustrations. 1936. Cambridge: at the University Press. (18s. net.)

In this book the author aims to give a complete theoretical account of the electronic properties of solids. The first chapter describes briefly the classical electron theory and Sommerfeld's theory of a metal, and includes a criticism of each. The general theory of the motion of electrons in a perfect lattice is then given and the approximations of nearly free and tightly bound electrons are worked out in detail. After these first two chapters most of the others can be read independently. Chapter 3 contains a discussion of the structure of metals, insulators, and alloys, and the problems of cohesion and magnetism. Ferromagnetism is left on one side, since the approximations break down and a more general type of wave function is required. The remaining chapters deal with optical phenomena, the formal theory of conduction, the mechanism of conductivity and superconductivity.

The book thus gives a survey of the whole field and is especially praiseworthy in bringing out clearly the assumptions on which each theory, or part of a theory, is based, and the difficulties with which it is unable to cope. It has been written for the theoretical specialist and to him it will prove invaluable.—B. M. DENT.

Werkstoffprüfung (Metalle). Von P. Riebensahm. (Werkstattsbücher für Betriebsbeamte, Konstrukteure und Facharbeiter, Heft 34.) Zweite, erweiterte Auflage. 16 × 23 cm. Pp. 66, with 97 illustrations. 1936. Berlin : Julius Springer. (R.M. 2.)

This little book on the testing of metals is the second edition of No. 34 of the publisher's series of workshop books which are intended for management officials and technical workers ; 58 volumes have so far appeared. The treatment of the subject in the present volume is more than adequate for the intended type of reader, and yet the author would not claim that British students of testing would require to consult it.

The usual static and dynamic tests are excellently described, and metallographic, radiographic, and magnetic tests are briefly dealt with. A table of standard German testing methods and symbols is a useful feature, and a list is given of the cost of typical tests.

A useful purpose of the book in its untranslated form would be as a text for students of engineering and metallurgy taking a technical course in German.—H. O'NEILL.

Materialprüfung mit Röntgenstrahlen unter besonderer Berücksichtigung der Röntgenmetallkunde. Von Richard Glocker. Zweite umgearbeitete Auflage. Pp. v + 386, with 315 illustrations. 1936. Berlin : Julius Springer. (Geb., R.M. 33.)

With the appearance of the second edition of this important work on the examination of materials by means of X-rays, the book has been completely re-written. It comprises sections devoted to most branches of the industrial and academic applications of X-rays for the investigation of structure, and is concerned principally with the latter type of investigations. It stresses details of practical procedure rather than physical principles. Fifteen pages only are devoted to the examination of massive structures by means of X-rays and γ-rays. The rest of the book is concerned with the investigation of crystal structures by these means. Sections are devoted to the excitation and characteristics of X-rays, spectrum analysis, and the investigation of fine structure, this including determination of the structures of metals and alloys, and inorganic and organic materials. Dr. U. Dehlinger contributes a valuable summary of the composition, crystal structures, and some physical characteristics of all the most important alloys (12 pages).

The book affords a very complete " bird's eye " view over the whole field of X-ray spectroscopy ; the section on radiography is nothing like so detailed. The book is well printed on good paper, is profusely and well illustrated and is well bound ; it is provided with an adequate subject-index and an extensive bibliographic name-index (16 pp.).—J. S. G. THOMAS.

Einführung in die Röntgenphotographie. Von John Eggert. Sechste Auflage. Pp. vii + 217, with 90 illustrations. 1936. Leipzig : S. Hirzel. (R.M. 5 ; geb., R.M. 6.)

Books on X-rays fall thick as leaves in Vallambrosa. Here is one of a rather special kind. It is published under the auspices of the Photographic Department of the I.G. Farbenindustrie A.-G., which markets the Agfa photographic materials. Its author is a well-known professor of Berlin University. This being its parentage, we expect something good, and we are not disappointed.

The main purpose of the book is to give information whereby the technique of X-ray photography, as ordinarily practised, may be improved. This is done, mainly by reference to procedure using the proprietary photographic materials just referred to. An introductory section, of 56 pages, is devoted to theoretical considerations relating to the excitation and nature of X-rays, and the production of the photographic image. The practical section is devoted to a description of X-ray plant, photographic material, and the technique necessary for the production of good X-ray photographs. The X-ray photography of constructional materials is treated very briefly (6 pages). The illustrations are derived principally from medical practice. The protection of X-ray operatives is described at some length. The book concludes with valuable working instructions for illumination, and the development and fixing of the films. A bibliography of 52 references (all German) and an adequate subject index are given. The book is well printed on good paper, is profusely illustrated, and is well bound ; its price is very reasonable.—J. S. G. THOMAS.

