I.—PROPERTIES OF METALS

(Continued from pp. 25–31.)

*Influence of Temperature on Elastic Limit of Single Crystals of Aluminium, Silver, and Zinc. Richard F. Miller and W. E. Milligan (*Metals Technology*, 1937, 4, (1), 18 pp.; *A.I.M.M.E. Tech. Publ.* No. 782).—Single crystals of aluminium and silver were submitted to slow tensile tests in which the rate of loading was 3 lb./minute at temperatures up to 300° C. The orientations of the crystals were determined by the back-reflection Laue method, and the shear stress calculated for the particular glide plane concerned. The results suggest that, below the recrystallization temperature of the metal, there is a small but definite elastic range; this elastic range is smaller the lower the temperature. Above the recrystallization temperature the critical shearing stress decreases rapidly. A marked yield-point elongation was noted in the aluminium single crystals, which was more marked the lower the temperature of the test, and the purer the metal. During this period increase of temperature decreases rather than increases the rate of flow; after this period the stress–strain curves cross, and the temperature effect is normal, *i.e.* increase of temperature increases the rate of flow. Slow tensile tests on zinc single crystals, in which the rate of loading was ½ lb./minute, above the recrystallization temperature, show an apparent elastic range the magnitude of which depends on the rate of loading; in creep tests there is no measurable critical shear stress above the recrystallization temperature.—W. H.-R.

*Tensile Strength and Elastic Limit of Refined Aluminium Sheet. H. Röhrig and K. Schönherr (*Aluminium*, 1937, 19, (1), 6).—The tensile properties of 5 mm. thick sheet of pure aluminium (99·992%) were determined in the hard-rolled and annealed states perpendicular to, and in the direction of rolling. There is very little directionality in the properties in either condition; the hard-rolled metal has a strength of 11·9–12 kg./mm.², an elastic limit (0·2%) of 9·3–10·1 kg./mm.², an elongation of 8·7–7·3%, and a reduction in area of 86%, whereas the corresponding values after annealing at 440° C. are 4·8–4·1, 1·7, 44·5–32, and about 98, respectively. The coarse crystalline structure of the cast metal persists to some extent even after annealing hard-rolled sheet.
—A. R. P.

*The Influence of Vibration on the Mechanical Properties of Materials of Construction [Aluminium, Duralumin, Brass, Steel]. (Welter and Bukalski.) See p. 84.

*Properties of Aluminium Sheet. Sadao Horiguchi (*Rep. Aeronaut. Res. Inst., Tôkyô Imp. Univ.*, 1936, 11, (138), 191–238).—[In Japanese.] H. studied the effect of cold-work and annealing on the properties of aluminium sheet. It was found that: (1) Strain hardening occurs when annealed aluminium sheet has been worked at room temperature. (2) Strain-hardened aluminium sheets are softened by annealing at about 300° C. notwithstanding their various degrees of final reduction. The softening temperature decreases with increasing amounts of working. (3) Aluminium sheet when reduced 50% at room temperature shows no marked directional properties due to the direction of rolling, but when reduced about 90% the directional properties

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

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can be recognized, especially in the annealed state after cold-rolling. (4) The rate of reduction per pass may not cause variations in the mechanical properties of aluminium. (5) Heat produced by cold-deformation of aluminium may affect the properties. Sheet rolled by continuous working is therefore somewhat softer than that rolled intermittently, in which case the metal cools after each pass. This phenomenon is remarkable in heavily reduced sheets. (6) The grain-size of sheets has a great effect on the mechanical properties. Fine-grained material has a greater strength and elongation than coarse-grained material. (7) The capacity of aluminium for strain-hardening was determined by a calculation of Meyer's index. (8) The electrical resistance of cold-worked aluminium can be decreased by short-time annealing at about 300° C. (9) To obtain good properties it appears desirable to limit the final reduction to about 50–60% and the final annealing to about 350° C.—S. G.

*A Study of the Properties of Refined Aluminium. Soji Hori (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, **2**, (8), 797–808).—[In Japanese.] Cf. Gadeau, *Met. Abs.*, 1936, **3**, 69. The results are given, in tables and diagrams, of some important physical properties of high-purity (99·996%) aluminium prepared by the Cie. des Produits Chimiques et Électrométallurgiques Alais, Froges et Camargue.—S. G.

Metallic Surfaces and Thin Films, with Particular Reference to Aluminium. —— (*Brit. Aluminium Co. Intelligence Memo.*, **1936**, 53 pp. (mimeographed)).— This is a very comprehensive review of the main features of research on surfaces and thin films, chiefly those of aluminium, and also deals with available information relating to some practical applications of aluminium films and surfaces. The upper limit of thickness of the films discussed is of the order 10 mμ. The potential commercial importance of preventing tarnishing of silver articles by means of a thin deposited film of aluminium is mentioned ; other commercial applications include the use of thin films (1) in the construction of valuable optical mirrors ; (2) in speculum metal gratings ; (3) for X-ray targets ; (4) for rectifiers ; (5) for gilding and silvering silks and fabrics ; and (6) for preserving wax (gramophone) records. The subjects discussed include : the production of thin aluminium films by evaporation and by sputtering ; their structure and the structures of metal surfaces and oxide films ; determination of the thickness of thin films ; the mechanical, optical, magnetic, chemical, and electrical properties of thin films, and applications of their properties. The optical properties of thin films are discussed in very considerable detail, reference being made to the properties both of the metal and some of its alloys. Each section comprises a valuable and extensive bibliography.—J. S. G. T.

*Secondary Electron Emission from an Oxygen–Cæsium Electrode. P. W. Timofeew and A. I. Pjatnitzki (*Physikal. Z. Sowjetunion*, 1936, **10**, (4), 518–530).—[In German.] The secondary electron emission from an oxygen–cæsium cathode deposited on various bases, *e.g.* silver, copper, nickel, molybdenum, and tungsten, coated with various thicknesses of oxide, is investigated. Maximum emission is found in the case of a cathode deposited on silver coated with a layer of silver oxide about 200 molecules thick.—J. S. G. T.

On the Magnetic Susceptibility of Metallic Cerium and Praseodymium. L. F. Werestschagin, L. W. Schubnikow, and B. G. Lasarew (*Physikal. Z. Sowjetunion*, 1936, **10**, (5), 618–624).—[In German.] Values of the magnetic susceptibilities, χ, of cerium and praseodymium were determined at temperatures between about 15° and 296° abs. The results show that, contrary to the conclusion of Janus and Dronin (*Sowjet. Phys.*, 1936, **9**, 72) the value of χ for cerium does not obey the Curie–Weiss law. At low temperatures, the curve connecting $1/\chi$ with T for cerium departs increasingly from that corresponding to the Curie law, as the temperature is reduced. No marked hysteresis was shown by cerium at 103°–200° abs. as found by Trombe (*Compt. rend.*, 1934,

198, 1591). Values of χ for praseodymium obey the Curie–Weiss law, and give the value of $\Theta = -6^\circ$.—J. S. G. T.

†**Production and Properties of Copper.** R. D. Burn (*Met. Ind. (Lond.)*, 1937, **50,** (5), 153–160 ; (6), 183–188).—Read before the London Section of the Institute of Metals. Flotation concentration of ores is of primary importance in the economics of copper production. In flotation, results are independent of the density of the concentrated material but depend entirely on the surface properties of the materials. The development and application of the process are described in detail, followed by a comprehensive account of the smelting and refining processes. Over 80% of the world production of copper is electro-refined. The effect of oxygen on the structure and properties of copper is reviewed, and the methods for producing deoxidized and oxygen-free coppers are compared. Casting, welding, and gas absorption are discussed, and this admirable review ends with suggestions as to the possible trend of developments.—J. E. N.

***Heats of Adsorption at** -183°. **Carbon Monoxide on Copper.** Ralph A. Beebe, George W. Low, Jr., and Seymore Goldwasser (*J. Amer. Chem. Soc.*, 1936, **58,** (11), 2196–2199).—A method is described for the direct measurement of the differential heats of adsorption of carbon monoxide on copper at -183° C. The differential heats are of the order of 8 k.cal./mole in the initial stages, and decrease to 3 k.cal. in the later stages of adsorption. The results seem to indicate that a considerable part of the adsorption for the initial increment of gas is of the activated type even at the low temperature of -183° C.—S. G.

***On the Variation with Time of the [Electrical] Resistance of Thin Metal Films [Gold and Silver] Deposited from Vapour in High Vacuum.** Vladimír Vand (*Z. Physik*, 1936, **104,** (1/2), 48–67).—The electrical resistances, R, of thin films of silver and gold deposited in high vacuum are found to decrease with time t in accordance with the hyperbolic relation $R = R_\infty[1 + r/(t + t_0)]$, in which R_∞, r, and t_0 are constants. For very small values of t the value of R changes somewhat more rapidly than in accordance with this relation. Air introduced into the vacuum increases the value of the film's resistance only very slightly. The course of the change of resistance is not interpretable by any kind of process of diffusion ; a theory of disintegration of lattice arrangement in the film effected by a minimum energy value equal to 155×10^{-14} erg, which explains all the facts, is developed.—J. S. G. T.

***The Absolute Photoelectric Yields of Mg, Be, and Na.** Marvin M. Mann, Jr., and Lee A. DuBridge (*Phys. Rev.*, 1937, [ii], **51,** (2), 120–124).—Fowler's theory of the surface photoelectric effect leads to the equation $I = \alpha A T^2 \phi(x)$, where I is the saturation current excited by incident light of frequency ν, $\phi(x)$ a universal function of the quantity $x = h(\nu - \nu_0)/kT$, A the thermionic constant, and α a proportionality constant involving the probability of light absorption by electrons at the surface. Measurements were made of the absolute photoelectric yields for distilled surfaces of magnesium, beryllium, and sodium ; the values of the work-function are, respectively, 3·68, 3·92, 2·29 v., and of α, 3·2, 25, and 180×10^{-34} cm.² second/quantum. These values of α range from 10^{-2} to 10^{-3} of the maximum theoretical values.

—W. H.-R.

Influence of Elastic Tension on Magnetostriction [Nickel]. B. K. Girenchin (*Physikal. Z. Sowjetunion*, 1936, **10,** (5), 689–693).—[In English.] Results obtained with nickel wires confirm the theoretical result, given by Akulov and Kondorsky, expressing the magnetostriction of a wire to the tension to which the wire is subjected.—J. S. G. T.

***Variation with Temperature of the Magnetostriction of Nickel.** W. Döring (*Z. Physik*, 1936, **103,** (9/10), 560–582).—The saturation-magnetostriction of polycrystalline nickel, and the dependence of the magnetostriction on field

strength are investigated at various temperatures up to the Curie point. Saturation-magnetostriction is found to be proportional to the square of the saturation magnetization. Using a process of extrapolation, it is shown that the saturation-magnetostriction does not vanish suddenly at the Curie point, but becomes asymptotically smaller and smaller as the temperature is increased to that point. The volume-magnetostriction is proportional to the field strength and its value is of the order 1×10^{-10} per oerstedt. From 280° C. up to the Curie point the length-magnetostriction is proportional to the field and increases rapidly with temperature. The extension is the result of two effects, *viz.* a true magnetostriction effect and an expansion due to magneto-caloric heating. The observed effect is about $\frac{1}{10}$ of that found by Weiss, Forrer, and Williams for the magneto-caloric effect. It follows that the first effect is negative and of about the same order of magnitude as the second. From this magnitude, the anomaly at the Curie point in the thermal expansion of nickel is deduced and a value is found which is in good agreement with the results obtained by Williams (*Met. Abs.*, 1935, **2**, 44).—J. S. G. T.

*Reversible and Irreversible Magnetization Processes Associated with Change of Temperature [Nickel and Nickel Alloys]. N. Embirikos and H. Bittel (*Physikal. Z.*, 1936, **37**, (24), 901–906).—The magnetic hysteresis loops of test-pieces of pure nickel, nickel + 1% manganese, nickel + 1% chromium, and nickel + 2% of chromium are found to be very narrow when the test-pieces are agitated before each measurement. The change of magnetization, at constant magnetic field, accompanying a change of temperature is found to comprise a reversible and an irreversible part; these parts have been separately measured by temperature transitions between 15° and 100° C. The reversible part is obtained by avoiding all agitation of the test-piece during the change of temperature; under these conditions an increase of temperature is accompanied by a decrease of magnetization, and *vice versa*. The magnitude of this reversible effect depends on the field strength, increasing with increase of field strength. The percentage change of magnetization is, however, about the same at all field strengths. This reversible magnetization is interpretable in terms of spontaneous magnetization. The change of electrical conductivity of the test-pieces is controlled to a considerable extent by reversible process.
—J. S. G. T.

*On the Effect of Stretching and Twisting on the Discontinuous Process of Magnetization in Nickel, Iron, and Nickel–Iron Alloys. Junzô Ôkubo and Mitiyasu Takagi (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **25**, (1), 426–479).— [In English.] A study was made of the effect of stretching and twisting on the discontinuous process of magnetization in nickel, iron, and some nickel–iron alloys. The chief results obtained are : (1) The discontinuities are mainly distributed in the steep portion of the hysteresis loop, and the correspondence between the steepness of the loop and the distribution of discontinuity is very close. (2) There is a linear relation between the values $\Sigma H \delta I_d$ and the areas of the hysteresis loops observed in the materials tested under the application of various tensions and twists, where I_d is the intensity of magnetization due to the discontinuous process at the field intensity H. (3) The relation between the change in maximum intensity of magnetization and the total sum of the discontinuities observed during a half cycle of the hysteresis loop was examined, and it was found that there are 3 cases of magnetization; in the case of applying the increasing stretching stress, the above two quantities simultaneously increase (*a*), or decrease (*b*), according to whether the magnetic elongation of the material is positive or negative ; the increase of the applied twisting stress results in the decrease of the maximum intensity of magnetization and the increase of the discontinuities (*c*) whether the magnetic elongation of the material is positive or negative. It was also shown that all the observed results may be explained by considering the distribution

of the magnetic axes of atoms in the material under tension as of a prolate or oblate spheroidal type.—S. G.

*Sputtered Palladium Films. I.—Cracks and Crumples Caused by Organic Contaminations. Sin Tanaka (*Tôkyô Teikoku-Daigaku Kôkû-Kenkyûzyo Hôkoku* (*Rep. Aeronaut. Res. Inst., Tôkyô Imp. Univ.*), No. 142, 1936, 367–406).—[In English.] The effect of various organic contaminations in producing cracks and crumples in sputtered palladium and other metal films is investigated experimentally. Contaminations effective in producing cracks in the films comprise two classes of substances, *viz.* simple unsaturated hydrocarbons of zero dipole moment, and oxygen- and nitrogen-compounds of dipole moment $> 2 \times 10^{-18}$ c.s.u. Crumples are attributable to the presence of similar contaminations, but the presence of a contaminating liquid film on the surface upon which the metal film is deposited appears to be necessary in this case. The mechanisms of the production of cracks and crumples are discussed in terms of electric and molecular force fields. The paper includes illustrations of about 80 cracked and crumpled films.—J. S. G. T.

The Emission of Negative Electricity from Platinum in Chlorine. S. Kalandyk (*Z. Physik*, 1936, **103**, (9/10), 583–597).—The effect of chlorine on the emission of electrons from platinum at various temperatures is investigated at pressures between 0·01 mm. and about 1 cm. of mercury. At low pressures of the order 0·01 mm., the effect of chlorine is independent of pressure and vanishes at about 1200° C., so that above this temperature platinum in chlorine behaves like platinum in a vacuum. At temperatures below 1000° C. the emission obeys Richardson's law, but the energy of emission is somewhat smaller for platinum in chlorine than that for platinum *in vacuo*; the value of A is increased about 100 times. At a pressure of 1·5 mm. the character of the emission is different within the ranges 700°–900° C. and 1000°–1300° C.; the respective values of A in these ranges are 1 v. and 5·3 v.—J. S. G. T.

The Measurement of the Abundance of [Crystal] Nuclei Formation in Supercooled Melts [Potassium]. I. N. Stranski (*Physikal. Z. Sowjetunion*, 1936, **10**, (5), 694–695).—[In German.] In this preliminary note S. discusses the possibility of investigating the formation of nuclei in melts as a volume reaction and not merely as a phenomenon occurring at phase boundaries, by increasing the pressure on the melt. The effect of the wall of the vessel can be eliminated by heating. Data relating to the effect of pressure on the melting point of potassium are given.—J. S. G. T.

Acid Activation of Metallic Silver. Franz Lieb (*Arch. Hyg. Bakt.*, 1936, **116**, 317–320; *C. Abs.*, 1937, **31**, 792).—The activating action of acids, when the latter are not oxidizing agents, on bright metallic silver in the cold and for short time intervals is uncertain. The activating action of acids is less than the oxidizing action. Effective activating agents are found only in the class of oxidizing substances.—S. G.

*The Modification of Apparent Thermionic Constants for Oxygenated Tungsten by the Temperature Variation of Adsorptive Equilibrium. M. C. Johnson and F. A. Vick (*Proc. Roy. Soc.*, 1937, [A], **158**, (893), 55–68).—The temperature variation of a saturated thermionic current i per unit area is usually shown by plotting $\log i/T^2$ against $1/T$, the slope and the vertical intercept of the graph being identified with the electronic work function ϕ, and the logarithm of the constant A, in the Richardson equation $i = AT^2 e^{\phi/kT}$. Certain metals give apparently straight "Richardson plots," but with anomalous values of A and ϕ. J. and V. suggest that this is due to variations in the surface covering caused by temperature variation of adsorption of impurities, chemical reaction, &c., at the surface. Under these conditions the Richardson plots, although linear over a limited range, are really curves; these lead to intercepts and slopes being measured which neither coincide with nor are even intermediate between the genuine constants for the clean or completely

covered surface. This interpretation of the anomalous values of thermionic constants is supported by a detailed study of the pressure and temperature dependence of emission from a tungsten surface in the presence of oxygen.

—W. H.-R.

*Exchange of Energy Between He-, Ne-, and Ar-Atoms and a Metal Surface [Tungsten]. G. Zacharjin and G. Spiwak (*Physikal. Z. Sowjetunion*, 1936, **10**, (4), 495–509).—[In German.] Values of the accommodation coeff. (*a*) of helium, neon, and argon at a surface of tungsten, either gas-free or coated with an adsorbed layer of nitrogen, oxygen, or hydrogen are determined at 300°–650° C. It is shown that at a constant temperature (about 400° abs.) of the adsorbing surface, the value of *a* is given by $a = AT^n$, where *A* is a constant for the respective gases and *T* is the temperature of the gas. The value of *n* for argon is 1·25, and for helium $n = 1·5$. The latter value is in good agreement, the former not in such good agreement, with values deduced from Landau's theory.—J. S. G. T.

*The Recrystallisation Diagram of Zinc. J. Czochralski and O. Lubinkowski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, **3**, (4), 177–179).—[In Polish, with English summary.] Cylinders of zinc cut from an 8 mm. diam. rod extruded at 150° C. were cold-worked, the lengths decreasing from 1 to 90%, and were subsequently annealed for $\frac{1}{2}$ hr. at temperatures ranging from 20° to 400° C. The samples were then cut along the axis, polished, etched, and the grain-sizes measured. From the results the recrystallization diagram was constructed to show the influence of the percentage deformation and of the annealing temperature on the resultant grain-size. This diagram is peculiar in that it consists of two and in some parts of three regions. At low temperatures the grains of the deformed zinc grow slowly, but at 150°–250° C., according to the extent of cold-working, there occurs an abrupt increase in the grain-size. A further abrupt increase occurs when specimens of 5–10% deformation are annealed above 350° C., the whole sample recrystallizing in a single crystal or in a few grains. These effects are not due to impurities in the zinc, and may be connected with the so-called " recovery of crystals."—P. W. R.

*Anisotropy in the Hardness of Zinc Single-Crystals. J. Czochralski and S. Brunne (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, **3**, (4), 180–183).—[In Polish, with German summary.] Tests on cylindrical and spherical single-crystals of zinc show that the hardness depends on the direction of measurement with respect to the hexagonal axis. The maximum Brinell hardness (36·9 kg./mm.²) is given by the {10$\bar{1}$0} face, while the minimum hardness (25·2 kg./mm.²) is shown by the {0001} plane.

—P. W. R.

*A Quantum Mechanical Discussion of the Cohesive Forces and Thermal Expansion Coefficients of the Alkali Metals. H. Fröhlich (*Proc. Roy. Soc.*, 1937, [A], **158**, (893), 97–110).—Theoretical. A quantum mechanical method is developed for calculating good approximate wave-functions for the alkali metals. The method involves the assumption that the approximation of free electrons is justified. The equations are used to calculate the radii of the atomic spheres (defined by $\frac{4\pi}{3} r_1^3 =$ atomic volume), the heats of sublimation, and the compressibilities. The agreement with the experimental values is good except for lithium, for which the model of free electrons is no longer valid.—W. H.-R.

*Electron Theory of Metals.—II. S. Schubin and S. Wonsowsky (*Physikal. Z. Sowjetunion*, 1936, **10**, (3), 348–377).—[In German.] Cf. *Met. Abs.*, 1936, **3**, 113. The electron theory of metals is discussed mathematically from the point of view of the Heitler–London method of approximation to the solution of the wave equation.—J. S. G. T.

*On the Detection of Transformations in Metals in the Solid State. Wiebold Frans Brandsma and Eduard Maria Henricus Lips (*Z. Metallkunde*, 1930, **28**, (12), 381–382).—The torsion method of Nipper and Lips (*Met. Abs.*, 1936, **3**, 6) has been applied to the detection of transformations in solid metals and alloys. A sudden change in the temperature–torsion curve occurs in mild steel at the A1 point and two inflections occur in the curve for cold-drawn aluminium (20% extension), the first at 300° C. being attributed to the change from crystalline to amorphous plasticity, and the second at about 460° C. to the end of the recrystallization. If the position of the second point for aluminium is plotted as a temperature-degree of extension curve the curve has a hyperbolic shape falling very sharply with extensions between 7 and 10% and then much more slowly until it becomes almost parallel to the extension axis at above 20% extension.—A. R. P.

*Theory of Fracture of Brittle Materials. Adolf Smekal (*Z. Physik*, 1936, **103**, (7/8), 495–525).—A mathematical theory of the fracture of brittle materials is developed. The theory discusses fracture being initiated at three-dimensional knicks and considers how heat transfer during the process of fracture introduces changes in the region of the knicks. Elastic stresses and superficial diffusion are correlated. The theory is limited to the range of applicability of Hooke's law. Fracture is shown mathematically to be initiated at that knick whereat the so-called " molecular " rupture stress is first attained and exceeded. The " technical " tensile strength of an ideal homogeneous body corresponds with its " molecular " tensile strength. The cases of fracture of a flat plate with a straight elliptic cleavage crack, of materials with plane circular internal cracks, of materials with globular empty spaces, and of materials with knicks of any form whatever are discussed. The theory is shown to be in agreement with experimental results relating to the fracture of glasses and of crystals in which cleavage is well developed.—J. S. G. T.

*Kinetics of the Plastic Deformation of Crystals. M. Kornfeld (*Physikal. Z. Sowjetunion*, 1936, **10**, (5), 605–617).—[In German.] The process of plastic deformation of a crystal is conceived as consisting of two parts : (1) the production of a deformation which, after application of the stress, increases with time, and (2) a deformation occurring suddenly. K. describes a method whereby the kinetics of plastic deformation of a crystal can be examined under such conditions that the plastic characteristics of the crystal are not materially altered by the deformation. The method, involving observation of the continuous increase of length under tension, is applied to 7 single crystals of aluminium, at 15°–600° C. The results indicate that the velocity of deformation is not proportional to the applied tension, and the plastic characteristics of the crystals vary considerably with temperature. For tensile stresses of the order 0–370 grm./mm.^{2}, the plastic deformation of aluminium crystals is not markedly different from that of an amorphous body. A change of temperature from 15° to 300° C. causes the sudden deformation to increase 3 or 4 fold. It is concluded that of the two parts referred to as constituting the plastic deformation, (1) is practically independent of temperature, but (2) is markedly dependent on temperature.—J. S. G. T.

†Laws and Fundamentals of Plastic Deformation. A. V. de Forest (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 783–788).—de F. reviews the difficulties involved in setting up laws of plastic deformation ; it is incorrect to speak of *laws* of plastic deformation since present-day knowledge of the phenomenon covers only special cases. The mechanism is essentially one of shear along crystallographically related planes ; factors determining the first slip are unknown. In the simplest case, *viz.* that of single crystals, the outward mechanism and the results of deformation are known. Reasons for the relative location of slip-planes, and factors which limit the slip on a plane are not understood. Metallurgical reasons for the different creep behaviours of similar material at

high temperatures are not clear. Fibring and re-orientation effects due to large deformations, and the application of spectrum analysis to metallurgical practice are briefly referred to.—J. S. G. T.

†**Metallic Single Crystals and Plastic Deformation.** S. L. Hoyt (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 789–830).—Matters reviewed are : the production of metallic single crystals ; mechanical tests of single crystals including a discussion of the mechanism of slip, the orientation effect, the hardness of single crystals, the effect of temperature, the effect of impurities and the properties of alloys, the physical properties of single crystals, lattice changes during deformation, and theories of hardening. A *bibliography* of 87 references is appended.—J. S. G. T.

*†**Creep Characteristics of Metals.** C. L. Clark and A. E. White (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 831–868 ; discussion, 868–869).—After defining " creep " and offering an explanation of the creep phenomenon, the authors discuss the various factors which may influence the high-temperature load-carrying characteristics of steels ; these include chemical composition, structural uniformity, heat-treatment, method of manufacture, grain-size, previous deformation, equi-cohesive temperature and structural stability. Creep is considered as the resultant effect of strain-hardening and recrystallization. The lowest temperature of recrystallization is, therefore, of great importance, the creep characteristics varying according as the actual temperature is above or below the temperature. " Creep " is influenced more by variations in the past history of the material than by its other physical properties.—J. S. G. T.

†**Interpretation and Use of Creep Results.** J. J. Kanter (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 870–912 ; discussion, 913–918).—Creep phenomena are now accepted as significant by structural engineers. The character of the constant load creep strain–time curve is discussed. Factors which influence creep rates are referred to. Evidence that creep is a viscous flow phenomenon at small stresses is considered. Data appear to indicate that creep viscosity decreases exponentially with increase of stress, and that the constant rate therefore varies with stress. Bailey's work on creep by shear (*Engineering*, 1930, **129**, 265 ; 1935, **140**, 595) is reviewed, and suggestions are offered in connection with the interpretation of creep under combined stresses. The subject of relaxation due to creep is of significance in the choice of bolting materials. Materials for use at high temperatures should be selected on the basis of creep results showing the limiting service temperatures at working stresses. A *bibliography* of 59 references is given.—J. S. G. T.

*†**Damping Capacity : Its Variation and Relation to Other Physical Properties.** G. R. Brophy and E. R. Parker (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 919–931).—Damping capacity or plasticity is defined as " the energy dissipated as heat by a unit volume of metal during a completely reversed cycle of unit stress." Its magnitude is greatly affected by stress, chemical composition, structure, heat-treatment, mechanical work, and temperature. Its relation to fatigue and creep in the case of steels is briefly discussed. It is particularly important in determining the differences in behaviour of steel repeatedly stressed and subjected to the effects of overstress, stress concentration, and speed. The order of creep resistance of a series of steels at high temperatures can be predicted from their damping capacities at those temperatures provided that there are no structural changes other than grain-size.
—J. S. G. T.

*Elastic Properties and Their Relationship to Strength and to Strain-Hardening.** M. F. Sayre (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 932–942).— Adjacent grains in a bar of iron may have respective elastic moduli in tension in a ratio as large as $3 \cdot 5 : 1$; even larger ratios exist in copper and brass. These stiffness variations must imply corresponding stress variations and

hence may be of great importance in controlling the strength of materials. Cold-work, for example, tends to develop a type of preferred orientation which corresponds with more favourable stress distribution relationships than is the case with a random crystal orientation, and so produces a directional increase of strength. The stiffness variations from grain to grain may account for occasional cases of poor surface in cold-pressing operations, and may explain differences between theoretical and experimental results in cases of localized stress concentrations. A *bibliography* of 10 references is appended.
—J. S. G. T.

The Effect of the Shape of the Test-Piece on the Energy Needed to Deform Materials in the Single-Blow Drop Test. (Ellis.) See p. 110.

†Hot-Working, Cold-Working, and Recrystallization Structure. (Goss.) See p. 93.

†Nuclear Physics. S. Flügge and A. Krebs (*Physikal. Z.*, 1937, 38, (1), 13–36).—Developments in nuclear physics during the period 1935–1936 are critically discussed. Considerable attention is devoted to the discussion of the atomic weights of the elements. A *bibliography* of 112 references is appended.
—J. S. G. T.

*On the Theory of Metallic Linking.—III. Paul Gombás (*Z. Physik*, 1936, 104, (1/2), 81–92).—In continuation of previous work (*Met. Abs.*, 1936, 3, 245, 532) it is shown that in the case of the alkali metals, a sufficiently close approximation to the lattice energy of the alkali metals is obtained by taking into account only the interaction of metal electrons and ions. Making this simplification in the case of the alkali metals, it is shown that the respective lattice energies are inversely proportional to the lattice constants δ, while the compressibilities are proportional to δ^4. These results are in agreement with experimental values. The lattice constant and energy of sublimation of potassium calculated by means of the simplified theory are likewise in agreement with experimental values.—J. S. G. T.

Physical Phenomena at High Pressures. M. Sansoni (*Nuovo cimento*, 1936, 13, 326–338; *Sci. Abs.*, 1937, [A], 40, 11).—The theoretical significance of the high-pressure investigations of physical properties is reviewed, with special reference to Bridgman's work. Compressibility, thermal dilatation, and phase equilibrium are discussed in some detail, while among other properties mentioned are viscosity and thermal and electrical conductivities. Their bearing on modern physical theory is considered, and it is concluded that it is possible to offer only a tentative, qualitative wave-mechanical explanation of the observed phenomena.—S. G.

*On the Properties of Metals at Very Low Temperatures. L. Landau and I. Pomerantschusk (*Physikal. Z. Sowjetunion*, 1936, 10, (5), 649–665).—[In German.] Taking into account inter-electronic forces, an expression is derived for the resistance of metals as a function of the temperature. The resulting formula can be written $R = \alpha T^2 + \beta T^5$. The term αT^2 is that attributable to inter-electronic action. This formula agrees well with experimental values of the resistance of platinum at temperatures down to 20° abs. An expression is derived for the thermoelectric power at a junction at low temperatures; the expression satisfies the Thomson–Onsager relations.—J. S. G. T.

*On the Optical and Electrical Properties of Thin Metallic Films at Low Temperature.—I. Tadao Fukuroi (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 80–97).—[In English.] The spectral reflectivity of light and the electrical conductivity at liquid air temperature of mercury, cadmium, and zinc films condensed from vapours were studied. The results of the experiments are in agreement with the views of Kramer and Smakula who classify films into two kinds, from their structures. F. classifies them as (a) granular and (b) non-granular. The properties of (a) are similar to those of a metallic colloid not only as regards absorption of light, as pointed out by

Dreisch, Rütten, and Smakula, but also as regards reflection of light; moreover, the specific resistivity of class (*a*) films is far greater than for (*b*).—S. G.

*On the Change of Electrical Resistance and of Reflecting Power of Metallic Mirrors Deposited at Low Temperatures. R. Suhrmann and G. Barth (*Z. Physik*, 1936, 103, (3/4), 133–169).—Irreversible changes of electrical resistance and of reflecting power are observed to occur in approximately non-transparent mirrors of copper, silver, gold, cadmium, thallium, lead, and bismuth, deposited at 20°–80° abs. and gradually heated to room temperature. The results are attributed to a transition of atomic arrangements in the films from the disordered to the ordered state.—J. S. G. T.

*The Contribution to the Electrical Resistance of Metals from Collisions Between Electrons. W. G. Baber (*Proc. Roy. Soc.*, 1937, [A], 158, (894), 383–396).—The contribution to the electrical resistance of metals from collisions between the conduction electrons is discussed for metals where two Brillouin zones are responsible for the conduction. The collisions of electrons in one zone with those in the other contribute to the resistance an extra term proportional to T^2. For normal metals this term is negligibly small down to less than 1° abs., but for the transition elements nickel, palladium, and platinum, it is the predominating term at helium temperatures, in agreement with experiment.—W. H.-R.

*Investigations Relating to the Micro-[Electric] Resistances of Superconductors. P. Grassmann (*Physikal. Z.*, 1936, 37, (16), 569–578).—Apparatus for determining resistances of the order 10^{-15} ohm is described, and is used to determine the resistance of thin sheets of superconducting metals at temperatures below the transition temperatures. The superconducting resistance of a film of tin 6·5 μ thick was found to be less than 10^{-14} R_s, where R_s is the resistance of the film at room temperature. That of a lead film 3·5 μ thick was less than $0·5 \times 10^{-15}$ R_s. No decrease of current-strength was observed in this film when the current density was as large as 4×10^5 amps./cm.². It is estimated that each 10^4 atoms must provide one superconducting electron or that the superconducting electrons do not radiate energy.—J. S. G. T.

*On the Variation with Temperature of the Intensity of Magnetization of Ferromagnetic Substances in Weak Magnetic Fields. Kôtarô Honda and Tamotsu Nishina (*Z. Physik*, 1936, 103, (11/12), 728–737).—The relation between the intensity of magnetization in weak magnetic fields of strengths 0·01–0·8 oerstedt is investigated for single-crystal iron, and polycrystalline, electrolytic iron and nickel at 15°–760° C. The magnetization–temperature curves corresponding to the various fields are made up of five sections : (1) a part in which the intensity of magnetization is practically constant or increases slowly followed by (2) a part whereon the magnetization increases suddenly stepwise to (3) a second region of practically constant intensity of magnetization which is followed by (4) a region of sudden increase of intensity of magnetization and finally (5) a sudden decrease to zero intensity. The step-like character of the graphs is interpretable in terms of the Honda–Ôkubo theory of crystallographic anisotropy applied to magnetic materials.—J. T.

*Discontinuous Change in Magnetization in Ferromagnetic Substances. Kiyoshi Murakawa (*Proc. Phys.-Math. Soc. Japan*, 1936, [iii], 18, (8), 380–401).—[In English.] [*Note by Abstractor :* The greater part of the change of magnetization in a ferromagnetic material placed in a continuously varying magnetic field occurs discontinuously. This phenomenon, known as the Barkhausen phenomenon, can be detected by means rendering it audible.] The hysteresis curve of a ferromagnetic material comprises four regions, *viz.* (1) the initial region of reversible permeability, (2) the region of the reversal (*Umklapp*) process, (3) the region of the rotation process, and (4) the saturation region. In this paper, region (2) is investigated for poly- and single-crystalline iron wires, and for silicon–iron wires by means of the Barkhausen

noise and by oscillographic records. The wires were subjected to a definite preliminary heat-treatment. Other things being equal, a polycrystalline wire and a silicon–iron wire give a louder Barkhausen noise than a single crystal wire. A single crystal of iron or of silicon–iron is partly demagnetized more easily than ordinary iron. The oscillographic records of magnetization consist of solitary single peaks and groups of peaks. An analysis of these shows that reversal nuclei are of various relatively small sizes and are unable to propagate the reversal process in polycrystals. In single crystals, internal strain is probably small, and even the smallest reversal nuclei are unhindered in extending the " wall displacement " investigated by Sixtus and Tonks (*Met. Abs.* (*J. Inst. Metals*), 1931, 47, 371).—J. S. G. T.

*The Velocity of Propagation of Inversion of Magnetization (Ummagnetisierung). F. D. Miroschnitschenko (*Physikal. Z. Sowjetunion*, 1936, 10, (4), 540–562).—[In German.] Barkhausen discovered that when the external magnetic field in the region of a metal is continuously increased, the resulting magnetization of the metal increases in a series of steps and not continuously. An explanation of this Barkhausen effect, based on Akulov's theory of magnetization, is given. An accoustic method for determining the velocity of propagation of magnetization in a metal enclosed in a coil by which an alternating field is produced, is described. The method is simple and is applied to determine the velocity of propagation (V) of magnetization in stretched and twisted samples of a nickel–iron alloy containing 15% nickel. V does not depend directly on the stress, but changes with the latter provided that the form of the hysteresis loop is changed. When the loop is rectangular, *i.e.* the magnetization has become homogenized, then the velocity is constant. V is a function of H_c, the coercivity field, and is inversely proportional to the intensity of magnetization.—J. S. G. T.

*The Variation of the Internal Friction and Elastic Constants with Magnetization in Iron.—I. W. T. Cooke (*Phys. Rev.*, 1936, [ii], 50, (12), 1158–1164).—A new and accurate method is described for measuring the elastic constants and coeffs. of internal friction of solid substances. The method uses the properties of a separately excited composite piezo-electric oscillator made by cementing a right circular cylinder of crystalline quartz to one end of a cylinder of the specimen of identical cross-section. The system is freely suspended, and a sinusoidally varying potential difference is applied between electrodes of gold leaf fixed to the quartz. In consequence of the piezo-electric stress which accompanies the electric field in the quartz, a stationary state of forced longitudinal or torsional vibration is established in the oscillator. The method is used to investigate the effect of magnetization on Young's modulus, and the longitudinal coeff. of internal friction of cold-work and annealed Armco iron at room temperature.—W. H.-R.

*The Variation of the Internal Friction and Elastic Constants with Magnetization in Iron.—II. William Fuller Brown, Jr. (*Phys. Rev.*, 1936, [ii], 50, (12), 1165–1172).—The method of Cooke (preceding abstract) is used to measure the variation of the rigidity modulus and torsional decrement with magnetization in both cold-worked and annealed Armco iron. The final corrected results for the decrements and elastic moduli are then discussed in the light of recent ferromagnetic theory.—W. H.-R.

*Ferromagnetic Anisotropy of Iron Crystals at Various Temperatures. Raymond G. Piety (*Phys. Rev.*, 1936, [ii], 50, (12), 1173–1177).—Small oblate spheroids were prepared from very pure iron crystals, and magnetization curves were taken by the pendulum magnetometer method at temperatures up to 700° C. The tetragonal axes of form ⟨100⟩ are the directions of easiest magnetization, and the trigonal axes of form ⟨111⟩ the directions for most difficult magnetization. In general, the purest iron obtainable is qualitatively and quantitatively very like that used by Honda and his collaborators (*Sci.*

Rep. Tôhoku Imp. Univ., 1926, [i], **15**, 755; 1928, [i], **17**, 111) especially at room temperatures. The pure iron, however, retains its anisotropy better at 300° and 500° C., and loses it more suddenly at about 600° C. The sixth order term in the anisotropy equation is relatively unimportant except above 500° C., where the fourth order term becomes negligible.—W. H.-R.

II.—PROPERTIES OF ALLOYS

(Continued from pp. ~~24~~–43.)

Pictorial Representation of Aluminium Alloys. H. Wiesthaler (*Aluminium*, 1937, **19**, (1), 11–19).—A scheme for the vectorial representation of standard aluminium alloys is put forward, the alloying constituents being represented by the directions, and their amount by the lengths of the vectors. The important tensile properties can be similarly represented.—A. R. P.

Thermal and Electrical Conductivities of Aluminium Alloys. L. W. Kempf, C. S. Smith, and C. S. Taylor (*Metals Technology*, 1937, **4**, (1), 12 pp.; *A.I.M.M.E. Tech. Publ.* No. **783**).—The electrical conductivity at 25° C. and the thermal conductivity at 25° and 200° C. were determined for 11 commercial aluminium alloys of compositions in considerable use for internal combustion motors. Specimens were examined after annealing treatments, and also in the original chill-cast or wrought condition. The heating involved in the determination of thermal conductivity may cause changes in structure, except in properly annealed specimens, which greatly affect the conductivity. The relation between thermal and electrical conductivity may be best expressed by the equation $K = 5 \cdot 02\lambda T \times 10^{-9} + 0 \cdot 03$, where K is the thermal conductivity (cal./cm.²/cm./second/° C.), λ the electrical conductivity, and T the absolute temperature. Alloys containing more than 5% silicon give larger values of $K/\lambda T$, but for the remaining alloys the agreement with the above equation is good, and the thermal conductivity can be calculated from the electrical conductivity.—W. H.-R.

The Influence of Vibration on the Mechanical Properties of Materials of Construction [Aluminium, Duralumin, Brass, Steel]. G. Welter and A. Bukalski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa* (*Warszawa*), 1936, **3**, (4), 205–211).—[In Polish, with French summary.] The effect of vibration on the mechanical properties of steel, brass, aluminium, Duralumin, and Elektron was studied. Experiments on wires and cylindrical specimens under normal conditions and while subjected to transverse vibration by bowing throughout the test showed that except in the case of Duralumin, which behaves abnormally, the limit of elasticity, the tensile strength, and the elongation are all appreciably diminished by this factor. Considering the short period (5–15 minutes) during which the specimens were subjected to vibration, it is clear that the influence of this factor is relatively large and must be of considerable importance in engineering practice.—P. W. R.

The Electrical Resistance of Some Binary Aluminium Alloys. Tsutomu Matsuda and Soji Hori (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, **2**, (7), 609–628).—[In Japanese.] The specific electrical resistance of aluminium with additions of up to 2% (still more where a wider range of solid solubility is expected) of a number of metals, after annealing at 350° C. and quenching at 500° C. was determined, and is shown in diagrams. The added metals were silver, bismuth, calcium, cadmium, cobalt, chromium, copper, iron, magnesium, manganese, molybdenum, nickel, lead, antimony, silicon, tin, titanium, vanadium, tungsten, and zinc.—S. G.

Etching Phenomena with Copper–Aluminium Alloys and the Influence of Impurities on Their Age-Hardening. Hans Lay (*Z. Metallkunde*, 1936, **28**, (12), 376–380).—When specimens of a 4% copper–aluminium alloy are aged

between 30° and 200° C. and then etched for 1–2 hrs. in 0·05% hydrofluoric acid, only those aged at 100°–150° C. develop a grain-boundary structure of relatively broad black lines. This effect is attributed to a non-homogeneous microscopic precipitation of $CuAl_2$ along the grain boundaries and is similar to that previously observed in silver–copper alloys; X-ray examination shows, however, that precipitation in a form not visible under the microscope has taken place within the crystal grains. Since the value of the autocatalytic factor producing non-homogeneous precipitation in copper–aluminium alloys is small, the effect is masked at higher temperatures by the normal homogeneous precipitation. These results explain the tendency of Duralumin which has been hardened at 120°–150° C. to undergo intercrystalline disintegration, since the precipitated phase along the grain boundaries considerably accelerates corrosion. Tests made on 4% copper–aluminium alloys with 0–1% of iron and silicon as impurities showed that the purer the alloy the more rapid is the age-hardening, especially at room temperature and the greater is the maximum hardness attainable. The effect of impurities on the rate of hardening decreases with increase in hardening temperature, but their effect on the maximum hardness remains unchanged. Single-crystal alloys harden much more slowly than polycrystalline aggregates at all temperatures, and the maximum hardness obtainable is much less; these effects are attributed to the absence of casting stresses in the single-crystal alloys.—A. R. P.

Development of 24S Alloy, Extensively Used in Aircraft. T. W. Bossert (*Metal Progress*, 1937, **31**, (1), 42–45).—The mechanical properties of " 24S," a light alloy containing about copper 4·2, manganese 0·5, and magnesium 1·5%, are tabulated for comparison with those of Duralumin in the form of sheet, tubing, and extruded shapes, together with Alclad in which the two alloys serve as base material. The necessary modifications in forming practice are indicated.—P. M. C. R.

*The Effect of a Third Element on the Ageing of Binary Systems. II.— **Copper–Aluminium–Nickel.** V. Gridnev and G. Kurdjumov (*Teoria i Praktika Metallurgii*, 1936, (2), 100–109; *C. Abs.*, 1937, **31**, 352).—[In Russian.] Cf. *Met. Abs.*, 1935, **2**, 338. The addition of 4% nickel causes practically no greater increase of the eutectoid temperature or a further narrowing of the α-field than does 2% nickel. The solubility at the eutectoid temperature is greater than at lower temperatures. Addition of 6% nickel increases the eutectoid temperature. For an alloy containing 10% aluminium the eutectoid line is at about 780° C. The process of ageing is easily observed under the microscope. Addition of 8% nickel should cause more ageing. Alloys containing 5–7% nickel have a high dendritic liquation and are suitable for antifriction alloys.—S. G.