Die Schlauchelektrode zur Lichtbogenschweissung von Kupfer. Von Wolfgang Lessel. Pp. vi + 56, with 41 illustrations and 3 tables. 1936. Berlin : V.D.I.-Verlag G.m.b.H. (Br., R.M. 3.8 ; V.D.I.-Mitgl., R.M. 3.40.)

This booklet describes the development of the " tubular " electrode, the technique for using it, and the results to be expected. A very similar account has been given in *Autogene Metallbearbeitung* (see *Met. Abs.*, 1936, **3**, 479).—H. W. G. HIGNETT.

Simplified Structure Factors and Electron Density Formulæ for the 230 Space Groups of Mathematical Crystallography. By Kathleen Lonsdale. $8\frac{1}{2} \times$ 11 in. Pp. 181. 1936. London : G. Bell & Sons., Ltd. (for the Royal Institution). (10s.)

Here, indeed, is a true labour of love, for tremendous pains must have gone to the making of this book, and it can, by the very nature of things, enjoy only a very limited circulation. Its object is the provision of simplified procedure and formulæ for determining the " structure factor " and electron density for the 230 crystallograph space groups, from data provided by X-ray crystal analysis. The necessary calculations, in the absence of tables such as these, may take many months to complete. These tables, which have been in use in the Davy–Faraday and other laboratories for some time, expedite the work considerably. Repeated revision of the manuscript, it is hoped, has probably eliminated all errors ; to avoid the possibility of the introduction of " printer's errors," the tables are now reproduced by a mimeographic process from the original manuscript. Research workers in the field of X-ray crystal analysis owe indeed a heavy debt to Dr. Lonsdale for undertaking the work of compiling these Tables, and will be grateful to the Managers of the Royal Institution for providing the financial assistance which has enabled her to complete and to publish the work.—J. S. G. Thomas.

Erhöhung der Schneidgeschwindigkeiten beim Brennschneiden durch neue Düsenformen. Von Theodor Zobel. Pp. 34, with 29 illustrations and 2 tables. 1936. Berlin : V.D.I.-Verlag G.m.b.H. (Br., R.M. 2.75 ; V.D.I.-Mitgl., R.M. 2.45.)

An account is given of a research by optical methods into the form and velocity of the oxygen stream from different types of cutting nozzle. It is found that a special form of nozzle, incorporating a throat, the shape of which is determined from the experimental results, produces a jet which is substantially parallel for a considerable distance and which gives greater speed and economy of cutting.—H. W. G. Hignett.

Reports on Progress in Physics. Volume III. General Editor, Allan Ferguson. Pp. 394. 1937. London : The Physical Society, 1 Lowther Gardens, Exhibition Road, S.W.7. (20s. net.)

This volume of reports on progress in physics, like good wine, needs no push. Physicists everywhere await the publication of these annual reports ; metallurgists and chemists will find much to interest them in these volumes. Volume III is devoted to progress effected mainly during 1935 and 1936, lives up to, and, I think, enhances the reputation of the series, already firmly established by the preceding volumes. Its contents comprise sections on *general physics*, fluid motion, the upper atmosphere, atomic physics, the conservation of energy, sound, *the measurement of noise, heat, magnetism, and experimental electricity*, electrical methods of counting, *superconductivity, photoelectricity*, optics, *X-rays*, and spectroscopy ; the sections of principal interest to metallurgists are indicated in this list by italics. Interesting information is scattered through the work. Thus, the invention of " stainless Invar," an alloy of iron, cobalt, and chromium, having a smaller coefficient of expansion at atmospheric temperature than ordinary Invar, and practically incorrodible in dilute sodium chloride solution is news to me (p. 173). The bias of the book is definitely on the experimental side ; this is in accordance with the purpose of the founder of the Physical Society, Professor Guthrie. There is very little reference to relativity and cognate matters. Practical men—and metallurgists are nothing if not practical—will be thankful for this, for a theory which asserts, in effect, that you can't know where you are unless you know the time, and you can't know the time until you know where you are, can make no appeal to the industrialist who keeps a timekeeper to see that his men are at a definite place at a definite time.