*On the Age-Hardening Mechanism in Al–MgZn₂ Alloys. Sadajirō Kokubo (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 694–701).—[In English.] To investigate the age-hardening in $Al–MgZn_2$ alloy a study was made of an alloy containing 15% $MgZn_2$ quenched from 450° C. in water after being heated at that temperature for 30 minutes, then aged at room temperature for several days and tempered for 6 hrs. at 60°, 100°, 150° C., &c., respectively, afterwards being cooled slowly in the furnace. The variation in density, electrical resistance, and hardness of specimens due to these heat-treatments was measured; dilatation curves and thermal curves of the quenched specimens during slow heating (2·5° C. per minute) were also taken. The results of the measurements are explained very satisfactorily on the basis of the theory of Honda and K.—S. G.

*The Influence of the Alkaline Earth Metals on Silumin. J. Czochralski and J. Kaczyński (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, **3**, (4), 173–176).—[In Polish, with French summary.] The effect was studied of small additions of calcium, strontium, and barium on the refining at

850° C. of Silumin containing silicon 13, iron 0·1, calcium 0·10% and the remainder aluminium. The refined alloys were studied by metallographic analysis and mechanical testing of sand-cast samples. It is concluded that of the alkaline earth metals concerned, only strontium has an advantageous influence, the optimum effect being produced by the addition of 0·047% strontium, which gives an alloy containing 0·01% of residual strontium having a considerably increased breaking load and elongation. Strontium therefore acts similarly to sodium, a fact which does not confirm the view that the action of the latter depends on its low freezing point, and that it acts purely mechanically as a colloid protector.—P. W. R.

*On Some Properties of Wrought Special Silumin. Isamu Igarashi, Masahide Ozaki, and Hyoji Nakata (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, **2**, (8), 788–796).—[In Japanese.] The authors studied the effects of magnesium, manganese, zinc, copper, antimony, nickel, chromium, and cobalt, alone and in combination, on the properties of wrought Silumin. The results are given in tables.—S. G.

*Influence of the Rate of Cooling and the Magnesium Content on the Hardness of Silumin-Gamma. E. Scheuer and E. Schulz (*Aluminium*, 1936, **18**, (11), 545–551).—The hardness and the rate of hardening of Silumin-γ increases with increasing rate of cooling; thus, with chill-casting maximum hardness is obtained after homogenizing for about 5 hrs., whereas with sand-castings this time varies from 7 to 20 hrs. according to the wall thickness. Increase in the magnesium content from 0·3 to 0·5% increases the hardness irrespective of the time of homogenization, but increase in the silicon content is without effect. These results indicate that the rate of cooling in all parts of the casting must be rapid; if this is not possible then the magnesium content should be increased (but not above 0·5% or the alloy becomes brittle) and the time of homogenization lengthened. Structures obtained under various cooling conditions and annealing treatments are illustrated.—A. R. P.

*On a New Alloy " Sendust " and Its Magnetic and Electric Properties. Hakar Masumoto (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 388–402).—[In Japanese.] The magnetic and electrical properties of iron–silicon and iron–silicon–aluminium alloys were measured, and the relation of these properties to concentration was studied. Alloys containing 6–11% silicon and 4–8% aluminium have especially good magnetic properties and a representative alloy contains silicon 9·62 and aluminium 5·38%. Physical constants of this alloy are: initial permeability 35,100, maximum permeability 117,500, magnetic hysteresis loss 28 ergs/cm.^{3}/cycle, coercive force 0·022 oersted, specific electrical resistance 81·2 microhms/cm.^{3} at 20° C.—S. G.

*An Examination of Some Light Alloy Air-Screw Blades. Isamu Igarashi and Reijiro Taketomi (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, **2**, (7), 629–641).—[In Japanese.] Gives the results of an analytical survey of the mechanical properties and macro- and micro-structures of some light alloy propeller blades manufactured by the authors' works. The alloys used were Duralumin, Super-Duralumin, " 25S," and the magnesium alloy " AZM."—S. G.

A Review of Aluminium Alloys. M. G. Corson (*Iron Age*, 1936, **138**, (26), 24–29).—It is claimed that all the known aluminium alloys are passed under review and grouped into 27 classes; 12 of these alloys, including binary alloys such as the more common alloys with zinc, copper, magnesium, manganese, and silicon, all non-heat-treated, are described, and the solid solubilities of different metals in aluminium are tabulated.—J. H. W.

*The Hall Effect in the Antimony–Tellurium and Antimony–Silver Alloys. Edmond van Aubel (*Compt. rend.*, 1936, **203**, (14), 614–615).—The Hall effect was measured for pure antimony and in antimony containing tellurium 4·26 and silver 10·0, 19·9, 39·1, 60·2, and 73·3%, in order to confirm the relation-

ship existing between this effect and the thermoelectric force. Addition of 4·26% tellurium to antimony reduces the Hall effect in the ratio of 1 : 0·64, that of the thermoelectric force being also greatly reduced. Curves relating these effects to composition in a series of antimony–silver alloys, in both cases show an angular kink corresponding to Ag_3Sb (73·3% silver).—J. H. W.

*Antimony–Tin–Zinc System, and Zinc-Base Antifriction Alloys. Robert Blondel (*Publ. sci. tech. Ministère Air (France)*, 1936, (89), 78 pp. ; *C. Abs.*, 1937, 31, 641).—Cf. *Met. Abs.*, 1935, 2, 337. The objective was to find a group of antimony–tin–zinc alloys suitable for antifriction uses at high speeds and heavy loads, and cheaper than existing alloys. The general conclusions are : (1) A study of the antimony–tin system by total and differential thermal analyses and by metallographic examination confirmed the results of Iwasé which concern the limits of the solid solutions found at 7·5, 42, 58, and 95% antimony, and the allotropic transformation $b_1 \rightleftharpoons b_2$ at 325° C. (2) The complete equilibrium diagram of the system antimony–tin–zinc was determined by thermal analysis of about 120 alloys ; plane equilibrium diagrams and a space model of the ternary liquidus were constructed, and 3 invariant points were found at 395°, 235°, and 197·5° C., corresponding to 3 ternary peritectic transformations. (3) Differential thermal analysis of annealed ternary specimens showed that while the $b_1 \rightleftharpoons b_2$ transformation occurred at the invariant temperature of 325° C., the peritectic arrest disappeared at 235° C. in the zone of two constituents (ZnSb + b). (4) Metallographic study of annealed specimens showed the constituents present in the state of equilibrium, particularly in the zones of two constituents (ZnSb + a, ZnSb + b, ZnSn + c) where thermal analysis gave erroneous results because of false equilibrium, and metallographic study revealed a ternary solid solution rich in tin. (5) Density determinations by the hydrostatic method showed sharp breaks in the curves of the antimony–zinc and antimony–tin systems and indicated the limits of solid solutions a, b, and c, and the intermetallic phases ZnSb, Zn_4Sb_3, and Zn_3Sb_2 ; in the ternary the lines of equal density and the lines of equal electrical conductivity indicated the preponderant rôle of ZnSb ; electrical conductivity determinations revealed the limits of the ternary solid solution ; coeffs. of expansion were determined from 0° to 200° C., but these tests were not useful in determining constituents. (6) Hardness, impact and friction tests (at loads of 9 and 18 kg./cm.² and at a speed of 4 m./second indicated that ternary alloys containing more than 40% antimony are very brittle and practically useless, whereas ternary alloys with less than 30% antimony can be used as antifriction alloys in machines operating at 1500–2000 r.p.m. and under loads up to 20 kg./cm.². The ternary Sn–Zn–ZnSb revealed a hard constituent, ZnSb, with better bearing properties than those of Zn_3Sb_2 and Sb (particularly less brittle than the latter two). The results are given in tables, diagrams, and photomicrographs and the apparatus sketched. 40 *references* are given.—S. G.

*On Fractures in Stellited Valve Seatings and the Mean Thermal Coefficients of Expansion of Two Stellites. Heinrich Cornelius and Franz Bollenrath (*Z. Metallkunde*, 1936, 28, (12), 383–385).—The formation of surface cracks in the Stellite layer of steel valve-seatings in aero-motor engines is shown to be due to differences in the coeff. of expansion of the Stellite and the steel backing. The tendency to crack can be judged by examination of the microstructure.
—A. R. P.

*The Equilibrium Diagram of the Copper–Antimony System. I.—Thermal Analysis and Microscopic Examination. Takejirô Murakami and Nisaku Shibata (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], 25, (3), 527–568).—[In English.] See abstract from periodical in Japanese language, *Met. Abs.*, this vol., p. 36.—S. G.

*On Some Properties of Beryllium Bronzes. Kenzō Inamura and Hidekichi Ōhashi (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, **2**, (7), 656–668).—[In Japanese.] Some physical, mechanical, and chemical properties of beryllium–copper alloys containing 1·7–2·6% beryllium were studied. Two tables (printed in English) give the results for (*a*) chill-cast and sand-cast alloys, and rolled sheet in the as cast (or rolled), softened, and hardened conditions for sp. gr., Brinell and Rockwell hardness, 0·2% proof stress, tensile strength, elongation, simple bending, and alternate bending, and (*b*) corrosion of rolled sheet—in the as rolled, softened, and hardened conditions—by sulphuric, hydrochloric, and nitric acids, ammonium hydroxide, sodium hydroxide, and sea-water.—S. G.

*The Equilibrium Diagram of Cu–Zn at Low Temperatures. S. Konobejewski and W. Tarassowa (*Physikal. Z. Sowjetunion*, 1936, **10**, (3), 427–428).—[In German.] It has been established, since 1934 (*Sow. Physics*, 1930, **5**, 858 and *Z. Metallkunde*, 1936, **28**, 73) that the solubility of the α-phase of the bronzes is dependent on the temperature and is much smaller at low than at high temperatures. A corresponding result has now been established for the solubility of the α-phase of the brasses. The solubility is found to decrease from 38·75% of zinc (by weight) at 400° C. to 33·35% at 167° C. The equilibrium diagram of the brasses in the region of the α/α + β boundary resembles, in its concavity, the corresponding part of the equilibrium diagram of the bronzes.—J. S. G. T.

*A Thermodynamic Study of the Lead–Bismuth System. H. S. Strickler and Harry Seltz (*J. Amer. Chem. Soc.*, 1936, **58**, (11), 2084–2093).—Methods of calculation are presented by which thermodynamic data can be used to establish accurately the conditions of phase equilibria in binary systems. The activities of partial molal heat contents of lead and bismuth in their liquid alloys were determined, and it is shown that the alloys may be classified as regular solutions. The activities and relative partial molal heat contents of lead in solutions of lead and bismuth were determined accurately up to 20% bismuth, and the approximate activities were established from 22·5 to 33% bismuth. The eutectic composition and temperature are fixed at 54·7 atomic-% bismuth and 125° C. The compositions of the two solid phases comprising the eutectic solid were found to be 36·5 atomic-% bismuth and practically pure bismuth. The liquidus curve on the bismuth side of the eutectic and the solidus on the lead side up to 20% bismuth were calculated. The indicated existence of a peritectic at 184° C. on the lead side of the system was verified by thermal analysis. A revised diagram of the system is presented.—S. G.

Printing Alloys. A. Bargilliat (*Chim. et Ind.*, 1936, **36**, (1), 3–15).—A general account is given of the lead–tin–antimony alloys of this group, together with detailed methods for the electrolytic and spectral analysis of these alloys.—W. A. C. N.

*The Activity of Sodium in Dilute Sodium Amalgams. H. E. Bent and E. Swift, Jr. (*J. Amer. Chem. Soc.*, 1936, **58**, (11), 2216–2220).—The thermodynamic properties of dilute amalgams were determined by means of concentration cells containing sodium iodide in dimethylamine as the electrolyte. The solubility of sodium in mercury was determined at 5°, 15°, and 25° C. The experimental results are compared with those of Richards and Conant on concentration cells and Lewis and Kraus on the sodium electrode. The data on very dilute amalgams indicate that deviations from Raoult's law, which can be attributed largely to the existence of compounds, cannot be explained quantitatively by the assumption that compounds exist which dissolve in mercury to give ideal solutions.—S. G.

*The Activity of Sodium and Mercury in Solid Sodium Amalgams. H. E. Bent and A. F. Forziati (*J. Amer. Chem. Soc.*, 1936, **58**, (11), 2220–2223).— A potentiometric method is described for studying intermetallic compounds

at room temperature. Values are given for the free energy of the formation of $NaHg_4$, $NaHg_2$, $NaHg$, Na_3Hg_2, and Na_3Hg. The value for Na_7Hg_8 is not so reliable. The activity of mercury and sodium in solid amalgams of all concentrations is computed.—S. G.

*Mercury–Thallium Alloys and Their Application to Thermometric Purposes. Helmut Moser (*Physikal. Z.*, 1936, 37, (24), 885–886).—Mercury and thallium form two eutectic alloys containing, respectively, 8·5 and 40·5% of thallium. The freezing point of the former alloy is $- 60·0 \pm 0·2°$ C.; that of the latter is $- 0·8°$ C., and its vapour pressure at 500° C. is about half that of mercury. Both alloys are suitable for the construction of thermometers, which if constructed of the alloy containing 8·5% thallium enable temperatures down to about $- 59·0°$ C. to be measured with their aid. Mercury freezes at $- 38·9°$ C.—J. S. G. T.

*On the Longitudinal Magneto-Resistance Effect at Various Temperatures in Nickel–Cobalt Alloys. Yuki Shirakawa (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 362–387).—[In English.] The change of electrical resistance for alloys of the system nickel–cobalt at various temperatures from $- 195°$ to $1150°$ C. was measured up to 1600 oersteds by the longitudinal magnetic fields. For face-centred cubic solid solutions the change of resistance is similar to that of nickel, but for the hexagonal close-packed solid solutions it is similar to that of cobalt. The magnitude of the change of resistance is much greater in the former than in the latter class of alloys. In a 40% cobalt alloy the change of resistance at $- 195°$ C. is very great, being 16·3% in a field of 1500 oersteds.—S. G.

*Ferromagnetic Anisotropy in Nickel–Cobalt–Iron Crystals at Various Temperatures. L. W. McKeehan (*Phys. Rev.*, 1937, [ii], 51, (2), 136–139).—Single crystals of ternary nickel–cobalt–iron alloys containing more than 40% nickel were examined for ferromagnetic anisotropy by means of a pendulum magnetometer ; all alloys in this range have the face-centred cubic structure. Experiments were carried out in all cases at room temperature, and at about 200° and 400° C., and some alloys were examined up to about 600° C. A region of low anisotropy exists for alloys with nearly equal percentages of cobalt and iron, and is connected with the points where binary alloys of nickel and cobalt on the one side, and of nickel and iron on the other change their anisotropy types. In general, at the higher temperatures, the anisotropy of either type diminishes, and in the region of low anisotropy, the principal anisotropy constant may change sign.—W. H.-R.

*Effect of Temperature on Young's Modulus of Elasticity in Nickel-Copper Alloys. Kiyosi Nakamura (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], 25, (3), 415–425).—[In English.] The variations of Young's modulus of elasticity for 8 specimens of nickel–copper alloys (0–35·7% copper) were measured from room temperature to 500° C. Below the Curie point the Young's modulus decreases with increase in temperature, when the copper content is less than about 13 weight-%, but it increases when the copper content exceeds this amount. Above the Curie point the moduli of the specimens decrease steadily with increase of temperature. The temperature coeff. of Young's modulus abruptly decreases at the Curie point, the magnitude of this change being about $- 3·4 \times 10^{-4}$.—S. G.

*An Investigation of Some Magnetic Alloys. Tamotsu Nishina (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 344–361).—[In English.] Measurements were made of the magnetic properties of a large number of alloys. New alloys of scientific and industrial importance were found with (1) high initial permeability—Super-Permalloy Nos. 1, 2, and 3 ; (2) high initial permeability and high electrical resistance—Resisto–Permalloy ; and (3) constant permeability up to a moderate field strength—Super-Perminvar.

—S. G.

*The Equilibrium Diagram of the System Nickel–Silicon.** Keizô Iwasé and Masazô Okamoto (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 777–792).—[In English.] This paper has also been published in Japanese; see *Met. Abs.*, this vol., p 5. —S. G.

*The Palladium–Hydrogen Equilibrium and New Palladium Hydrides.** Louis J. Gillespie and Lionel S. Galstaun (*J. Amer. Chem. Soc.*, 1936, **58**, (12), 2565–2573).—Seven isotherms, from 200° to 313° C., have been traced on the pressure-composition diagram for palladium and hydrogen, in most cases from zero pressure through the heterogeneous region and well into the second homogeneous solid phase. The diagram, including the previous results at lower temperatures of Gillespie and Hall, indicates that the compounds Pd_2H, Pd_3H, Pd_4H, and Pd_6H have chemical individuality, even though in the second case, and possibly others, the tangent to the boundary curve is not vertical, the curve then resembling the analogous curve for FeO in the iron–hydrogen–oxygen system. In all cases the compound is to be regarded as a solid solution that has a stoichiometrical composition over a limited range of temperature. The finding of Brüning and Sieverts of a critical solution temperature for the solid phases near 300° C. is confirmed, and the critical constants are found to be: temperature 295·3° C., pressure 19·87 atm. and atomic ratio H : Pd 0·270. The validity is denied of (1) certain evidence against the existence of Pd_2H and (2) certain evidence in favour of the existence of PdH. Mention is made of palladium mercuride, probably Pd_4Hg_3, of very low decomposition pressure. The palladium investigated was found at the conclusion of the experiments to contain a presumably harmless amount of mercury, much less than 0·2%.—S. G.

*Thermodynamic Properties of the Tellurides of Zinc, Cadmium, Tin, and Lead.** J. H. McAteer and Harry Seltz (*J. Amer. Chem. Soc.*, 1936, **58**, (11), 2081–2084).—A potentiometric study was made of the tellurides of zinc, cadmium, tin, and lead at higher temperatures, using fused salt electrolytes. The method has been shown to give results which are reliable and accurate when applied to the proper substances. The data obtained have been employed in calculating the free energies of formation, heats of formation, and entropies of formation at 25° C.—S. G.

*Drop-Hammer Tests on White Metals.** Sinzi Sunaga (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 1088–1095).—[In English.] The compressive strengths of some copper–tin (up to 8·04% copper), antimony–tin (up to 17·04% antimony), and copper–antimony–tin alloys were tested by the drop-hammer method. The impact strength is closely related to the structure of the alloys. White metal for aeronautical use must contain sufficient copper and antimony to form a strong eutectic structure. With excessive hardener the alloy is apt to crack under severe impact.—S. G.

*On the Phenomenon of Incubation of Alloys.** Kotarô Honda and Kanzi Tamaru (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 677–685).—[In English.] The incubation phenomenon in Duralumin has been known since the alloy was discovered by Wilm in 1911, but its cause has not yet been satisfactorily explained. The authors studied the phenomenon in beryllium–copper as well as in Duralumin. The nature of the incubation, hardness, electrical resistance, and density were measured. Incubation is explained by the differential effect of hardening caused by the lattice distortion by dissolved atoms present near grain boundaries and of softening due to their subsequent precipitation.—S. G.

*Solubilities of Hydrogen in Binary Alloys in Relation to Their Equilibrium Diagrams.** Masaji Fukusima and Saburô Mitui (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 940–948).—[In English.] The solubilities of hydrogen in binary alloys whose equilibrium diagrams are of simple and typical types, such as (*a*) single series of solid solutions (copper–nickel); (*b*)

two series of solid solutions (iron–cobalt); (c) a mixture of two saturated solid solutions (cobalt–copper), or (d) two phases lying between compounds (nickel–antimony) were measured, and the results are explained with the aid of the equilibrium diagrams. It is found that the solubilities of hydrogen in alloys forming a single series of solid solutions change with variation of composition, giving a continuous curve with or without a maximum point, while those in alloys forming a mixture of two phases change in a linear relation with change of composition, and the solubility curves abruptly change by transformation or indicate a break at the composition of a stable compound.
—S. G.

*Theoretical Study of the Diffusion of Solids. Jean Cichocki (*J. Phys. Radium*, 1936, [vii], **7**, (10), 420–426).—The inter-diffusion of two metals is discussed theoretically. At the interface between two metals in contact it is assumed that an alloy layer is formed and this layer diffuses into the respective metals at appropriate rates. The theory of probability is applied to deduce an expression for the coefficient of diffusion (*D*) of one metal in another in terms of the melting points of the respective metals and their respective weights per gram-atom. This formula corresponds with the empirical formula given in the form $D = Ae^{-b/T}$, and satisfactory agreement is found between calculated and experimental values of *D* in the case of gold, silver, cadmium, bismuth, thallium, tin, and thorium-*B* diffusing into lead at 285° C. Calculated values of *D* for gold diffusing into lead or silver are also in agreement with experimental values determined between 100° and 197° C., and between 836° and 935° C. Values for the diffusion of thorium-*B* in lead at 260° and 324° C. are not in such satisfactory agreement.—J. S. G. T.

*On the Relation Between Diffusion and Transformation Point of Metals. Tsutomu Kase (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 670–676).—[In English.] A study was made of the diffusion of zinc, antimony, aluminium, and tin into Armco iron and copper, and of carbon into Armco iron. The curves showing the relation between the logarithm of the increase in weight of the specimen and the reciprocal of the corresponding absolute temperature reveal the melting point or transformation point of the diffusion material or the specimen.—S. G.