Like its predecessors, the book is nicely got up, is well printed on good paper, is not too lavishly illustrated (Fig. 1 occurs on p. 108), is well bound, and should command a very ready sale at its very reasonable price.—J. S. G. Thomas.

The Structure of Metallic Coatings, Films, and Surfaces. A General Discussion. (Faraday Society.) Pp. iv + 1043–1290, with lxxvii plates and numerous illustrations in the text. 1936. London : Gurney & Jackson. (21s. net.)

The general discussions held by the Faraday Society from time to time on scientific subjects of outstanding importance or interest have played a great part in bringing to the notice of the scientific world in general recent advances in these subjects and in providing the experts with an opportunity of expounding their views and of criticizing one another's work with the aim of co-ordinating and directing further progress. In this volume all the papers read at the

congress held in London in 1935 are collected together with the most instructive discussions to which they gave rise. The first part of the book contains papers dealing with methods of electron diffraction and their use in studying thin metallic films and the surface structure of polished metals, and the second part papers dealing with the structure of electrodeposited coatings, evaporated metal films, sprayed coatings, and hot-dipped coatings. All interested in electroplating and the structure of metallic films will find a large amount of valuable information in the book both on the theoretical and on the practical side.—A. R. POWELL.

Gmelins Handbuch der anorganischen Chemie. Achte, völlig neubearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. System-Nummer 55: Uran und Isotope mit einem Anhang über Trans-urane. Sup. Roy 8vo. Pp. xviii + x + 279. 1936. Berlin: Verlag Chemie G.m.b.H. (R.M. 46; ausl. Pr., R.M. 34.50.)

This section of the Handbuch covers the chemistry of uranium and its isotopes, and includes all material published up to the end of 1935. Except for details of methods of preparing the metal, an account of its physical and chemical properties and some notes on its alloys with nickel, cobalt, mercury, tungsten, and molybdenum the book contains little of metallurgical interest. The analytical section is good and appears to be complete. The treatment of the compounds of the metal follows the usual procedure adopted throughout the series and appears to be very thorough. The last few pages contain an account of recent work on the building up of uranium isotopes and elements of higher atomic weight than uranium, but it must be remembered that the results of this work still require confirmation.—A. R. POWELL.

Handbook of Chemistry and Physics. A Ready-Reference Book of Chemical and Physical Data. Editor-in-Chief Charles D. Hodgman. Twenty-First Edition. Fcap. 8vo. Pp. xix + 2023. 1936. Cleveland, O.: Chemical Rubber Publishing Co. ($6.00.) Obtainable in England from A. Harvey, 17 Market St., London, S.E.1, or A. Bird, 22 Bedford St., W.C.2.

For 23 years the *Handbook of Chemistry and Physics* has been giving a unique service to those in need of accurate tables, formulæ, and scientific data in a single convenient volume. The twenty-first edition of the handbook represents a 23-year accumulation of necessary data for the busy scientist and engineer, that is not only acceptable but highly essential in the commercial, educational, and research laboratory. There is an increase over the last issue of over 175 pages of new composition entailed by complete revision of several important tables.

For convenience the Handbook is divided into five sections, approximately equal in size. These sections are indicated by inserts of stiff coloured paper on which is printed a summary of the contents of the particular section. The divisions are: (1) mathematical tables; (2) properties and physical constants; (3) general chemical tables; (4) heat, hygrometry, sound, electricity, and light; (5) quantities and units—miscellaneous tables.

The book is one of the most useful of its kind published in any language. It can be confidently recommended to chemists, physicists, and engineers and all others who have need of the information which it contains.

Book of A.S.T.M. Standards, 1936. Issued Triennially. Med. 8vo. Part I. —Metals. Pp. xvii + 898. Part II.—Non-Metallic Materials. Pp. xxvi+ 1477. 1936. Philadelphia, Pa.: American Society for Testing Materials, 260 S. Board St. (Cloth, $7.50; half-leather, $8.50 per volume; Two volumes: cloth, $14.00; half-leather, $16.00.)