*On the Theory of Equilibrium in Alloys.—I. William Hume-Rothery (*Phil. Mag.*, 1936, [vii], **22**, 1013–1047).—In some copper and silver alloys the α-solid solubility curve shows a characteristic form in which the α-solid solution limit increases with decrease of temperature. This usually occurs when the α-solid solution is in equilibrium with a body-centred cubic β-phase, and to a first approximation the α-solid solubility limits in different systems at a given temperature correspond with the same electron concentration. To a higher degree of accuracy the solid solubility limits are affected by the lattice distortion, and curves are given showing the relation between the electron concentration and lattice distortion at the solubility limits in different copper and silver alloys. It is concluded that up to a certain point, lattice distortion affects the electron concentration at the solid solubility limit comparatively slightly, but that beyond this point a rapid change takes place, and the lattice distortion at the solid solubility limit falls sharply. The solid solubility limits in ternary alloys are discussed, and a characteristic type of solid solubility isothermal is shown to exist when the two solute elements unite to form a compound. The same kind of isothermal is found when an intermetallic compound crystallizes from the liquid state, and a preliminary theory is developed for the crystallization of an intermetallic compound from liquid and solid solutions of ternary alloys.—W. H.-R.

*The Relations Between Heat of Formation, Structure, and Properties of Technically Important Alloys. Friedrich Körber [with W. Oelsen, W. Middel, and H. Lichtenberg] (*Stahl u. Eisen*, 1936, **56**, (48), 1401–1411).—A simple

method is described for the direct determination of the heat of formation of molten alloys, and possible sources of error are discussed. Determinations were made of the heat of alloying of binary alloys of iron, nickel, and cobalt with silicon and aluminium, of cobalt, nickel, and copper with tin, and of copper with aluminium, as well as of iron–cobalt–aluminium and iron–nickel–aluminium alloys. The results are shown graphically on the usual equilibrium diagrams. The heats of formation of the solid solution alloys (per grm.-atom of solute metal) are always somewhat greater than those of the intermetallic compounds. The values for the heats of formation of the latter in the solid state are (in kg.-cal./grm.-mol.); FeSi 19·2, CoSi 24, NiSi 20·6, FeAl 12·2, CoAl 26·4, NiAl 34, CuAl 9·5, CoSn 7·1, Ni_3Sn_2 37·5, NiSn 15.—A. R. P.

*On the Nature of Peritectic Reaction and the Mechanism of the Grain-Refinement Resulting Therefrom. Keizô Iwasé, Ju-n Asato, and Nobuyuki Nasu (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 652–669). —[In English.] Cf. *Met. Abs.* (*J. Inst. Metals*), 1933, 53, 11; *Met. Abs.*, 1934, 1, 175, 575; 1935, 2, 8; 1936, 3, 390. In a preliminary experiment it was found that the grain-refinement of aluminium bronze with an addition of iron is closely related to the peritectic reaction in the binary system copper-iron. An introductory investigation has been made, therefore, of many peritectic alloys of the systems copper–iron–zinc, copper–iron–tin, copper–iron–manganese, copper–iron–nickel, copper–cobalt, copper–cobalt–tin, copper–cobalt–nickel, copper–tin, copper–silicon, copper–zinc, silver–cadmium, silver–zinc, aluminium–nickel, and antimony–tin and similar phenomena have been observed in various degrees. In all these alloys the sizes of the polygonal grains become very fine when they are formed secondarily by peritectic reaction. To make the nature of grain-refinement clearer the nature of the reaction was studied from the theoretical point of view, as well as by experiments on the antimony–tin–lead alloys. The results obtained were : (1) In an ideal case the secondary crystal formed by the reaction between the primary and the melt does not envelop the primary crystal because in such a case it is not easy for the reaction to proceed further ; (2) the above-mentioned enveloping phenomenon is the result of the establishment of an apparent equilibrium ; (3) the contact between the primary crystal and the melt should be increased in the course of the reaction in order that the systems should change in accordance with the equilibrium diagram as nearly as possible ; this requirement is fulfilled when the disintegration of the primary crystal takes place ; (4) the disintegrated fragments of the primary crystal may have different orientations with each other and behave as separate nuclei for further peritectic reaction. These conclusions have been proved successfully from an examination of the structures of typical peritectic alloys of antimony, tin, and lead. Therefore, the grain-refinement (of secondary crystals) in the case of peritectic alloys found in this investigation is attributed to the nature of the peritectic reaction, *i.e.* to the disintegration of the primary crystals by the reaction. It is suggested that in some cases in which the primary crystal forms a massive grain, an enlargement of the grain-size may be found as the effect of the peritectic reaction. The process of " Umhüllung " (enveloping) observed when the solid solution crystallizes from the melt is clearly explained from a similar point of view.—S. G.

III.—STRUCTURE

(Metallography ; Macrography ; Crystal Structure.)

*Crystal Growth Across Interfaces. A Note on Some Experimental Evidence. B. S. Barham and W. D. Jones (*Met. Ind.* (*Lond.*), 1937, 50, (6), 181–182).— Ewing and Rosenhain in 1901, took clean freshly cut surfaces of lead, pressed them together under high pressures, and then subjected them to prolonged

heating at 200° C. Growth occurred in each portion of lead, but none across the artificial boundary. They took this as proof of their theory that even in the purest metals the crystals were surrounded by an intercrystalline cement. B. and J. carried out experiments on an internal cavity in an ingot of tin, and on specially annealed and etched surfaces of gold. Crystal growth across the interfaces occurred readily. When the experiment on gold was repeated, without etching to remove the adsorbed film of magnesia used in polishing, no such growth occurred.—J. E. N.

Grain Structure and Grain-Size in Cast Metals. R. Mitsche (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (1) 4–13).—The factors which control the structure and the grain-size of cast metals are discussed with reference to recent work. A *bibliography* of 23 references is included.—A. R. P.

*Structural Investigations on Aluminium Alloys. H. Hanemann (*Aluminium*, 1937, **19**, (1), 7–11).—A so-called " comparison " structure is obtained by melting 13 grm. of the clean alloy under a magnesium chloride flux in a carbon crucible heated electrically at 680° C. and, after 3 minutes, allowing the crucible to cool in the air on an asbestos plate. When the resulting button is sectioned and etched, the various constituents in equilibrium with one another are clearly revealed. Photographs are included showing these structures for Duralumin, Lautal, Aludur, and Hydronalium.—A. R. P.

On the Micrography of Aluminium Forging Alloys. Herm. A. J. Stelljes (*Aluminium*, 1936, **18**, (12), 601–607).—The changes which take place in the structure of alloys of the Duralumin type during working and heat-treatment are illustrated by photomicrographs, particular attention being given to the use of micrography for detecting faulty work.—A. R. P.

*Stress Distribution Figures in Magnesium–Aluminium Forging Alloys. Walther Roth (*Z. Metallkunde*, 1936, **28**, (12), 388–389).—As is the case with wrought iron and some other alloys stress distribution lines can be developed in cold-worked homogenized magnesium–aluminium alloys by annealing at 100°–150° C. and etching to develop the grain structure ; zones of high stress concentration are delineated by dark lines due to accelerated precipitation of Mg_2Al_3 by the cold-work. Characteristic effects are illustrated.—A. R. P.

*†Hot-Working, Cold-Working, and Recrystallization Structure. N. P. Goss (*Trans. Amer. Soc. Metals*, 1936, **24**, (4), 967–1021 ; discussion, 1021–1036).—A very readable account, with an essentially practical bias, of the application of X-ray analysis to the investigation of changes in the internal structure of metal grains when metals are hot- or cold-worked and heat-treated. The matters discussed are : evidence of imperfection in crystal structures, significance of " radial asterism " found in X-ray diagrams of cold-worked metals ; plastic deformation ; preferred orientation in hot-rolled strips ; effects of small and large deformations ; new orientations developed by heat-treatment, and their stability on cold-rolling ; time required to remove directional properties in high carbon steel wires and to complete the recrystallization of cold-worked strip steels ; directional properties due to small and large plastic deformations ; effect produced by bending and twisting annealed wires. An appendix is devoted to the hardening of metals by cold-working, the X-ray structures of amorphous and crystalline materials, crystal size, and line width. A *bibliography* of 24 references is given.—J. S. G. T.

*Structural Changes and the Destruction of the Ordered Atomic Distribution in Solid Solution Alloys by Plastic Deformation. H. J. Seemann (*Naturwiss.*, 1936, **24**, (39), 618–619).—The specific electrical resistance of an alloy of copper with 47 atomic-% palladium is increased by cold-drawing, the cubic body-centred lattice with ordered atomic distribution being converted into a face-centred lattice with random atomic distribution. Hence the destruction of the ordered lattice by plastic deformation induces a transformation in the lattice type.—B. Bl.

*The Production of Large Metallic Single-Crystals. M. Śmiałowski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa* (*Warszawa*), 1937, 3, (4), 184–188). —[In Polish, with English summary.] A method is described for the production of large single-crystals of low-melting metals and of aluminium and copper. Spherical crystals of tin, lead, and zinc were obtained in Pyrex-glass vessels, and of aluminium and copper in graphite crucibles. Copper, lead, and tin show a pronounced tendency toward single-crystal formation, while this tendency is not so great for zinc, aluminium, antimony, and bismuth. The reflections from the etched surface of single-crystalline zinc samples belong to the planes {10$\bar{1}$0}, {10$\bar{1}$1}, or {0001}.—P. W. R.

*On the Mosaic Structure of Metal Crystals. M. Śmiałowski (*Wiadomości Instytutu Metallurgji i Metaloznawstwa* (*Warszawa*), 1936, 3, (4), 212–215).—[In Polish, with German summary.] Experiments with single-crystals of zinc and copper grown from their respective melts show that their coarse mosaic structures depend more on the conditions of solidification than on the orientation of crystal nuclei. Zinc single-crystals in which the hexagonal axis is almost perpendicular to the direction of cooling show, after deep etching, a striated structure. Individual layers lie strictly parallel to the direction of crystallization, making an angle with the {0001} face, which becomes zero only in the particular case when the basal plane is parallel to the direction of crystallization. Single-crystal specimens in which the geometric axis (direction of cooling) is almost parallel to the hexagonal axis show a regular, often hexagonal, cellular structure which bears no direct relation to the hexagonal structure of zinc, since similar figures may be obtained on the cube face of copper. Spectroscopically pure zinc from New Jersey shows no appreciable tendency to mosaic-structure formation.—P. W. R.

" Extra " Spots in Electron Diffraction Patterns. V. A. Kolpinsky (*Physikal. Z. Sowjetunion*, 1936, 10, (4), 563–564).—[In English.] Brück was unable to explain certain " extra " spots found in the electron diffraction spectra of thin films of silver, nickel, and gold (*Ann. Physik*, 1936, 26, 233). K. suggests that these are explainable along lines similar to those used by Finch and Wilman to explain the presence of " extra " rings in their diffraction spectra (*Nature*, 1936, 137, 271). It is suggested that the films consist of regularly arranged pyramids or octahedra 3 atoms in height.—J. S. G. T.

*Oriented Oxidation of Barium. W. G. Burgers and J. J. A. Ploos van Amstel (*Physica*, 1936, 3, (10), 1057–1063).—[In English.] Layers of metallic barium were obtained by volatilizing the metal in the (evacuated) electron diffraction apparatus and depositing it on a flat polished copper disc. Depending on the conditions of evaporation (temperature), they show either random orientation of the crystallites or a preferential orientation characterized by a [111] direction perpendicular to the plane of the supporting disc. The oriented layers, on oxidation, yield likewise oriented oxide layers. In these latter the normal to the support is nearly parallel to a [110] direction of the oxide lattice, deviating from it by about 10°–15° towards [100]. It is thus found that a direction of closest packing of the metal atoms in the face-centred oxide lattice (*i.e.* a [110] direction) is closely parallel to a corresponding direction in the body-centred metal lattice (*i.e.* a [111] direction). The relationship is further discussed in connection with that found by Mehl, McCandless, and Rhines to occur between FeO and iron on oxidation of a single crystal of iron. It was found that the [111] direction in the oriented barium layers, formed under conditions of oblique incidence of the vapour beam, deviates slightly from the normal to the supporting disc towards the direction of the incident beam, a behaviour analogous to that observed previously with layers of CaF_2, deposited in vacuum from the vapour.—S. G.

*On the Scattering of Fast Electrons by Thin Films of Beryllium. Hikoo Saegusa and Keiji Kikuchi (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], **Honda**

Anniv. Vol., 72–79).—[In English.] The total angular distribution of the electrons scattered by a thin foil of beryllium was observed. Comparing the values obtained by the authors and those of Klemperer with the values calculated from Wentzel's formula, it was found that the authors' values gave the best agreement.—S. G.

*The Identity of Structure in Liquid Lead and Bismuth. J. T. Randall and H. P. Rooksby (*Trans. Faraday Soc.*, 1937, **33**, (1), 109–110).—X-ray examination of liquid lead and bismuth in thin films shows that both metals give rise to a single diffraction band and that they both give identical patterns with spacings of 2·95 A., assuming that the Bragg law applies to liquid metals.
—A. R. P.

*Texture of Thinly Rolled Tungsten Foil. W. G. Burgers and J. J. A. Ploos van Amstel (*Physica*, 1936, **3**, (10), 1064–1066).—[In English.] Electron diffraction photographs of very thinly rolled tungsten foil show the presence of a pronounced rolling texture, the crystallites lying with a cube plane parallel to the plane of the foil and a cube edge (with very little spreading) at 45° to the direction of rolling. On oxidation, an oxide layer is formed consisting of crystallites oriented at random.—S. G.

*On the Energy States of Valency Electrons in Some Metals. I.—The Stationary States of Valency Electrons in Zn Crystal. Mituru Satô (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, **25**, (4), 771–779).—[In English.] The photoelectric threshold, photoelectric selective emissions, and selective absorptions of light of zinc are explained in the terms of the energy levels of the valency electrons (determined in previous papers, see *Met. Abs.*, 1936, **3**, 396), and the nature of the so-called potential energy barrier in the surface layer of solid zinc has thus been clarified. Further, based on the results as obtained above and referring to photoconductive effect, it is concluded that the levels E_3 and E_4 are the conduction levels of the valency electrons and that in the bulk mass of solid zinc the levels E_1, E_2, E_3, and E_4, at least, are stationary ones. The origin of the catalytic action at the surface layer of solid zinc is discussed.
—S. G.

*Energy Bands for the Face-Centred Lattice. William Shockley (*Phys. Rev.*, 1937, [ii], **51**, (2), 129–135).—Theoretical. The method of Slater (*Met. Abs.*, 1934, **1**, 447) for obtaining wave functions for metallic lattices is applied to the face-centred cubic lattice.—W. H.-R.

*On the Atomic Forces of Solid State [—IV]. Weng Wen-Po (*Phil. Mag.*, 1937, [vii], **23**, (152), 33–49).—(Cf. *Met. Abs.*, 1936, **3**, 532). The theory is further developed with special reference to the process of melting, latent heats of fusion, and the structure and surface tension of liquids. Comparison is made with experimental data for both metals and non-metals.—W. H.-R.

Precision Determination of the Lattice Constants of Coarse-Grained Substances. Hans Kostron (*Z. Metallkunde*, 1936, **28**, (12), 390–391).—A modified driving mechanism for rotating the specimens in determining the lattice constants of coarse-grained material by the back-reflection method is described and illustrated.—A. R. P.

A Note on the Work of M. U. Cohen : " The Elimination of Systematic Errors in Powder Photographs." A. Ievins and M. Straumanis (*Z. Krist.*, 1936, **95**, (5/6), 451–454).—[In German.] The method of Cohen (*Met. Abs.*, 1936, **3**, 306) for eliminating errors from powder photographs is again criticized. Cf. Ievins and Straumanis (*Met. Abs.*, 1936, **3**, 307), and Cohen (*Met. Abs.*, 1936, **3**, 458).—W. H.-R.

*The Employment of Contoured Graphs of Structure-Factor in Crystal Analysis. W. L. Bragg and H. Lipson (*Z. Krist.*, 1936, **95**, (5/6), 323–337).—[In English.]—W. H.-R.

IV.—CORROSION

*On the Influence of the Purity of Aluminium on the Corrosion in Hydrochloric Acid of Different Concentrations. W. J. Müller and E. Löw (*Aluminium*, 1936, 18, (11), 541–544).—Cf. *Met. Abs.*, 1936, 3, 533. The rate of dissolution of aluminium in hydrochloric acid increases extremely rapidly as the proportion of impurities present increases from 0·002 to 0·05% ; a further increase in the impurities has only a relatively small effect on the rate of dissolution. This and other differences in the behaviour of pure and technical aluminium is explained as follows : The effects of local elements are governed by the total resistance of the surface film, *i.e.* by the sum of the resistances of the film itself and of the pores, the resistance of the film on pure aluminium in $4N$-hydrochloric acid is large (about 5000 ohms/cm.²) while that of the film on the commercial metal is small (about 0·7 ohm/cm.² for 99·5% metal), and the thickness of the film decreases with increasing concentration of acid, so that in the case of the commercial metal the concentration of metal particles in the film is enormously increased. Simultaneously the film swells up in electrolytes and the conductivity in the pores increases 100-fold, so that the period of induction is reduced as the concentration of acid increases.—A. R. P.

*On the Corrosion of Aluminium and Some of Its Alloys in Petrol. Shinkich Higashio (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku (Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, 2, (8), 809–813).—[In Japanese.] The results are given, in tables, of a study of the corrosion of aluminium, 3S, SA4, and SA2–A in petrol. The object was to find a material suitable for aeroplane petrol tanks. It was found that the materials studied are not perceptibly corroded by petrol.—S. G.

*On the Resistance to Weathering of Light Metal Wood Screws. W. Nicolini (*Aluminium*, 1936, 18, (12), 622–623).—The behaviour of screws of Duralumin, with and without surface treatment, when embedded in various woods and exposed to moist air for 1 year is recorded. Those which had no surface treatment all failed, generally in the threaded portion, whereas those which had been anodically oxidized and treated with lanolin not only stood up very well but also screwed into the wood more easily. Of the three woods tested, oak had the most corrosive effect, while box and pine showed little difference.

—A. R. P.

*Scaling of Pure and Alloyed Copper [on Heating in Air]. Karl Wilhelm Fröhlich (*Z. Metallkunde*, 1936, 28, (12), 368–375).—The rate of oxidation of pure copper and of copper alloys containing silver, aluminium, arsenic, boron, beryllium, calcium, cerium, cobalt, chromium, iron, lithium, magnesium, manganese, nickel, phosphorus, antimony, silicon, tin, titanium, or zinc was determined at 700°–1000° C., and the nature of the scale obtained investigated ; the results are shown graphically as increase in weight with time of heating. With pure copper the rate of oxidation is independent of its method of manufacture or its previous history, and also of the partial pressure of the oxygen between 45 and 760 mm. ; oxidation appears to proceed by diffusion of copper atoms into the cuprous oxide scale which always contains somewhat more copper than corresponds to Cu_2O. With copper alloys the alloying element generally concentrates at the boundary between the metal and the outer cuprous oxide layer, forming, in the case of calcium, chromium, lithium, manganese, silicon, and titanium, an intermediate layer of almost pure oxide of the alloying element. Protective films are formed when the intermediate oxide film is of such a nature as to prevent or hinder diffusion of the copper atoms into the outer layer; this occurs with alloys containing beryllium, aluminium, or magnesium, and to a smaller extent with alloys containing

boron, silicon, or much tin or zinc. In most alloys diffusion of oxygen through the scale into the metal also occurs to a greater or smaller extent; if the alloy contains constituents which diffuse only slowly in copper, *e.g.* manganese, nickel, silicon, tin, titanium, nickel, or zinc, this action results in the formation of a copper-rich metallic layer containing irregularly distributed inclusions of the oxide of the alloying metal just below the scale. In some cases, *e.g.* nickel–copper and nickel–zinc–copper alloys, this action results in a considerable and progressive reduction in tensile strength with increase in the degree of scaling. With zinc–copper alloys, which do not exhibit this effect the strength remains practically unchanged even after considerable scaling has occurred.—A. R. P.

*Some Experiments on Copper Water Tubing. Tomojiro Tanabe and Goro Koiso (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku* (*Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, 2, (7), 642–655).—[In Japanese.] Measurements were made of the quantity of free carbon dioxide in the town waters of some large Japanese cities and also of the copper dissolved in tap-water in buildings where copper water tubes are in use. As a result of a study of the action of carbon dioxide and oxygen on the corrosion of copper in pure distilled water it was found that (1) most of the town waters contained 2–3 mg./litre of free carbon dioxide, and more than 6 mg./litre in a few cases; (2) copper is corroded to some extent by pure distilled water in the presence of carbon dioxide, and oxygen accelerates the rate of corrosion by carbon dioxide; (3) copper is not corroded perceptibly in pure water containing oxygen alone, owing to the formation of a protective oxide film on the surface of the metal.—S. G.

Corrosion in Water Works. G. Wiegand (*Gas u. Wasserfach*, 1936, **79**, (13), 198–202).—The corrosion of copper and brass wire mesh filters by water derived from old wells is described; the corrosion is attributed to the action of surface water containing traces of hydrogen sulphide.—B. Bl.

*On the Behaviour of Lead in Distilled Water. O. Bauer and G. Schikorr (*Mitt. Material., Sonderheft* 28, 1936, 67–70; and (in German) *Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 949–958).—Exposure to moist air produces a protective film on lead which considerably increases its stability towards water free from carbon dioxide. The strong attack of distilled water on mechanically stressed parts, frequently observed, is due to rupture of this film at these places. Lead coated with a protective film has an electrolytic potential against the *N*-calomel electrode which is always more noble than − 0·52 v. whereas that of lead without the film remains permanently less noble than this. Addition of antimony to lead facilitates the film formation and makes it more complete.—B. Bl.

*The Corrosion of Magnesium Alloys. I.—Binary Magnesium Alloys. Hikozô Endô and Susumu Morioka (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 959–968).—[In English.] A study was made of the effect of added metals on the corrosion of magnesium. Various binary alloys were prepared containing up to 8% of the metals : tin, bismuth, thallium, cadmium, lead, zinc, antimony, aluminium, calcium, silver, copper, manganese, silicon, nickel, and cobalt. The specimens were subjected to the action of distilled water, 1/10 *N* sodium chloride solution or sea-water by the dipping, spray, or intermittent immersion test, and the loss in weight was measured after a definite interval of time. From the results an intimate relation was found between the corrosion of magnesium and the position of the added element in the periodic table.—S. G.

Resistance of Nickel and Monel Metal Towards Chlorinated Solvents in Dry Cleaning. W. Müller (*Korrosion u. Metallschutz*, 1936, **12**, (12), 349–350).— Data are given for the rate of corrosion of nickel and Monel metal in dry and moist carbon tetrachloride in both the liquid and vapour state. In general nickel is the more resistant, but the rate of corrosion of Monel metal is very small even in the wet vapour so that both metals give very satisfactory service

as constructional materials for apparatus used in dry cleaning and in the recovery of the solvents.—A. R. P.

Second Report on the Corrosion of the Tinplate Container by Food Products. T. N. Morris and J. M. Bryan (*Dept. Sci. Indust. Res. Food Invest. Special Rep.* No. **44**, 1936, 54 pp.).—The seat of corrosion in lacquered cans is mainly at the seams and at imperfections in the lacquer caused by the process of manufacture. Improvements could be obtained by a second application of lacquer to the finished can, by improvements in lacquers and lacquering technique, and by lessening the damage done during soldering and fashioning the can. The corrosion of tin in the presence of air in solutions of citric acid and sodium citrate is increased by ferrous iron content and to a lesser extent by copper. Sucrose and sodium chloride have an inhibiting action. Lactic, tartaric, and malic acids have approximately the same corrosive powers as citric acid, but tin is not affected by acetic and succinic acids. Oxalic acid is particularly corrosive. Commercial beet sugar has an inhibiting action on the corrosion of iron and is beneficial for canned fruit. The effect of p_H on the efficiency of inhibitors is discussed. There is a close correlation between the rate of attack of steel by various fruit extracts and the rate of formation of hydrogen swells in cans containing the various fruits. Consideration is given to the effect of lacquering. In the discussion of the tin–iron couple it is suggested that the tendency of sugar to inhibit the corrosion of iron is more than offset by its tendency to decrease the inhibiting power of tin salts on the corrosion of iron, and to retard the rate of corrosion of tin in the presence of air. This affords an explanation of the tendency of fruits canned in syrup to yield more hydrogen swells than fruits canned in water. Tests with sulphur dioxide and the tin–iron couple in the presence of sucrose and inverted sugars show large increases in the corrosion of the steel. Both tin and iron tend to discolour certain fruits, tin affecting the soluble anthocyanin pigments and the iron affecting the tannins.—W. D. J.

Discoloration and Corrosion in Canned Cream. C. J. Jackson, G. R. Howat, and T. P. Hoar (*J. Dairy Research*, 1936, **7**, 284–290; and *Tech. Publ. Internat. Tin Res. Develop. Council, Series A*, No. **49**, 1936, 10 pp.).—Several defects in canned cream after some months' storage have been classified: (1) " purpling " of the can, due to a film of tin sulphide; (2) pitting of the can, associated with (3) formation of black patches and of black specks in the body of the cream, consisting of ferrous sulphide, stannous oxide, or both. " Purpling " is produced by excessive time and temperature of sterilization, owing to the liberation of active sulphur compounds which attack the tin. Addition of sodium bicarbonate up to 5 grm. per gall. has, if anything, a slightly beneficial effect. Pitting is only slight after 6 weeks' storage, and black discoloration of the cream was only observed in this period in cans in which the steel was deliberately exposed.—W. D. J.

Destruction of Zinc Gutters and Zinc Linings on [Bituminous] Pasteboard Roofs. F. Huth (*Korrosion u. Metallschutz*, 1936, **12**, (12), 350–351).— Corrosion of the zinc is shown to be due to the leaching out of acidic substances from the bitumen impregnation of the board by rain-water and to the action of the resulting acid solutions on the metal. Tar-impregnated board also gives rise to water-soluble acids but these are smaller in amount than, and not nearly so corrosive as, those derived from bitumen.—A. R. P.

Corrosion Action of Various Types of Water on Household Plumbing. Charles P. Hoover (*Water Works and Sewerage*, 1936, **83**, 384–387; *C. Abs.*, 1937, **31**, 193).—Experiments were carried out with 6 galvanized hot-water heating tanks and different make-up waters over a period of 1 year. The results failed to confirm the belief that high p_H leads to less iron corrosion and that, other factors being constant, corrosion is a factor of oxygen content. The data strongly indicate that (1) water of low alkalinity containing nearly all calcium and magnesium normal carbonates, at 150° F. (66° C.), is more

corrosive than water containing no normal carbonates despite appreciable dissolved oxygen and some free carbon dioxide; (2) normal calcium and magnesium carbonates deposit a somewhat adherent uneven scale ($\frac{1}{32}$–$\frac{1}{8}$ in. thick) while their bicarbonates produce a tightly adhering thinner scale (probably basic zinc carbonate); (3) zinc corrosion varies more with $p_{\rm H}$ than with dissolved oxygen content; (4) corrosion by normal carbonate-containing water starts at pinholes in galvanizing and progresses underneath the zinc; (5) corrosion products produced by calcium and magnesium bicarbonates fill such pinholes and act as protective films.—S. G.

Effect of Polishing on Corrosion-Resistance. William M. Phillips (*Monthly Rev. Amer. Electroplaters' Soc.*, 1937, **24**, (1), 27–30; discussion, 30–33).— Rolled steel that has not been polished stands up better to the salt-spray test after nickel-plating than that which has been polished with a fine or coarse grit. Polishing with a chromium buffing compound, however, yields a surface which, when nickel-plated, stands up extraordinarily well to the salt-spray test.

—A. R. P.

A Method of Measuring Attack on Metals by Weak Corrosive Agents. W. R. van Wijk (*Arch. tech. Messen*, **1936**, (60), T163).—The difficulties presented by the measurement of attack by feebly corrosive liquids, especially if these are in constant motion, as in fuel pumps, are reviewed; the method suggested involves the use of thin vacuum-deposited films of metal or alloy, variations in the thickness of which can readily be determined by observations of the absorption of light by the sample. Metals so tested include copper, lead, zinc, and a number of alloys. The method of preparing the samples is described.—P. M. C. R.

*The Application of the Logarithmic Sector to Corrosion Problems. S. A. Burke (*Trans. Faraday Soc.*, 1937, **33**, (2), 309–324).—The spectrographic determination of corrosion products of steel in the corroding medium by the logarithmic sector method is described together with the necessary apparatus and methods of calibration. Tests on stainless steels showed that all the constituents dissolved in acids in the same proportions as they existed in the solid steel.—A. R. P.

V.—PROTECTION

Problems of the Electrolytic Surface Treatment of Aluminium and Aluminium Alloys. I.—Theory and Principles of the Surface Treatment of Aluminium. The Importance and Uses of the Various Methods. F. Nückel (*Korrosion u. Metallschutz*, 1936, **12**, (10), 283–290).—A brief description is given of the Eloxal process for anodically oxidizing aluminium, and of the properties and uses of the treated metal. The anodic film produced may be coloured by dyeing or by impregnation with inorganic pigments or organic lacquers or may be decorated with ornamental or useful designs by the " Seo–Foto " process which consists in impregnating the surface with a light-sensitive silver salt, producing a positive contact print thereon and developing the picture in the usual photographic way. " Seo–Foto " prints are remarkably stable to corrosion and to heat; they remain unaffected at all temperatures up to the melting point of the metal base. If the oxide film of Eloxal aluminium is partly removed by treatment with a suitable etching agent the remainder serves as a valuable " key " for subsequent plating with nickel or copper.—A. R. P.

Problems of the Electrolytic Surface Treatment of Aluminium Alloys. II.— Basis of the Technological Conditions for the Eloxal and Elytal Processes and a Discussion of the Practical Aspects. W. Birett (*Korrosion u. Metallschutz*, 1936, **12**, (10), 290–297).—The chemical and electrical principles on which the

formation of oxide films on aluminium is based are described in detail with special reference to the Eloxal anodic oxidation and the Elytal nickel-plating processes.—A. R. P.

*The Chemical Oxidation of Aluminium Foil by the M.B.V. Process. Heinrich Neunzig (*Aluminium*, 1937, 19, (1), 2–3).—Foil thinner than 0·03 mm. cannot satisfactorily be treated by the M.B.V. process; at this thickness not more than 1 minute's immersion is permissible otherwise perforation occurs. Longer immersion can be given to thicker foils, *e.g.* foil 0·05 mm. thick can be treated for 10 minutes. In all cases the protective film withstands the water vapour and salt-spray tests very well.—A. R. P.

*Artificial Oxide Films Improve the Adhesion of Coloured Coatings to Light Metals. W. Nicolini (*Aluminium*, 1937, 19, (1), 4–5).—Bright-rolled, M.B.V.-treated, and Eloxal-treated aluminium sheets were painted with an aluminium bronze paint and subjected to saturated air and to the salt-spray test for 600–800 hrs. The results, which are tabulated, show that adhesion of the paint is improved considerably by the oxidizing treatment provided that the film is sufficiently porous and absorbent. The Eloxal film is to be preferred when the finished article is to be subjected to hard wear.—A. R. P.

On the M.B.V. Treatment and Lacquer Impregnation of Aluminium Coiled Tubes. H. Neunzig (*Aluminium*, 1937, 19, (1), 20–22).—To protect the inside of aluminium tubes by the M.B.V. process the solution is forced through the tube under pressure at 95°–100° C.; an apparatus for doing this work is described. After washing and drying a thin lacquer may be forced through the tube to impregnate the oxide film; the excess of lacquer is blown out of the tube and the impregnated film hardened by passing a current of hot air through the tube for 10–15 minutes.—A. R. P.

*The Colouring of Aluminium and Its Alloys with Inorganic Materials by the M.B.V. Process. (Helling and Neunzig.) See p. 115.

Machining Operations [and Anodizing Treatment] on Motor-Car Pistons. —— (*Machinery* (*Lond.*), 1936, 49, (1263), 373–376).—Includes a brief illustrated account of plant for anodizing aluminium alloy pistons at the Buick works of the General Motors Corporation, U.S.A. The thickness and hardness of the anodic coating is determined by observing the time required for a sand blast to cut through the coating and allow electrical contact to be established with the metal.—J. C. C.

Special Methods for the Surface Protection of Metals. R. Mitsche (*Berg- u. Hüttenmann. Jahrb.*, 1936, 84, (3), 116–124).—The Parkerizing and similar processes of rustproofing steel and the Alclad process of coating aluminium alloys are described at some length and their advantages discussed.—A. R. P.

*The Production of Black Anodic Coatings on Tin and Tin Alloys. R. Kerr and D. J. Macnaughtan (*J. Electrodepositors' Tech. Soc.*, 1937, 12, 19–25; and *Tech. Publ. Internat. Tin Res. Develop. Council, Series A*, 1936, (48), 7 pp.).—Deep blue black anodic films, which may be used in producing decorative effects, may be obtained by anodic treatment of tin or pewter in a solution containing sodium phosphate ($Na_2HPO_4,12H_2O$) 100 grm. and phosphoric acid (*d* 1·75) 20 c.c. per litre. The bath is operated at 90° C. with a current density of 30–40 amp./ft.^{2} using copper cathodes which are removed from the bath when not in use. The optimum results are obtained with a 6 minutes' treatment, which gives a film about 0·0001 in. thick which can be polished on a mop fed with lime to produce an ebony black effect. To obtain decorative effects, the parts which are required to remain bright are stopped-off with an oil paint which is subsequently removed by swabbing with trichloroethylene.
—A. R. P.

Cladding of Sheet [Iron]. L. Mayer (*Berg- u. Hüttenmann. Jahrb.*, 1936, 84, (2), 82–87; discussion, 87–88).—The preparation and properties of doublé iron and steel sheets with rolled-on coatings of brass, copper, nickel, and stainless steel are described.—A. R. P.

*The B.N.F. Jet-Test for Local Thickness Measurement of Nickel and Other Coatings. S. G. Clarke (*J. Electrodepositors' Tech. Soc.*, 1937, **12**, 1–18; and *Met. Ind.* (*Lond.*), 1936, **49**, (17), 419–422; discussion, (18), 445–446).—The method, which can be used for determining the local thickness of electroplates of nickel, copper, bronze, cadmium, and zinc on various basis metals, depends on the measurement of the time taken for a standard jet of corroding liquid dropping under a head of 10 in. to perforate the plate which is inclined at 45° to the vertical; the thickness of the coating is then read from a previously constructed time–thickness curve. The test takes only 2 minutes and is applicable to flat or curved surfaces giving results accurate to 15%. Appropriate corroding solutions for nickel, cadmium, zinc, and cadmium coatings are given together with the curves obtained at various temperatures of test and the effects observed at the end point with various basis metals.—A. R. P.

Precious Metal Coatings. Viktor Schwenk (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (2), 88–95).—The manufacture of doublé metal is described with especial reference to rolled gold, and brief notes on silver, gold, and rhodium plating are given.—A. R. P.

*Microchemical Surface Testing. M. Niessner (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (3), 105–108).—Porosity in tin- or zinc-plated copper may be detected by moistening the surface with ammonia and covering it with paper coated with gelatin containing dithio-oxamide, the pores being revealed by the development of greyish-green spots. For nickel-plated copper the test-paper should contain benzoinoxime which gives a green spot where the copper is exposed. Likely anodic areas in aluminium are detected by covering the metal with a paper impregnated with morin solution and then examining the paper in ultraviolet light, a greenish fluorescence being visible where aluminium ions have reacted with the morin.—A. R. P.

Discussion on Electro-Tinning. (Schlötter.) See p. 103.

†Theoretical Principles of Hot-Dip Galvanizing. H. Grubitsch (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (2), 47–54).—A critical review of the work of G. and others on the mechanism of the hot-dip galvanizing process, with 43 references to recent literature.—A. R. P.

Temperature of the Galvanizing Furnace. Wallace G. Imhoff (*Machinist* (*Eur. Edn.*), 1937, **80**, (53), 1077–1078).—Discusses the effect of temperature in the design of hot-dip galvanizing furnaces. Heat should be applied above the dross line and so as to give a steady temperature of not more than 900° F. (480° C.) at either the top or the bottom of the pot, and without the production of hot spots.—J. H. W.

Automatic Control Increases Wire Galvanizing Efficiency. L. E. Smith (*Indust. Gas*, 1936, **15**, (3), 17–19).—A gas-heated galvanizing plant is described.
—A. R. PE.

Galvanizing Kettle Heated by Gas-Fired Vertical Alloy Tubes. W. H. Spowers, Jr. (*Indust. Gas*, 1936, **15**, (2), 9–10).—The bath is heated by a series of vertical tubes inside the furnace walls, with burners at the top and exit to flues at the bottom.—A. R. PE.

Zinc Surfaces Protected by New Bonderizing Process. —— (*Indust. Gas*, 1936, **15**, (5), 23).—Describes a method of treating zinc surfaces to produce a phosphate coating.—A. R. PE.

Prevention of Corrosion in Aircraft. A. Eyles (*Machinery* (*Lond.*), 1936, **49**, (1259), 253–254).—A letter, making reference to the Parkerizing and Bonderizing processes for producing corrosion-resisting coatings on steel, and the Pylumin process for protecting aluminium. Figures are quoted for the life of cadmium and zinc coatings under the salt-spray test.—J. C. C.

The Principles of the Modern Theory of Corrosion and Corrosion Passivity and Their Application to the Problem of Surface Protection of Metallic Materials. Wolf Johannes Müller (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (2), 55–62).—A review of M.'s work and of the practical applications of his theories.—A. R. P.

The Schoop Metal Spraying Process. J. Friedli (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (2), 68–77).—A review describing the apparatus, preparation of the base metal for coating, properties of the coating, and methods of testing it.—A. R. P.

Report [on Metallization] Received from One of the Major Steel Companies. —— (*Metallizer*, 1936, **5**, (6), 2).—Tests showed that sprayed copper coatings 0·005 in. thick give protection to steel during the carburizing process; aluminium coatings were not so successful.—W. E. B.

Protection of Steel Bridges Against Brine Drippings [by Metal Spraying]. B. R. Meyers (*Metallizer*, 1936, **5**, (6), 5, 13).—Gives some details of the cost of spraying steel bridges with zinc, and suggests that the coating will overcome the trouble of brine drippings.—W. E. B.

Chlorinated Rubber as a Surface Coating Against Corrosion. G. Schultze (*Korrosion u. Metallschutz*, 1936, **12**, (9), 249–253).—The preparation, application, and value of paints with a basis of chlorinated rubber, a plasticizer, and a pigment are discussed. Aluminium powder is an excellent pigment for this type of paint and the resulting product adheres well to iron and steel, affording one of the best protective coatings yet known.—A. R. P.

Uses and Advantages of Aluminium Paints. Milton W. Lightcap (*Products Finishing*, 1936, **1**, (2), 38–39; *C. Abs.*, 1937, **31**, 889).—A review. The aluminium painting of Louvre fencing for water-cooling towers is given as an illustration.—S. G.

Spray Painting for the Protection of Metals. O. Th. Koritnig (*Korrosion u. Metallschutz*, 1936, **12**, (9), 241–245).—The application of paints, lacquers, and varnishes by various forms of spraying is described.—A. R. P.

*****The Practical Problems of Corrosion. IX.—Some Tests on Protective Painting. Final Report.** S. C. Britton and U. R. Evans (*J. Soc. Chem. Ind.*, 1936, **55**, (49), 337–341T).—The protective value of red lead, iron oxide, and lead chromate paints and of sprayed aluminium layers on various ferrous metals has been determined over a period of 6 years in London and in sea air. The results emphasize the importance of using as primer a coating containing an inhibiting pigment.—A. R. P.

VI.—ELECTRODEPOSITION

Recent Developments in Hard Chromium Plating. W. E. Bancroft (*Products Finishing*, 1936, **1**, (2), 30–37).—S. G.

Analytical Control of Chromium Plating Solutions. (Halls.) See p.105.

Alloy Plating (Cobalt–Nickel Alloy). George B. Hogaboom (*Products Finishing*, 1936, **1**, (1), 16–18; *C. Abs.*, 1937, **31**, 612).—Copper–zinc alloys of the same compositions have different colours when cast and when electrodeposited. An 80 : 20 copper–zinc alloy electrodeposited matches the colour of a 65 : 35 cast brass. Such conditions are found with nearly all metallic alloys. In electrodeposited nickel–cobalt alloys there is a slight difference in the physical properties but a remarkable change in lustre, which is far different from that obtained by the use of addition agents in any other single metal or alloy. The addition agent used in the plating solution is not occluded in the nickel–cobalt deposit. The alloy can be deposited on ferrous or non-ferrous metals and the deposited alloy is not affected by bending, forming or distorting the basis metal. The fine texture and ductility of the deposit exceed those obtained in the electrodeposition of many single metals and all alloys. The physical properties are better than those of dull or bright electrodeposited nickel or cobalt. The plating solution contains nickel chloride and formate, cobalt and ammonium sulphates and formaldehyde. The solution is used at

60° C. with a current density of 20–100 amp./ft.² without any change in lustre and yielding a deposit of 0·00002–0·002 in. The deposit is completely " active " and need not be activated previous to receiving a deposit of chromium. The undercoat of this bright nickel–cobalt alloy improves the colour of the chromium deposit.—S. G.

*The Rectification of Faulty Acid Copper Solutions. E. A. Ollard (*J. Electrodepositors' Tech. Soc.*, 1937, **12**, 35–43 ; and *Met. Ind.* (*Lond.*), 1936, **49**, (25), 613–616).—Most of the troubles encountered in using acid copper plating baths are due to contamination with colloidal organic matter or to accumulation of suspended impurities. The latter are removed by filtration and the former by saturating the bath with sulphur dioxide and running it for 6–8 hrs. at a high current density at 6 v. using scrap copper cathodes and lead anodes, so that the lead plates gas freely ; the scum which forms on the surface is carefully skimmed off and the bath should then operate satisfactorily. If the copper deposit is too soft addition of 0·5 grm. of phenol per litre will generally cure the trouble in a few hrs. The growth of micro-organisms in the bath is prevented by addition of sodium fluoride.—A. R. P.

*Brass Plating for Rubber Adhesion. Operation of the Plating Bath. H. P. Coats (*Monthly Rev. Amer. Electroplaters' Soc.*, 1937, **24**, (1), 5–25 ; discussion, 25–26).—Brass plating for rubber adhesion requires close control of the zinc : copper ratio ; adhesion is optimum for a zinc content of 24·4–33·6% in the plate. The zinc content of the plate is increased by increasing the zinc cyanide content of the bath, by increasing the p_H and by addition of nickel or arsenic to the bath, and is decreased by increasing the copper and sodium cyanide contents of the bath and by raising the temperature and current density. Addition of arsenic increases the current efficiency and addition of sodium cyanide reduces it. The best results are obtained with a bath containing cuprous cyanide 2·4, zinc cyanide 1·25, and free sodium cyanide 1·12 oz./U.S. gall. ; it has a p_H of 10·1 and is operated at 30° C. with a current density of 9 amp./ft.². Addition of 50 mg. of arsenic (as As_2O_3) per litre increases the cathode efficiency by about 40%.—A. R. P.

*The Electrodeposition and Properties of Black Lead Peroxide Coatings. S. G. Clarke (*J. Electrodepositors' Tech. Soc.*, 1937, **12**, 26–32).—Smooth black lustrous deposits of lead peroxide are obtained on metallic anodes from a solution containing 120 grm. of sodium hydroxide and 30 grm. of yellow lead oxide per litre at 40° C. using a current density of 3 amp./ft.² for 1–1½ hrs. In coating copper a preliminary " strike " at 20 amp./ft.² for a few seconds is necessary to render the metal passive. The presence of addition agents is detrimental. The deposit is hard and resistant to abrasion, but relatively brittle and tends to chip on impact ; the best adhesion is obtained if the surface to be coated is first sandblasted or plated with nickel or copper (unpolished). Coatings of 0·0005 in. thickness, when oiled to prevent staining, are very resistant to outdoor corrosion even in tropical or sea-air conditions. Above 290° C. the black coating is converted into red lead.—A. R. P.