This triennial publication contains all of the standard specifications, methods of test, recommended practices, and definitions formally adopted by the American Society for Testing Materials. The 1936 issue is in two parts—Part I giving in their latest form all A.S.T.M. standards covering metallic materials; Part II, all standards relating to non-metallic materials. Both parts aggregate 2400 pages. In each Part, the specifications for a particular class of material are given first, followed directly by the test methods, definitions, &c. A complete subject index lists each standard under the principal subject covered, with the keywords in alphabetical sequence. This index, together with two tables of contents, one listing standards by the materials covered, the other in order of sequence of the serial designations facilitates the use of the book.

Part I.—Metals. Of the 181 standards in Part I, 109 cover the ferrous metals, steel, wrought iron, pig iron, and iron castings and ferro-alloys, while 60 relate to non-ferrous metals, including aluminium and magnesium alloys, copper and copper alloys, lead, nickel, zinc, bearing metals, solder metal, deoxidizers, electrical-heating and electrical-resistance alloys. Twelve of the

standards involve metallography and general testing methods. The section of Part I devoted to ferrous materials (109 standards) covers : structural and rivet steel; boiler steels; steel for welding; concrete reinforcement steel; commercial bar steels; steel rails and accessories; spring steel and springs; steel blooms, forgings, axles; steel wheels and tyres; steel castings; steel tubes and pipe; steel for high-temperature service; zinc-coated steel and iron articles; wrought iron; pig iron and iron castings; and ferro-alloys. The 60 standards relating to non-ferrous metals are grouped according to the classifications : aluminium alloys; copper and copper alloys (copper ingot; brass and bronze; copper and brass plates, tubes, rods, &c.; copper wire and cable); lead; nickel; solder metal; white metal (bearing metal); zinc; deoxidizers; and electrical-heating and electrical-resistance alloys. Other standards in Part I cover grain-size for classification of steels, metallographic testing of steel and of non-ferrous metals and alloys, radiographic testing of metal castings, thermal analysis of steel, Brinell and Rockwell hardness testing, tension testing of metallic materials and definitions of terms relating to (1) metallography, (2) methods of testing, and (3) specific gravity.

During 1936 many new standards were adopted relating to widely used materials. In Part I, materials covered by new specifications are : alloy-steel castings for structural purposes; carbon-steel and alloy-steel castings for railroads; welded and seamless steel pipe for ordinary uses; electric-fusion-welded steel pipe; lap-welded, seamless and electric-fusion-welded steel pipe for high-temperature and high-pressure service; alloy-steel pipe, forgings and castings for service at temperatures from 750° to 1100° F.; uncoated wrought-iron sheets; zinc-coated (galvanized) wrought-iron sheets; grey-iron castings; copper-base alloys in ingot form for sand-castings; bronze trolley wire; and Rockwell hardness testing.

Revisions in some 35 of the existing standards covering metallic products were adopted during 1936. Materials covered by these standards include : steel for bridges and buildings; axle-steel reinforcement bars; commercial quality hot-rolled and cold-finished bar steels; multiple-wear wrought-steel wheels; wrought steel wheels for electric railway service; lap-welded and seamless steel and lap-welded iron boiler tubes; carbon-steel castings and alloy-steel bolting materials for high-temperature service; aluminium bronze castings; steam or valve bronze castings; copper trolley wire; resistivity of metallic materials (test); and metallo-graphic testing of metals.

Part II.—Non-Metallic Materials. Included in the 335 standards in Part II—Non-Metallic Materials—are specifications and test methods covering refractories and fire-brick, and coal and coke.

The Directory of Shipowners, Shipbuilders, and Marine Engineers, 1937. (Thirty-Fifth Year of Publication.) Compiled under the direction of the Editor of *Shipbuilding and Shipping Record.* Demy 8vo. Pp. 830 + 83. 1937. London : The Directory Publishing Co., Ltd. (20s. net.)

This directory furnishes, in a handy form, particulars of all the leading steamship companies, shipbuilders, ship-repairers, and marine engineering works throughout the world. It also gives the names of the directors and principal officials of the companies, and, in the case of shipping concerns, details of the fleets. A supplementary section includes a list of societies, institutions, trade and labour federations, and a directory of consulting marine engineers and naval architects. At the end of the volume are exhaustive indexes covering some 25,000 entries.