Discussion on Electro-Tinning. Max Schlötter (*J. Electrodepositors' Tech. Soc.*, 1936, **11**, 183–190).—Alkaline stannate baths must be operated at 80° C., have a low cathode and anode efficiency, and require a high voltage. During operation the caustic alkali is converted into carbonate and part of the tin is precipitated as metastannic acid, so that the tin content of the bath requires frequent adjustment and the deposits become porous owing to deposition of the metastannic acid on the cathode. Recently an acid bath (composition and details of operation not given) has been developed which overcomes all these difficulties. In the tinning of wire and sheet power costs are about 7% of the value of the tin deposited, whereas in the hot-dipping process of tinning the loss of tin by oxidation is about 25% of that applied. Electro-tinned metal can readily be soft soldered, deep drawn, or twisted without flaking, and is fairly

resistant to sulphide tarnishing. Electro-tinned copper wire remains soft, since no intermediate bronze layer is formed as in hot tinning, but the deposit is not so firmly anchored to the copper and may contain electrolyte which reacts with a subsequently applied rubber sheathing.—A. R. P.

Aluminium Pickle " C." **An Aid to Faultless Electroplating of Light Metals with an Aluminium Basis.** —— (*Aluminium*, 1936, **18**, (11), 556–557). —The material is a white powder (nature not stated) 0·5 kg. of which is dissolved in 1 litre of water for use. Treatment of aluminium, Silumin, Duralumin, or other commercial aluminium alloys in this solution for 3 minutes is stated to produce a surface which can be plated directly with copper or brass or which can be polished to a highly lustrous, corrosion-resistant finish.—A. P.

The Evolution of Electrodeposited Coatings and of Plating Technique. Maurice Déribéré (*Pratique Ind. mécaniques*, 1936, **19**, (8), 299–311 ; 1937, **19**, (10), 387–390).—A review of recent developments, especially in nickel-plating practice, includes a potential series containing 18 metals. The preparation of steel, aluminium, copper, and zinc objects for nickel plating is described, and the design of the bath, the composition of the plating solution and methods of suspension and stirring are discussed. The final section deals with the production of thick deposits of nickel, and with the " Fescolizing " and " Allionizing " processes, the latter especially in connection with chromium deposits. Both processes are used in the building up of worn parts ; the results of wear tests on Fescolized and Allionized deposits are reproduced.—P. M. C. R.

Plating Non-Metallic Surfaces. P. Tree (*Machinist (Eur. Edn.)*, 1937, **80**, (52), 754E).—Very briefly describes the copper-plating of wood and other non-metallic surfaces.—J. H. W.

The p_H of Electroplating Solutions. Richard Springer (*Met. Ind. (N.Y.)*, 1936, **34**, (12), 473–476).—The use of " Peha " papers for determining the p_H of various plating solutions is described.—A. R. P.

Electroplating and the Surface Protection of Metal Articles. A. Wogrinz (*Berg- u. Hüttenmann. Jahrb.*, 1936, **84**, (2), 41–47).—A review of the principles and practice of electroplating.—A. R. P.

Equipment and Methods in the Plating Plant. Fred. W. Vogel (*Products Finishing*, 1936, **1**, (1), 9–14 ; *C. Abs.*, 1937, **31**, 612).—A review of (1) silver stripping ; (2) chromium, nickel, silver, and cadmium plating ; and (3) enamelling or lacquering.—S. G.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY
(Other than Electrodeposition.)

(Continued from p. 53.)

*Zinc and Zinc Amalgam Electrodes. William J. Clayton and Warren C. Vosburgh (*J. Amer. Chem. Soc.*, 1936, **58**, (11), 2093–2096).—The electromotive force of the cell $Zn(s)|Zn^{++}|Zn$ (saturated amalgam) is zero. The symbol $Zn(s)$ may be understood to stand for either a pure zinc electrode or a superficially amalgamated zinc electrode, these two having the same electrode potential.
—S. G.

Overvoltage. Graham Chen (*Sci. Rep. Nat. Univ. Peking*, 1936, **1**, (3), 1–11).—A review.—S. G.

The Current Supply of Large Electric Plants. G. Brehm and F. Knauth (*Siemens Rev.*, 1936, **12**, (4), 130–137).—4200 million kWh. are consumed annually in the electrochemical industry in Germany. B. and K. outline the electrical requirements of electrolytic operations, including voltage regulation under various conditions. The generation of current is discussed and the relative merits of motor generators, rotary converters, and rectifiers for the conversion of a.c. are considered.—R. Gr.

IX.—ANALYSIS

The Analysis of Copper–Nickel–Aluminium Alloys. Some Alternative Methods. J. Williamson (*Indust. Chemist*, 1936, **12**, (136), 204).—Details are given of methods of determining Cu, Al, Ni, Co, Mn, C, and Si in alloys containing Cu 4–6, Al 12–14, Ni up to 30, Mn, C, and Si up to 0·25%, remainder iron. Cu is determined iodometrically after precipitation with H_2S, Al as $AlPO_4$ by the usual $Na_2S_2O_3$ process in acetate solution, Ni by means of dimethylglyoxime in ammoniacal tartrate solution, Mn by the bismuthate process, C by combustion with Pb_3O_4, and Co by precipitation with α-nitroso-β-naphthol in 10% HCl after removing the $Fe^{···}$ with ZnO.—A. R. P.

The Analysis of Magnesium Alloys. W. H. Withey (*J. Soc. Chem. Ind.*, 1936, **55**, (51), 357–359).—The HCl solution of the alloy (1–1·5 grm.) is evaporated to dryness with twice as much $N \cdot H_2SO_4$ as is equivalent to the metals, other than Mg, present. The residue is extracted with industrial C_2H_5OH and the insoluble sulphates of Ca and Ce are collected, washed with C_2H_5OH, gently ignited and dissolved in 0·35N-HCl. The solution is treated with 1–2 grm. of NH_4Cl and sufficient $H_2C_2O_4$ to precipitate the Ce and leave 3 grm. of $H_2C_2O_4$ per 100 c.c. in solution. Ignition of the precipitate affords CeO_2 and treatment of the filtrate with NH_4OH gives CaC_2O_4 which is ignited to CaO for weighing. The alcoholic filtrate from the sulphates is evaporated to dryness, the residue dissolved in HCl and the Co precipitated with H_2S in the presence of $CH_3 \cdot CO_2NH_4$. Mn is recovered as MnS by adding NH_4OH to the filtrate together with $(NH_4)_2S$; it may eventually be determined colorimetrically or volumetrically by the bismuthate method or converted into $MnSO_4$ for weighing.—A. R. P.

Attempt at Quantitative Analysis of Silver–Gold Alloys by Optical Spectroscopy. Winifred Mankin (*J. Proc. Roy. Soc. N.S. Wales*, 1936, **70**, 95–99; *C. Abs.*, 1937, **31**, 628).—About 3 amp. of current at 250 v. was passed between C electrodes. A bead of Au–Ag alloy was placed in a depression at the lower pole. The arc was focussed on to the slit of a Hilger spectrometer, type D 1. A reducer of blue glass was placed in front of the spectrometer slit so that each spectrum would show an upper portion of reduced intensity and a lower portion of full intensity. On each photographic plate 4 photographs of arc spectra were taken and for calibration purposes a number of continuous spectra obtained from a 6 v. tungsten lamp. The intensities of the continuous spectra varied by known amounts, according to the width of the slit used. No definite relations could be found between relative intensities or corresponding lines and composition of the alloy. The pairs of lines selected for comparison were 4669–4241; 5465–4793; 5472–4811; the first number in each pair is the wave-length of the Ag line and the second of the Au line.—S. G.

Analytical Control of Chromium-Plating Solutions. E. E. Halls (*Metallurgia*, 1937, **15**, (88), 105–107).—The analytical control of Cr-plating solutions is discussed from the point of view of (1) the total CrO_3 content, (2) H_2SO_4 content, and (3) trivalent Fe and Cr (present probably as dichromates). Several methods of evaluating these quantities are described, and it is stated that alternatives are only given when they are justified. As regards trivalent Fe and Cr, information on the extent to which salts of these elements exist in solution can only be obtained by their separate estimation, but the extent to which they depress the effective CrO_3 content can be determined by determining the two together as oxides, and although this is an approximation, the error introduced is small and negligible for practical purposes as the equivalents of the metals are very close to each other.—J. W. D.

I

A Rapid and Accurate Method for the Determination of Chromic Acid and Trivalent Chromium in Chromium Plating Solutions. R. B. Saltonstall (*Products Finishing*, 1936, 1, (1), 26–29; *C. Abs.*, 1937, 31, 629).—*Determination of chromic acid.*—Dilute 5 ml. of the Cr plating solution to 100 ml. To 5 ml. of the diluted solution in a 250-ml. Erlenmeyer flask, add 100–150 ml. of H_2O, 2–4 ml. concentrated H_2SO_4, 1 drop o-phenanthroline–ferrous–complex indicator solution and titrate with a standard solution of Mohr's salt until, after turning from reddish yellow to light green, the colour changes sharply from light green to pink or violet. At the same time determine the strength of the Fe^{++} solution by titrating with standard $Ce(SO_4)_2$ solution. *Determination of trivalent chromium.*—This value is obtained by determining the total Cr after oxidation with $(NH_4)_2S_2O_8$ in the presence of Mn^{++} and Ag^+, reducing the MnO_4 formed and precipitating Ag^+ with HCl, and titrating as above.—S. G.

*The Application of the Logarithmic Sector to Corrosion Problems. (Burke.) See p. 99.

*A New Highly Sensitive Drop Reaction for Cerium. Leonid Kuhlberg (*Mikrochemie*, 1936, 21, (1), 35–37).—The solution is treated with $K_4Fe(CN)_6$, KCN, and NaOH to alkalinity, and the precipitate is collected, washed, exposed to the air for a short time and then dissolved in a 1% solution of leuco-malachite green in 2% H_2SO_4; a green colour appearing after a short time indicates Ce.—A. R. P.

*A New Method for the Separation of Yttrium from Yttrium Earths. H. C. Fogg and Lewis Hess (*J. Amer. Chem. Soc.*, 1936, 58, (9), 1751–1753).—S. G.

*An Improvement in the Method for the Determination of Aluminium in the Presence of Iron. Saburô Ishimaru (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, 25, (4), 780–784).—[In English.] The present methods for the separation and determination of Al in presence of various amounts of Fe leave much to be desired as regards accuracy and ease of manipulation and speed. I. reviews the 4 known methods, discusses their application, and proposes a new procedure. The slightly acid solution is treated with $Na_2S_2O_3$ (Chancel's method) and then cooled as quickly as possible to room temperature; the alcoholic solution of $C_6H_5NH\cdot NH_2$ (1 : 1) is added (Hess and Campbell's method), filtered and the washed precipitate is ignited to Al_2O_3. The results obtained (only a single separation) show that the procedure is good.—S. G.

*A Rapid Method for the Determination of Antimony in Lead-Rich Alloys. K. Stanford and D. C. M. Adamson (*Analyst*, 1937, 62, (730), 23–28).—The alloy (1 grm.) is fused with 5 grm. of $KHSO_4$, the melt dissolved in a mixture of concentrated HCl 10, H_2SO_4 (d 1·8) 30, and H_2O 200 c.c., and the solution boiled, cooled to 5°–10° C. and titrated with $KMnO_4$ without an indicator or at 60° C. with methyl orange as indicator.—A. R. P.

*On the Microdetermination of Antimony, Arsenic, Iodide, and Thiocyanates by Direct Titration with Potassium Iodate. I. M. Korenmann and Z. A. Anbroch (*Mikrochemie*, 1936, 21, (1), 60–67).—The solution (10 c.c.) of $SbCl_3$ or $AsCl_3$ is treated with 5 c.c. of HCl (d 1·16), and 5 c.c. of $CHCl_3$ or CCl_4 and titrated with vigorous shaking with $0.01N\text{-}KIO_3$ until the upper layer becomes colourless; 1 c.c. of $KIO_3 = 0.6088$ mg. Sb or 0·3748 mg. As.—A. R. P.

*Modifications of the Gutzeit Method for the Determination of Arsenic. H. E. Crossley (*J. Soc. Chem. Ind.*, 1936, 55, (38), 272–276T).—A modified apparatus is described in which the moisture content of the test paper is controlled by means of a water-cooled condenser. The optimum temperature for the generation of AsH_3 is 20° C., about 45 minutes being required in the usual test if not more than 12 μg. of As is present.—A. R. P.

*Determination of Bismuth as o-Nitroquinoline Bismuth Iodide. G. Canneri and D. Bigulli (*Annali Chim. applicata*, 1936, 26, (10), 455–460).— The sulphate solution containing 0·01 grm. of Bi in 30 c.c. and 3% of free H_2SO_4 is treated with 10 drops of 10% SO_2 solution and 3 c.c. per 30 c.c.

volume of a solution containing 2·5 grm. of *o*-nitroquinoline and 1·3 c.c. of H_2SO_4 per 100 c.c.; $0·02N$-KI solution is then added drop by drop with constant stirring 6 c.c. being required for every 0·01 grm. of Bi. The precipitate of $C_9H_6N_2O_2\cdot HBiI_4$ is collected in a porous crucible after ⅓ hr., washed with a dilute solution of the precipitants, dried at 105° C. and weighed; it contains 26·13% Bi. Alternatively the precipitate may be dissolved in 10% HCl and the solution titrated with $KBrO_3$.—A. R. P.

Electroanalysis with Small Quantities of Substances [Determination of Copper, Gold, and Mercury]. Fr. Hernler and R. Pfeningberger (*Mikrochemie*, 1936, **21**, (1), 116–130).—Details are given for the micro-electrolytic determination of Cu by deposition from sulphate, nitrate, cyanide, and ammoniacal solutions, of Au by deposition from cyanide solutions, and of Hg by deposition from nitrate solutions.—A. R. P.

*Colorimetric Method for the Determination of Germanium. I. P. Alimarin and B. N. Ivanov-Emin (*Mikrochemie*, 1936, **21**, (1), 1–10).—The Ge is separated from other metals by distilling the solution in a current of Cl_2, the distillate is decolorized with $NaHSO_3$ and, after adjusting the acidity to $6N$-HCl, saturated with H_2S, and the GeS_2 precipitate is collected, washed, and dissolved in NaOH and H_2O_2 (free from SiO_2 and P_2O_5). The solution is boiled to destroy H_2O_2, treated with 5% of $(NH_4)_2MoO_4$, and acidified with HNO_3 to $0·15–0·35N$; the yellow colour of the germanomolybdate produced is then compared with that of a standard.—A. R. P.

Determination of Iron in Nickel–Chromium and Nickel–Chromium–Iron Alloys. Fred P. Peters (*Chemist-Analyst*, 1937, **26**, (1), 6, 7, 9, 10, 15).—The method depends on the oxidation of the Cr to CrO_3 by evaporation with $HClO_4$, separation of the $Fe^{···}$ with NH_4OH, and titration of the Fe with $KMnO_4$ after reduction with $SnCl_2$. Alternatively, the Cr may be oxidized to CrO_3 by boiling the H_2SO_4 solution with $K_2S_2O_8$, the Fe and Ni then precipitated with NaOH, and the bulk of the Ni separated by precipitating the Fe with NH_4OH and NH_4Cl; the analysis is then finished as above.—A. R. P.

*Studies of the Reducing Action of Mercury. II.—Stability of Quinquivalent Molybdenum Solutions. A Method for the Determination of Molybdenum by Reduction with Mercury and Titration with Ceric Sulphate. N. Howell Furman and W. M. Murray, Jr. (*J. Amer. Chem. Soc.*, 1936, **58**, (9), 1689–1692).—S. G.

*A New Method for the Indirect Volumetric Determination of Nickel. Saburô Ishimaru (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [ii], **Honda Anniv. Vol.**, 493–500).—[In English.] No reliable method has been published for the indirect volumetric determination of Ni using dimethylglyoxime as a special reagent. I. describes a new procedure. After decomposing dimethylglyoxime liberated by the treatment of the Ni oxime precipitate with dilute H_2SO_4, using a known excess of $10N$-$K_2Cr_2O_7$ solution, the excess amount may be determined by the $FeSO_4$–$KMnO_4$ method or titrated back potentiometrically with the $FeSO_4$ solution in the usual way. In this procedure it is found that 1 c.c. $10N$-$K_2Cr_2O_7$ solution $= 0·00024_0$ grm. as Ni. The representative method is found to give satisfactory results if the Ni oxime precipitate amounts to less than 20 mg. in the case of the $FeSO_4$–$KMnO_4$ method and not more than 100 mg. in the potentiometric titration with the $FeSO_4$ solution calculated as Ni, respectively; however, a much higher concentration in the standard $K_2Cr_2O_7$ solution, such as $N5$, cannot be recommended.—S. G.

*Spectrographic Determination of Platinum by the Constant Pair Method [in Dental Alloys]. James J. Manning and James Coull (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1937, **9**, (1), 28–29).—The alloy (1 grm.) is dissolved in *aqua regia* and the solution diluted to 25 c.c.; several portions of 5 c.c. are then treated with an equal volume of Mo solutions containing various known weights of Mo and 2 drops of the different mixtures are spectrographed on graphite electrodes the intensities of the lines Pt 2893·8 and Mo 2871·5 being

compared. Adjustment of the amounts of Mo is made until the intensities of the two lines are equal. The concentration of the two metals is then equal.
—A. R. P.

*The Electrolytic Precipitation of Divalent Ytterbium. Alfred Brukl (*Angew. Chem.*, 1937, **50**, (3), 15–21).—Electrolysis of sulphate solutions containing Yb and 50 grm./litre of free H_2SO_4 affords almost complete deposition of the Yb as the insoluble green divalent sulphate at a Hg cathode using 5 amp./dm.² Completion of the precipitation is obtained by addition of freshly precipitated $SrSO_4$. The method may be used for separating Yb from Tm and Lu as well as for determining the metal in a mixture of yttria earth metals. The green colour of the reduced solution affords a rapid method for detecting Yb.—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from p. 58.)

A **Metallographic Microscope of Exceptional Power.** F. F. Lucas (*Bell Lab. Record*, 1936, **15**, (4), 103–107).—L. gives a brief illustrated account of his new equipment, capable of critical work up to × 7000. Monochloronaphthalene immersion objectives and very long camera extensions (with a low-power projection lens) are employed. The complete apparatus is 12 ft. long. The illuminating system, mounted on a separate stand, allows carbon or mercury arc lamps or a spark generator to be used. Photomicrographs showing carbide particles in steels are reproduced.—J. C. C.

Small Refractory Crucible for Laboratory Work. M. Riddihough (*Iron Steel Ind.*, 1937, **10**, (5), 5).—In a description of a simple and rapid method for the manufacture of small laboratory crucibles, R. deals with the type of mould used, preparation of the refractory mixture, and method of filling the mould. A formula is given for calculating the porosity of the crucibles, and also of various mixtures of varying grades of fused crushed alundum with flour suitable for crucibles, together with their approximate firing temperatures and porosities.—J. W. D.

*A **Simple Apparatus for the Measurement of Thermal Expansion.** J. W. Bampfylde (*Bull. Brit. Cast Iron Res. Assoc.*, 1936, **4**, (10), 389–390).—In this apparatus a specimen of length 2 in. is heated in a small resistance furnace, one end being in contact with a fixed, and the other with a movable, silica tube. The expansion is read by means of a measuring microscope.—W. H.-R.

A **Thermal Extensometer.** I. Polevoy (*Tech. Physics U.S.S.R.*, 1936, **3**, (11), 973–981).—[In English.] The principle of the electrical tele-extensometer described is as follows : A metallic rod covered with thin copper wire is connected at one end to a support. It is heated by a current until its other end just touches a contact piece. From a measurement of the resistance of the heating wire its temperature is determined. Constructional details are given. The sensitivity of the device is of the order 4 μ per 1 ohm change of resistance.—J. S. G. T.

*The **Automatic Description of Magnetization Curves.** W. Steinhaus and E. Schoen (*Physikal. Z.*, 1937, **38**, (1), 1–5).—Apparatus is described, comprising a super-aperiodic damped galvanometer and a rotating potential divider for providing cyclic variation of the magnetic field to the specimen investigated, designed to produce photographic reproduction of undistorted hysteresis curves in a few seconds or minutes. The device can be applied to obtain the hysteresis curves of materials of high permeability in the region of initial permeability as well as those of nickel–aluminium steels in the region of saturation.—J. S. G. T.

Instruments for the Measurement of the Quantities of Liquids, Gases, and Vapours. —— Netz (*Anz. Masch.*, 1936, **58**, (94), 29–32).—Standard types of apparatus for measuring the absolute quantities and rates of flow of liquids, gases, and vapours are described.—B. Bl.

A Practical Mirror Stereoscope for X-Ray Examination. C. D. Moriarty (*Gen. Elect. Rev.*, 1936, **39**, (11), 523–525).—A brief description of a practical mirror stereoscope suitable for examining stereoscopic radiographs.—S. V. W.

An X-Ray Spectrograph with a Curved Crystal. B. Borisow and J. Fogel (*Tech. Physics U.S.S.R.*, 1936, **3**, (11), 997–1004).—[In English.] Describes an X-ray spectrograph employing a curved crystal, whereby the necessary time of exposure is reduced, and not requiring adjustment of the crystal- and film-holders.—J. S. G. T.

The Focussing of X-Rays, Analogous to Focussing with a Converging Lens. W. Arkharow (*Tech. Physics U.S.S.R.*, 1936, **3**, (10), 905–912).—[In German.] The Seemann–Bolin and Hulubei–Rogosinski or Brentano methods of focussing X-ray spectral lines are briefly described and A.'s method, which combines these two methods, is discussed.   Preliminary results obtained by employing, as diffracting surface, a concave hemispherical zinc surface deposited on iron are briefly referred to.   It is suggested that the device is especially adapted to the investigation of the structure of very thin films.—J. S. G. T.

*The Electron Mirror. G. Hottenroth (*Z. Physik*, 1936, **103**, (7/8), 460–462).—It is shown that it is possible to devise an arrangement for reflecting electrons which can be employed in much the same way as the electron lenses hitherto used in the electron microscope.—J. S. G. T.

XI.—PHYSICAL AND MECHANICAL TESTING, INSPECTION, AND RADIOLOGY

(Continued from pp. 58–59.)

Recommendations for Leaded Gun-Metals.   The Most Suitable Type of Test-Bar. H. J. Roast (*Met. Ind.* (*Lond.*), 1937, **50**, (6), 189–191).—A discussion of results obtained by R. on test-bars of G.M.2 alloy, using the " cast to size " bars suggested by the Non-Ferrous Sub-Committee of the Technical Committee of the Institute of British Foundrymen, and on a " keel-bar." It is claimed that the keel-bar gives more consistent results.—J. E. N.

*Fatigue Bending and Tension-Compression Testing.—II. G. Welter (*Wiadomości Instytutu Metalurgji i Metaloznawstwa* (*Warszawa*), 1936, **3**, (4), 189–198). —[In Polish, with German summary.]   A new machine for fatigue tension-compression testing is described and clearly illustrated by diagrams and photographs.   Particular emphasis is laid on the design of the stainless steel guide-collar into which the specimen under test is fitted, since this has an important influence on the experimental results.   The test-piece is made as short as possible and is firmly fitted into the strong guide-collar so that lateral effects are completely prevented and the stress applied is exclusively axial. The collar is so constructed that the specimen may easily be tested at different experimental temperatures or in different media, so that the influence, for example, of corrosion or oxidation may be determined.   It is concluded that this method of testing is in many respects superior to fatigue-bending tests, since the latter are much more sensitive to surface effects which may give rise to erroneous results.   A series of experiments performed with this machine on steels and Duralumin gave duplicate results agreeing always within $\pm 30\%$, while in most cases the agreement is very much closer.—P. W. R.

*Some Measurements in the Region of the Elastic Limit of Soft Steel. G. Welter (*Wiadomości Instytutu Metallurgji i Metaloznawstwa* (*Warszawa*), 1936, **3**, (4), 199–204).—[In Polish, with German summary.]   Experiments were

performed on soft steel specimens to determine the influence on the stress–strain diagram of the experimental arrangement for loading and force measurement, and the rate of flow of the specimen during yielding. Elastic loading attained by the interposition of a strong coil-spring between the test-specimen and the loading apparatus caused the disappearance of the typical peak at the yield-point on the stress–strain curve, the stress increasing continually even during the yielding of the specimen.—P. W. R.

*On an Approximate Method for Determination of Stress Distribution in Machine Parts by Means of Creep of Metals. Etuji Takahashi (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 1069–1077).—[In English.] T. used the creep of a soft metal for the determination of stress distribution in a body. A model made of a soft metal is subjected to external force imitating actual conditions for a definite time. Permanent strains due to creep are measured at various parts of the specimen, and percentage deformations with reference to the original gauge-length are thus calculated. Comparing these results with amounts of creep of the same metal, previously determined, the intensities of stresses acting at various parts of the specimen can be estimated. Some examples are discussed.—S. G.

*The Determination of Young's Modulus by Flexural Vibration. G. Grime and J. E. Eaton (*Phil. Mag.*, 1937, [vii], 23, (152), 96–99).—A method is described for determining Young's modulus from the frequency of flexural vibration of a prism. For commercial lead at $18°$ C. the value (lb./in.^{2}) obtained is $2\cdot63 \times 10^6$.—W. H.-R.

*The Effect of the Shape of the Test-Piece on the Energy Needed to Deform Materials in the Single-Blow Drop Test. Owen W. Ellis (*Trans. Amer. Soc. Metals*, 1936, 24, (4), 943–964; discussion, 964–966).—In continuation of previous work (*J. Inst. Metals*, 1934, 54, 145), E. has investigated the energy (E) needed in the single-blow test to deform cylinders, frusta, and cones of equal height and volume of copper and nickel, and has examined the mode of deformation of the test-pieces. Graphs are given, showing the relationship between the percentage reduction in height (D) and the ratio of the smaller to the larger diameter of frusta of copper and nickel samples of respective heights 1 in. and $0\cdot5$ in. The experiments with nickel show that E is related to D by an equation of the form $E = bD^n$, when b is a parameter derivable from a single-drop test. This equation is similar to that found by E. for straight carbon steels; n is related to $\log b$ by the linear equation $n = 1\cdot55 - 0\cdot52 \log b$. This relation of E to D applies to cylinders, cones, and conic frusta of equal volume. It applies to steel and nickel at all temperatures, to copper, lead, and possibly aluminium at room temperatures, but does not apply to cadmium, tin, and brass. The examination of etched sections of deformed nickel samples suggests that the energy absorbed in the formation of the " ovoidal segment " becomes proportionally greater as the forging temperature is reduced and as the energy of the blow is reduced.—J. S. G. T.

*Law of Similarity in Impact Test-Piece. Ryônosuké Yamada and Yôzô Matuoka (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 1031–1040).—[In English.] The law of similarity in the Charpy impact test-piece with the Mesnager notch was studied on steels. It was found that the absorbed energy E is represented, where the radius of the notch is constant, by the formula $E = cbh^2$, where b is the breadth and h the height at the bottom of the notch of the test-piece. The impact value of a material is represented by c ($= E/bh^2$, mkg./cm.^{3}), which depends on the material only and not on the dimensions of the test-piece. The formula is found to be applicable for steels with a sorbitic structure.—S. G.

A Machine for Testing Enamelled Wire. H. H. Staebner (*Bell Lab. Record*, 1936, 15, (3), 76–80).—A description is given of a testing machine for recording both the number of pinholes and the enamel strength (hardness, toughness,

and adherence) of enamelled copper wire.   Pinholes and insulation defects are
detected and automatically recorded as the wire is passed without stretching
between two electrically charged rollers.   The strength of the insulation is
determined by measuring the length of wire which is scraped bare by a ground
sapphire edge under an observed pressure.   The pressure under which 10%
of the wire is scraped bare is found to represent a useful measure of the quality
of the enamel and is related to the degree of baking.—J. C. C.

Calorimetry of a Hot Wire.   H. Duculot (*Bull. Assoc. Ing. Élect. Liége,*
1936, **16,** 204–219 ; *Sci. Abs.,* 1937, [A], **40,** 66).—A calorimeter is described in
which measurements are made of the heat communicated to the air from
electrically-heated wires composed of a large number of different metals.   The
wires are all of the same size and each is heated for periods of 15 seconds by
steady currents whose values are gradually increased until fusion occurs.   The
energy supplied is measured, and the proportion lost by radiation and con-
vection determined in each experiment.   Tests are also made in which the
length of wire is gradually increased.   In this way information is obtained as
to the loss by conduction to the electrodes, and the length of wire needed before
such loss becomes negligible is determined for each material.   For the purpose
of obtaining information as to the additional loss occurring from fuse wires in
contact with insulators, tests are carried out with various lengths of the wire
surrounded by discs of mica.   As the length in contact with mica is increased
the time taken for fusion to occur when a fixed current is passed increases.
—S. G.

*Note on the Use of the Lloyd–Fisher Square for Permeability Measurements.
C. E. Webb and L. H. Ford (*J. Sci. Instruments,* 1936, **13,** (12), 386–392).—
An examination is made of the errors involved in the measurement of normal
and incremental permeability on strips assembled in the Lloyd–Fisher square,
as used for total loss testing.—W. H.-R.

XII.—TEMPERATURE MEASUREMENT AND CONTROL

The Photoelectric Pyrometer.   W. R. King (*Gen. Elect. Rev.,* 1936, **39,** (11),
526–533).—The theory of operation, apparatus, and calibration of the pyro-
meter are discussed.   It is necessary to calibrate the instrument in position
and this makes it best suited to applications where it can be permanently
installed for the purpose of giving a continuous record or indication of the
temperature.   The fundamental accuracy is dependent on the accuracy of the
temperature-measuring device used in making the one-point calibration.
Assuming this to be correct, from a consideration of other factors $\pm$ 10° F. is
given as a reasonable figure for the accuracy obtainable.—S. V. W.

*A Thermionic Relay Circuit for A.C. or D.C. Supply for Use with a Thermo-
regulator.   P. L. Temple (*J. Sci. Instruments,* 1936, **13,** (12), 414–415).—An
improved form of valve relay is described for control of a thermoregulator.
It is a simplified form of the circuit of Folley and Temple (*J. Sci. Instruments,*
1935, **12,** 392), and is designed to minimize both the current consumed and
the current across the thermoregulator contacts.—W. H.-R.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

Pistons Made of Several Light Alloys by Casting One on the Other.   ——
(*Anz. Masch.,* 1936, **58,** (99), 2–3).—Diesel motor pistons are cast out of two
alloys in such a way that the centre of the bottom of the piston consists of

copper–aluminium alloy and the outer mantle consists of silicon–aluminium alloy.—B. Bl.

*The Influence of the Alkaline Earth Metals on Silumin. (Czochralski and Kaczyński.) See p. 85.

Lead in Silicon–Bronze May Cause Trouble. N. K. B. Patch (*Foundry*, 1937, 65, (1), 34–78).—The presence of lead in silicon–bronzes may lead to the formation of hard spots of lead silicate. Lead should therefore not be added to silicon–bronzes in the hope of improving machining properties. Machining by methods and tools used for steel is the most successful.—J. E. N.

The Melting of Platinum. C. M. Hoke (*Met. Ind. (N.Y.*), 1936, 34, (12), 468–470).—The use of the oxy-hydrogen torch and of the Ajax–Northrup induction furnace for melting platinum and its alloys is described.—A. R. P.

Future Possibilities of Die-Casting with Zinc Alloys. Herbert Chase (*Machinery (Lond.*), 1936, 49, (1259), 249–251).—Die-castings can be made to more complex forms and closer dimensional limits than stampings and can sometimes replace welded assemblies. Radiator grills and " Zipp " fasteners are examples of parts now produced by die-casting. The use of die-castings as inserts or as cores to strengthen plastic mouldings is discussed.—J. C. C.

XV.—FURNACES AND FUELS

Constructing Brass Furnaces. —— (*Foundry*, 1937, 65, (1), 27, 78).—A brief description, with dimensions, of the construction of pit furnaces suitable for crucible melting of copper alloys, using natural draught.—J. E. N.

On Foundry Furnaces. Erich Becker (*Feuerungstechnik*, 1936, 24, (11), 191–196).—Different types of furnace for core-drying and for melting and heat-treatment of ferrous and non-ferrous metals and castings are discussed with special reference to German practice.—A. R. PE.

Combustion Chamber Design for Industrial Furnaces. M. H. Mawhinney (*Indust. Heating*, 1936, 3, (9), 563–566, 596).—Data are developed from which limitations may be applied by the furnace designer to the factors which influence the speed of combustion. Their specific application is to the design of over-fired furnaces having a perforated arch between combustion and heating chambers, and of underfired furnaces in which the combustion chamber is below the heating material. The conclusions reached include the following : all the heat losses from the combustion chamber depend on the temperature of the latter ; wall conduction is of minor importance ; the area of openings is of major importance in fixing the chamber temperature ; the rate of heat liberation in the chamber should not exceed 7 to 10 B.Th.U./ft.^{3}/second or 400 B.Th.U. per in.^{2} of slot.—W. A. C. N.

A Gas-Serviced Brass Foundry Now Handles Ferrous Metals. J. B. Nealey (*Indust. Gas*, 1936, 15, (5), 10–12).—Gas-fired furnaces are used for melting copper, bronze, nickel, Monel metal, and iron and steel alloys.—A. R. PE.

Redesigning an Old Furnace Gives Customer Satisfaction. S. T. Olinger (*Gas Age-Record*, 1937, 79, (1), 37–38).—Describes improvements to a furnace used for annealing brass stampings.—A. R. PE.

Recent Developments in the Gas Furnace Industry. H. M. Heyn (*Indust. Gas*, 1936, 15, (4), 14–16).—A discussion of different types of atmosphere-control for heat-treatment furnaces.—A. R. PE.

Electric Furnaces for Aluminium. A. J. Gibbs Smith (*Metallurgia*, 1937, 15, (87), 85–86).—A description of a 10-cwt. induction furnace used in the melting of aluminium and metals and alloys of low melting point. S. deals with the general construction of the furnace and its manipulation. Furnace linings are stated to have a minimum life of 3000 heats, and an output of 7 cwt. of

aluminium per hour is obtained. Comparison figures are given for the melting losses, cost of energy or oil, repairs, and depreciation for this furnace and an oil-fired furnace, and show for the induction furnace a melting loss of 0·8% as against 1·5% in the oil-fired furnace, and also a considerable reduction in total melting costs.—J. W. D.

The Electric Furnace : Its Influence on Civilization. P. H. Brace (*Metal Progress*, 1937, **31**, (2), 184–186, 188, 194).—A short historical survey of the development of the electric furnace is followed by brief accounts of the discovery, properties, and principal applications of aluminium, beryllium, magnesium, chromium, and calcium carbide ; reference is also made to the sintering of metallic powders, the bright-annealing process and copper brazing.
—P. M. C. R.

The High-Frequency Induction Furnace. M. Naruse (*Nenryo Kyokwai Shi* (*J. Fuel Soc. Japan*), 1936, **15**, 77–78).—[In English.] A review.—S. G.

German Metal Working Practice. Progress in Production Methods and Equipment. —— (*Met. Ind. (Lond.)*, 1937, **50**, (4), 139–140).—A brief review of recent progress in gas welding of light metals, the use of solid carbon dioxide in foundry practice, and new materials for press tools. A new German crucible furnace for melting magnesium alloys is briefly described with the aid of a diagram. The capacity of the furnace is 150 lb. of metal and consumption about 37 kw.—S. G.

*The Regulation of Temperature in Electric Resistance Furnaces. Manfred Melzer (*Arch. Elektrotech.*, 1936, **30**, 398–409 ; *C. Abs.*, 1937, **31**, 322).—The theory of the subject is developed. Experiments were carried out to check the results of calculations ; a platinum resistance furnace designed for temperatures up to 1350° C. was used. Runs were made from 300° to 900° C., and 400 to 1400 w.—S. G.

History and Development of Mond Gas for Industrial Purposes in South Staffordshire. H. A. Humphrey (*J. Inst. Fuel*, 1936, **10**, (50), 95–104).—The use of Mond gas for annealing and other purposes is described.—A. R. Pe.

*Combustion Control by Means of Electrical Meters. V. Binns and S. Bairstow (*J. Inst. Fuel*, 1936, **10**, (50), 79–85).—Methods for determining carbon dioxide, hydrogen, oxygen, and carbon monoxide in flue gases by thermal conductivity are described.—A. R. Pe.

†*Further Notes on Sampling Analysis, with Application to Coal. M. C. Holmes and Richard Downs (*J. Franklin Inst.*, 1936, **222**, (3), 337–343).—H. and D. do not accept as satisfactory the cardinal principle relating to sampling contained in the code of the " A.S.T.M. Standards on sampling coal and coke " (Sept. 1934). Data contained in a paper by Monroe and Proctor (*Amer. Inst. Min. Met. Eng. Tech. Publ.* No. **645**, 1935) are analyzed in accordance with H. and D.'s theoretical equation (*J. Franklin Inst.*, 1935, **219**, 483), and the advantage of using small sized increments is clearly brought out. By using smaller sized increments, the same sampling accuracy is obtained with less coal, less trouble, less cost. Chemical analysis showed that results obtained with small, crudely-selected 11-lb. and 4-lb. samples agreed reasonably well with those from large 1000-lb. samples. A re-examination of coal-sampling methods is desirable.—J. S. G. T.

XVII.—HEAT-TREATMENT

Heat-Treating Equipment at Consolidated Aircraft Corp. C. F. Olmstead (*Metal Progress*, 1937, **31**, (1), 53–55).—The construction and grouping of the heat-treating units of an important aero construction plant are described. Duralumin is treated in a liquid bath of sodium and potassium nitrates, heated

by gas burners directed into distributing ducts. A small gas-fired furnace is provided for engine mounts, a second for the heat-treatment of miscellaneous small parts, and an electric furnace is used for tempering. The selection and installation of refractory linings are described.—P. M. C. R.

*Experiments on Electrothermal Treatment of Thin-Walled [Chromium–Molybdenum] Tubes. Ts. N. Rafalovich and F. N. Vdovin (*Teoria i Praktika Metallurgii*, 1936, (9), 64–72; *C. Abs.*, 1937, **31**, 322).—[In Russian.] The chromium–molybdenum tubes were treated by passing an electric current through them. The best mechanical properties and microstructure are obtained by heating for 1 minute at 900°–920° C.—S. G.

XVIII.—WORKING

(Continued from pp. 63–64.)

Some Factors which Influence the Production of Seamless Tubes. Gilbert Evans (*Metallurgia*, 1937, **15**, (87), 87–88).—The manufacture of seamless tubes is discussed from the point of view of the necessity for soundness of materials in slabs and billets, intensive testing and inspection, and examining for internal defects. A low-power microscope designed for the internal inspection of long lengths of steam, condenser, and other tubes is illustrated, and two applications of it are shown and some indication of the field covered is given.—J. W. D.

Plastic Deformation. See pp. 79–80.

*Properties of Aluminium Sheet. (Horiguchi.) See p. **73**.

American Metal Working Practice. A News Review of Production Methods. —— (*Met. Ind. (Lond.)*, 1937, **50**, (1), 11–12).—The production of aluminium foil by the Hazelett process, vacuum pouring for the extrusion of lead sheath, rolling and ball burnishing, and a new rocking arc furnace are briefly dealt with.—S. G.

Working of Non-Ferrous Metals by Hydraulic Presses. Ernst Trebesius (*Anz. Masch.*, 1936, **58**, (94), 22–23).—The operation of the Dick press is described.—B. Bl.

The Metallurgical Aspect of the Fourdrinier Wire. H. H. Parrett (*Papermakers' Assoc. Great Britain, Tech. Section, Advance Proof*, 1936, 4 pp.).—Wire screens for papermaking machines are prepared from phosphor–bronze (7% tin) warp wires and α-brass weft wires. To obtain satisfactory weaving both wires must be fully and uniformly annealed without allowing the grains to become too coarse. The methods used in weaving the screens are described and reasons for obtaining faulty screens are discussed.—A. R. P.

Production of Ornamental Stampings. Nickel Silver Buttons and Badges. —— (*Met. Ind. (Lond.)*, 1937, **50**, (7), 211–212).—A brief account of the sequence of operations in the manufacture of embossed metallic buttons and badges.—J. E. N.

Machining of Light Metals. H. Klein (*Leichtmetall*, 1936, (3), 1–4).—The differing behaviour of pure aluminium, its hard alloys, Silumin, and magnesium alloys is discussed, and recommended technique (tool angles, cutting speeds, &c.) is given for turning, drilling, countersinking, reaming, tapping, milling, sawing, filing, and grinding.—H. W. G. H.

Free-Cutting Aluminium Alloys. —— (*Metallurgist* (Suppt. to *Engineer*), 1936, **10**, 190–191).—A review of recent work in Germany.—R. G.

Drilling Tests with Machine Brass and Various Aluminium Alloys. Eugen Vaders (*Z. Metallkunde*, 1936, **28**, (12), 389–390).—Machine brass drills more readily than the aluminium-base alloys Heddur, Tordal, and Pantal when new sharp drills are used, but as the drills become blunted the rate of drilling of

brass decreases much more rapidly than that of the aluminium alloys so that the latter are much more readily drilled than is brass with an old drill.

—A. R. P.

Metal Cutting and the Selection of Cutting Fluids. —— (*Lubrication*, 1936, **22**, (11), 121–132; (12), 133–140).—The special functions of lubrication and cooling are considered in connection with the various types of cutting operations, and the influence of the fluid on finish, the prevention of corrosion, and the life of tools is reviewed. Modern cutting fluids are classified, and a table summarizes proprietary types of oil suited to various operations and materials. The handling, storage, and reconditioning of cutting fluids are discussed, and a concluding section deals with the prevention of infection among workers.

—P. M. C. R.

XIX.—CLEANING AND FINISHING

Evacuation of Acid Vapours in Metal Pickling Shops. —— (*Anz. Masch.*, 1936, **58**, (87), 2–3).—The air removed from above the pickling vats is passed through a packed stoneware tower in which it is countercurrently washed with water and the wash water is then neutralized with lime in a special chamber.

—B. Bl.

*****The Colouring of Aluminium and Its Alloys with Inorganic Materials by the M.B.V. Process.** W. Helling and H. Neunzig (*Aluminium*, 1936, **18**, (12), 608–611).—The oxide film produced on aluminium and on copper-free aluminium alloys by the M.B.V. process can be coloured shades of brown, black, and blue by immersion in solutions containing potassium permanganate and copper or cobalt nitrate or in mixtures of potassium ferrocyanide and ferric chloride. If the M.B.V. film is first heated at above 100° C. the resulting coloured films will be more lustrous, but if it is first boiled in water lighter tones are obtained in the colouring process. The colours produced in the nitrate solutions are completely stable to light but those produced in permanganate solutions are stable only if the time of treatment exceeds 30 seconds. The coloured films are further stabilized by heating at 100°–150° C. and impregnating them with wax or a colourless lacquer.—A. R. P.

Metal Finishing. Herbert R. Simonds (*Iron Age*, 1937, **139**, (1), 635–638, 640, 642; (2), 37–43, 52).—Describes the developments during 1936 in metal finishing, and, in particular, in electroplating, "sputtering," white brass and pink gold plating, lacquering and painting, rust-proofing, cleaning, colouring, and special finishes.—J. H. W.

Lacquer Finishes for Metal Products. M. H. Corbin (*Products Finishing*, 1936, **1**, (2), 18–24; *C. Abs.*, 1937, **31**, 892).—C. discusses the use of nitrocellulose, other cellulose esters and ethers, and rubber resins in lacquers; cleaning of metal surfaces with chlorinated solvents or mixtures of solvent and phosphoric acid with or without wetting agents; chemical coatings such as Bonderizing and Parkerizing; improving the adhesion of paint films on zinc by depositing on its surface an inert metallic compound (nickel) that will not be absorbed into the zinc and at the same time will not react with the paint film; increasing the durability and speed of drying of glycerol phthalate enamels by the addition of relatively small amounts of nitrocellulose or ethylcellulose; the prevention of "spotting out" of lacquers on metals; clear and pigmented lacquers for the manufacture of etched metal name plates; and the use of drying materials made from rubber resin bases in finishes used to withstand the action of concentrated acids and alkalis in solution or fumes.—S. G.

XX.—JOINING

Soldering. K. Bihlmaier (*Mitt. Forschungsinst. Edelmetalle*, 1937, **10**, (10/11), 108–113).—The various fluxes used in hard and soft soldering are described and their functions discussed.—A. R. P.

*Observations on the Hard-Soldering of Light Metals in the Electric Furnace. M. Maier (*Aluminium*, 1936, **18**, (12), 618–621).—Hard-soldering of light metals with a blowpipe has only a limited field of application and often leads to deterioration in the quality of the metal by reason of the long period of heating necessary and the danger of local overheating. By using Silumin as the solder and " Autogal C " paste as flux good joints can be made in the electric muffle in 3 minutes at 580°–600° C. The solder is preferably used in the form of wire or strip which is laid in the joint and covered with a thin film of the flux paste. Numerous examples of joints made in this way in thin sheet with 1–5 mm. solder wires are illustrated.—A. R. P.

Soldering Aluminium. —— (*Automobile Eng.*, 1937, **27**, (355), 42).—A brief description of a newly developed jointing alloy named Alunize, having a tensile strength of 26 tons/in.², suitable for joining all alloys in the aluminium group, as well as Elektron and other magnesium alloys.—J. W. D.

New Uses of Electric Furnace Brazing Process. H. M. Webber (*Gen. Elect. Rev.*, 1936, **39**, (8), 381–387).—The increasing use of the copper hydrogen brazing process is illustrated by reference to many assemblies used in motor-cars, refrigerators, business machines, and similar products. The three types of furnace in common use for the process are the box or batch type, the mesh-belt-conveyor type, and the roller hearth type, each of which is described briefly. The artificial atmosphere supplied to the furnaces contains (about) hydrogen 17, carbon monoxide 11, carbon dioxide 4, and nitrogen 68%.
—S. V. W.

*Researches on the Spot-Welding of Dissimilar Light Metal Sheets. Hans Röhrig and Elfriede Käpernick (*Z. Metallkunde*, 1936, **28**, (12), 385–387).—In spot-welding together two dissimilar light metal sheets the lenticular area of fused metal extends to the greatest extent into the more fusible metal, the strength of the joint under standard welding conditions being the greater the smaller is the difference between the melting points of the two metals. The composition of the fused area is an average of that of the two constituents but if copper is present this tends to concentrate round the boundaries of the area.—A. R. P.

The Use of Fluxes for Welding Aluminium and Its Alloys. Richard MacClure (*Leichtmetall*, 1936, (2), 1–5).—The necessary properties of a satisfactory flux are enumerated and some typical mixtures are given. It is emphasized that no one mixture is suitable for the different types of alloys and that the essential precautions of mixing make it advisable for welders to buy their fluxes from firms specializing in their manufacture.—H. W. G. H.

Characteristic Properties of Copper and Their Influence on the Welding Process. E. C. Rollason (*Welder*, 1936, 8, (35), 1109–1112).—The relations of hydrogen and oxygen in copper are discussed, and the advantages of deoxidized copper for welding are explained. The difficulties which may be caused by its high conductivity and coefficient of expansion, and low strength at high temperatures, are pointed out.—H. W. G. H.

Lead Burning : A Report upon an " Exhausted Blow-Pipe." Ronald E. Lane (*J. Indust. Hyg. Toxicol.*, 1936, **18**, 391–400 ; *C. Abs.*, 1937, **31**, 77).—" Lead burning " or the high-temperature welding of lead alloys is recognized as a dangerous process. The exhausted blow-pipe will carry away about 90% of the volatilized lead. A limit of 0·2 mg. of lead per m.³ of air is recom-

mended. A high-pressure exhaust ventilation applied near the point of burning decreases the lead content of the atmosphere.—S. G.

Welding and Its Application to the Mining and Metallurgical Industries. C. R. Whittemore (*Canad. Min. Met. Bull.*, No. 296, 1936, 782–823 ; discussion, 823–824).—The acetylene flame, welding systems, and technique are first considered, with applications to mild steel, bronze-welding (of steel, cast-iron, and wrought-iron) and aluminium and its alloys. The characteristics of the electric arc are then explained, and generators, transformers, and arc-welding technique are discussed with reference to steel only. Hard-facing, by both gas and electric methods, and the testing of welds are briefly considered.
     —H. W. G. H.

Internal Stresses in Welding and Their Determination. Lewis Reeve (*Welding Ind.*, 1936, 4, (9), 344–355).—A full review is given of the mechanical and X-ray methods used to determine internal stresses. The X-ray methods, from the point of view of welded structures, are not thought too promising. The effects of internal stress are considered under the headings : (1) distortion effects ; (2) cracking of welds ; and (3) effect upon permissible external loading (static and dynamic). A *bibliography* of 34 references is given.—H. W. G. H.

Flow Phenomena in the Stress-Measuring Method of J. Mathar. G. Mesmer (*Elektroschweissung*, 1936, 7, (11), 218–220).—In the Mathar method, internal stresses are measured by boring holes and measuring the resulting deformation of the surrounding material. Flow phenomena are shown to have a considerable effect on the accuracy of the results, which may require a correction of up to 35%.—H. W. G. H.

Standardization of Oxy-Acetylene Welding Blowpipes. —— (*Rev. Soudure autogène*, 1936, 28, (273), 4–6).—Tentative specifications for 3 classes of blow-pipe, *viz.* 50–225, 300–1250, and 1500–4000 litres capacity, are presented for consideration and criticism. Standard dimensions for the hose-nipples, valves, and nozzles are suggested and set forth in detail.—H. W. G. H.

Alternating and Direct Current Welding. S. P. G. de Lange (*Machinery* (*Lond.*), 1937, 49, (1265), 443–444).—The special characteristics of d.c. and a.c. methods of arc welding are briefly reviewed, and a description given of the Philips dual-current welding machine having a capacity of either 25–140 amp. d.c. or 60–300 amp. a.c. Two rectifying tubes are provided to supply d.c. when this is required.—J. C. C.

The Dry Welding Rectifier. An Important Advance in the Field of Arc Welding Machines. Rod. Hofmann (*Elektroschweissung*, 1936, 7, (11), 215–217).—The welding rectifier is said to have all the advantages of d.c. and a.c. generators, and none of their disadvantages. The A.E.G. machine, which is described, uses a metal-oxide rectifier instead of mercury-vapour or hot-cathode valves, and, therefore, is much more robust and retains its efficiency indefinitely. It is claimed to have a voltage recovery time of only 0·008 second and to give an exceptionally smooth welding arc.—H. W. G. H.

Characteristics of a Universal Welding Generator. Nairne F. Ward (*J. Amer. Weld. Soc.*, 1936, 15, (11), 2–7).—The characteristics of an ideal generator for universal service, on all thicknesses and types of material, are enumerated as : safe open circuit voltage, provision for unloading the generator, constant wattage output, high ionization voltage with adequate current accretion, and quick arc recovery. A generator, designed to fulfil these requirements, is described. It has an armature core divided into two parts, one being the ordinary armature and the other rotating in the field of a rotary pole ring, the windings of which can be moved from approximate alignment with the stator poles to an interpole position. This rotary pole ring acts as a reactor and can be wound for any desired characteristic. Tests on the generator and its successful use for welding aluminium, copper, and steel are described.
     —H. W. G. H.

Preparing General Training Course for Welding Operators. —— (*Canad. Welder* (Suppt. to *Canad. Mach.*), 1936, **47**, (12), 179–188, 192).—The various stages of the course are enumerated. They include a study of the design and control of welding equipment, and practical exercises in the welding of a wide variety of ferrous and non-ferrous materials in various forms.—P. M. C. R.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 66–68.)

Aluminium and Its Alloys. Wm. Ashcroft (*Metallurgia*, 1937, **15**, (87), 83–84).—Aluminium and its alloys are considered with reference to such physical properties as density, high thermal and electrical conductivity, high thermal reflectivity, and the susceptibility of certain alloys to heat-treatment for their use for many types of machinery components and equipment in the transport, marine engineering, and chemical industries. Special attention is given to the corrosion-resistance of these alloys.—J. W. D.

Aluminium in Printing Technology. Fritz Hansen (*Aluminium*, 1936, **18**, (12), 623–624).—Aluminium plates can be used in printing in a similar way to zinc plates and in lithography in place of the usual stones. In the first case the design is etched on the plate with suitable acids and in the second a porous phosphate film is produced on the surface by treating it with dilute phosphoric acid solution containing gum arabic; this film after drying behaves similarly to the lithographer's stone.—A. R. P.

Aluminium for Packing Joints in Tubes. Joh. Reiprich (*Aluminium*, 1936, **18**, (12), 639–640).—Cf. *Met. Abs.*, 1936, **3**, 598. Aluminium wool for packing joints should be made of metal with less than 0·7% of impurities and the threads should be 0·3–1 mm. broad. Corrugated foil should be 0·06 mm. thick. Standard specifications for packings for various joints are included.—A. R. P.

High-Frequency Technique and Aluminium. A. Habermann (*Aluminium*, 1936, **18**, (12), 612–617).—With increasing frequency the difference between the conductivity of copper and aluminium becomes smaller owing to " skin effects." The efficiency factor of high-frequency coils of aluminium clad with a thin outer layer of copper is almost as good as that of similar coils of pure copper, but the weight is very much less. Examples of the use of such coils are given.—A. R. P.

Modern Railway Trains in the United States 1936. E. Isdahl (*Aluminium*, 1936, **18**, (11), 552–556).—Cf. *Met. Abs.*, 1936, **3**, 600. Further examples of American trains and Diesel-engined rail-cars are described and illustrated.

—A. R. P.

Aluminium Alloy Pistons in Heavy Oil Engines. Some Notes on Their Design and Application. J. F. Paige (*Nickel Bull.*, 1937, **10**, (1), 5–7).—Describes the application of " Y " alloy and Hiduminium R.R.53 in the manufacture of pistons for high duty.—J. H. W.

Light Alloys for Automatic Machining. —— (*Metal Treatment*, 1936, **2**, (8), 198–200, 204).—A review of recent publications. Methods recently proposed for making aluminium alloys " free-cutting " include the addition of magnesium, of compound-forming elements, and of lead. Dispersal and decomposition of massive compounds in the cast structure have been effected by heat-treatment, during which the magnesium diffuses into the compounds. Methods for producing a fine dispersion of lead in Duralumin are discussed, and reference made to the American copper–aluminium alloys containing bismuth and lead.—J. C. C.

Gasket Materials for Water Pipes. C. von Strampf (*Tech. Fortschr. öffentlichen Betrieben* (Suppt. to *Z. öffentliche Wirtschaft*), 1936, **3**, (5), 11–13; *Wasser u. Abwasser*, 1936, **34**, 235–236; *C. Abs.*, 1937, **31**, 490).—Aluminium

foil was substituted for lead.   For protection against corrosion the joints were coated with " Semperfix," and asphalt paint.—S. G.

Boron : The Metal and Its Uses.   L. Sanderson (*Sands, Clays, and Minerals,* 1936, **3,** (1), 33–35).—A brief review of the minerals, salts, and uses of boron, its applications in metallurgy, and methods for its determination.—A. R. P.

Adaptor Coupling for Copper Tubing.   Thomas G. Seifert (*Gas Age-Record,* 1936, **78,** (23), 623).—A moulded rubber sleeve is used as an insulating union for copper and iron gas-pipes.—A. R. Pᴇ.

What Do You Know About Babbitt ?   A. Eyles (*Machinist (Eur. Edn.*), 1937, **80,** (53), 1084).—A short article setting out the requirements and characteristics of Babbitt (see A. Hoyt Levy, *Met. Abs.,* 1936, **3,** 520).—J. H. W.

Lead Poisoning Due to Prolonged Use of Pewter Wine-Pot.   Chih-Shih Yang (*Chinese Med. J.,* 1936, **50,** 165–171 ; *C. Abs.,* 1937, **31,** 500).— Liquor containing 52% alcohol, when placed in pewter vessels for 15 minutes at 100° dissolves 0·0054–0·0155 grm. lead per 100 c.c.   Only one-third of this amount of lead goes into solution when allowed to stand overnight without heating. Two cases of lead poisoning are reported.—S. G.

Nickel in Canada : The Rise of a Great Industry.   A. H. A. Robinson (*Sands, Clays, and Minerals,* 1936, **3,** (1), 11–20).—An interesting account is given of the development of the nickel industry in Canada and of the methods adopted for recovering nickel and copper from the ores and refining the metals.   Some uses of nickel are indicated and statistics of the production of nickel and by-product metals from Canadian ores in 1935 are included.—A. R. P.

Making False Teeth.   Robert Lejeune (*Indust. Gas,* 1937, **15,** (7), 15).— Platinum cores and gold hooks are used for the attachment of false teeth.

—A. R. Pᴇ.

Silver for Dyestuff Plant.   C. H. S. Tupholme (*Amer. Dyestuff Reporter,* 1936, **25,** 628–629 ; *C. Abs.,* 1937, **31,** 259).—The most extensive application of silver to chemical apparatus is in condensation and general handling of acetic acid ; in addition it is used in condensers in the recovery of solvents, and in alloy form as valves, cocks, and taps.   Fine sheet silver may be rolled on to copper or other base metal, thus reducing the first cost of the apparatus. Electrolytic silver, owing to its pronounced ductility, has great advantages in application to existing apparatus.   Electrolytic silver has a permanent investment value of 50–75% of the original cost of the plant.   The behaviour of electrolytic silver to a large number of acids and reagents is indicated.—S. G.

Producing Auto Horns on a Mass Output Basis.   J. B. Nealey (*Indust. Gas,* 1936, **15,** (6), 14–16).—The magnetic vibrator contains tungsten contact points and the resonator is of magnesium alloy.—A. R. Pᴇ.

Developments in Aircraft Metallurgy. —— (*Metal Progress,* 1937, **31,** (1), 33–36).—Light alloys of the Duralumin type, but with increased magnesium content, are now much used in sheet form, whilst a recently developed alloy permits hot-forging without subsequent cracking and is used as rivet material.   Magnesium alloy castings are increasingly used : their resistance to corrosion is improved by chromate coatings or anodic oxidation.   Copper–lead bearing alloys have been improved by effecting finer and more uniform dispersion of the lead.   Extended uses for K–Monel and Inconel are indicated.

—P. M. C. R.

Metals and Alloys Used in Modern Housing.   Tomojiro Tanabe (*Sumitomo Kinzoku Kōgyō Kenkyu Hōkoku (Res. Rep. Sumitomo Metal Industries, Ltd.*), 1936, **2,** (8), 814–831).—[In Japanese.]   T. describes the rôle of metallic materials in modern architecture, and their practical applications in Japan and elsewhere.   The materials dealt with are : aluminium alloys (MD2, SA1, SA2–B, &c.), " white bronze," " white brass," art bronze, copper water tubes, and 18 : 8 stainless steel.   A few photographs are given.—S. G.

XXII.—MISCELLANEOUS

(Continued from pp. 68–69.)

Bibliography of Professor Kôtarô Honda. —— (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 1109–1126).—A *bibliography* of 167 references.—S. G.

†**Physics in the Metal Industry.** Zay Jeffries and E. Q. Adams (*J. Applied Physics*, 1937, **8**, (1), 48–54).—The parts played by the physicist in the development and present-day operations of the metal industry are reviewed.—J. T.

The Discovery of Bronze. J. R. Partington (*Scientia*, 1936, **60**, 197–204).—Historical.—S. G.

Bibliography. Nickel Alloys in the Power Field. —— (*Japan Nickel Rev.*, 1937, **5**, (1), 123–148).—[In English and Japanese.] The references, with very brief notes on contents, are classified under the headings : From publications in the Japanese language : (1) water wheels ; (2) steam power equipment ; (3) steam turbines ; (4) electric generators ; (5) electric motors. Other languages : (1) general ; (2) dam construction ; (3) water wheels ; (4) boilers and boiler tubes ; (5) boiler fittings ; (6) bolts ; (7) valves ; (8) pumps ; (9) steam turbines ; (10) condenser tubes ; (11) gears ; (12) electric equipment ; (13) high-temperature properties of nickel alloys ; (14) miscellaneous.—S. G.

Progress in Smelting Non-Ferrous Metals. Continuity the Main Feature of Modern Practice. T. J. Taplin (*Met. Ind. (Lond.)*, 1937, **50**, (3), 51–56).—A review of modern extraction methods of copper, lead, zinc, and tin. Refining processes are considered, and no marked changes noted with the exception of the continuous distillation and reflux condensers for 99·99% zinc.—J. E. N.

Electrolytic Extraction and Refining. Principles of Operation and Recent Developments. H. J. T. Ellingham (*Met. Ind. (Lond.)*, 1937, **50**, (3), 57–63).—The applications of the principles of operation (which are discussed) on a commercial basis are described, with special reference to aluminium, and the alkaline earth metals (as metals or suitable alloys) from fused electrolytes, copper, zinc, cadmium, nickel, and on occasion manganese, cobalt, and vanadium from aqueous solution electrolytes. Copper, silver, and gold are the principal metals refined by electrolysis.—J. E. N.

Smelting and Refining in Great Britain. The Future of Domestic Supplies. L. B. Hunt (*Met. Ind. (Lond.)*, 1937, **50**, (3), 64–70).—A review of the economic and political factors affecting the mining, smelting, and refining of the principal non-ferrous metals in Great Britain. It is suggested that a British Base Metals Federation should be formed to revive smelting and refining in Great Britain.—J. E. N.

Production and Market Control. Effects on Technical Developments. O. W. Roskill (*Met. Ind. (Lond.)*, 1937, **50**, (3), 71–76).—A discussion of the agreements and restriction schemes for the control of production. The general conclusion is reached that when control of a commodity is based on exports it is more likely to succeed than when based on production, most working schemes of the latter being based on production concentrated in a few non-consuming countries so that production and exports are then almost equivalent. The schemes relating to copper, tin, lead, and zinc are considered in detail.—J. E. N.

Developments in Aluminium Production. Accurate Control of All Processes. George Boex (*Met. Ind. (Lond.)*, 1937, 50, (3), 83–86).—S. G.

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Developments in Lead Smelting. Increasing Production in Great Britain. W. T. Butcher (*Met. Ind. (Lond.)*, 1937, 50, (3), 105–110).—S. G.

The Production of Magnesium. Growing Output and Rival Methods. —— (*Met. Ind. (Lond.)*, 1937, **50**, (3), 99–104).—S. G.

The Extraction and Refining of Nickel. Refining Operations Carried Out in Great Britain. W. T. Griffiths (*Met. Ind. (Lond.*), 1937, **50**, (3), 95–98).
—S. G.

Metals of the Platinum Group. Methods of Recovery and Refining. R. H. Atkinson and A. R. Raper (*Met. Ind. (Lond.*), 1937, **50**, (3), 114–116).—S. G.

The Tin Producing Industries. Economic and Metallurgical Developments.
—— (*Met. Ind. (Lond.*), 1937, **50**, (3), 87–94).—S. G.

The British Zinc and Cadmium Industry. Developments in Smelting Practice. L. B. Robinson (*Met. Ind. (Lond.*), 1937, **50**, (3), 111–113).—S. G.

Metals [Developments in 1936]. T. W. Lippert (*Iron Age*, 1937, **139**, (1), 200–202, 204, 208, 210, 212, 214, 218, 220, 222, 224, 226, 228).—Describes the developments in 1936 of steels, zinc alloy, aluminium alloy, magnesium alloy and brass die-castings, gun-metal, special bronzes, lead-base bearing metals, and magnesium–zinc and magnesium–aluminium alloys.—J. H. W.

The Record of the Metal Industries in 1936. The Primary Metals. D. K. Crampton. Brass and Copper Alloys. W. R. Hibbard. Uses for Zinc. W. M. Peirce. Uses of Cadmium. Gustaf Soderberg. Uses of Tin. D. J. Macnaughtan. Uses of Lead. F. E. Wormser. Aluminium Metallurgy. E. H. Dix, Jr. The Aluminium Industry. S. K. Colby. Nickel in Non-Ferrous Metals. Robert C. Stanley. Magnesium. John A. Gann. Platinum and the Platinum Metals. E. M. Wise (*Met. Ind. (N.Y.*), 1937, **35**, (1), 2–9). —Brief reviews of the progress made during 1936.—A. R. P.

Metal Manufactures—Products and Processes. The Ingot Metal Industry. G. H. Clamer. Ingot Metal Problems. H. Kramer & Co. Ingot Metal Production. W. A. Scheuch. The Brass Foundry. William J. Reardon. Brass Foundry Practice. H. M. St. John. Brass Foundry Progress. William J. Laird. Die-Casting Practice. Charles Pack. Brass Rolling Practice. William J. Pettis. Brass Rolling Mills. W. A. Wood. The Copper and Brass Fabricating Industry. Bertram B. Caddle. Copper and Brass Mill Products. J. J. Whitehead. Metal Products Manufacturing. Charles W. Hardy. Machine Shop Practice. W. B. Francis. Industrial Heating of Non-Ferrous Metals. C. D. Barnhart. Powder Metallurgy. R. L. Patterson. Welding Copper Alloys. I. T. Hook. Silverware Manufacturing. B. Egeberg. Jewelry Manufacturing. C. M. Hoke (*Met. Ind. (N.Y.*), 1937, **35**, (1), 10–22). —Reviews of American progress in 1936.—A. R. P.

The Metal Coating and Finishing Processes. Hot-Dip Galvanizing and Tinning. Wallace G. Imhoff. Electrometallurgy. Colin G. Fink. Metal Cleaning. Walter R. Meyer. The Structure of Electrodeposits. Louis Weis-berg. Metal Finishing Practice. W. M. Phillips. The Electroplating Indus-try. William Blum. Electroplating Practice. George B. Hogaboom. Practical Plating Advances. Joseph P. Sexton. Rhodium Plating. Sigmund Cohn. Rustproofing. Gustaf Soderberg. Metal Colouring Practice. C. B. F. Young. Coating Materials for Metals. Frank A. Strauss. The Job or Con-tract Plating Industry. Henderson Bell (*Met. Ind. (N.Y.*), 1937, **35**, (1), 22–30).—Notes on the progress made in these fields in America during 1936.
—A. R. P.

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XXIV.—BOOK REVIEWS

Platinum and Allied Metals. Second Edition. (Reports on the Mineral Industry of the British Empire and Foreign Countries.) Med. 8vo. Pp. 137. 1936. London: The Imperial Institute. (3s. net.)

The first 38 pages of this useful book deal with the minerals in which the metals occur and the manner in which they are extracted and refined, methods of working the metals, the properties of the metals and their most important alloys, and statistical information on production, marketing, and prices. The remainder of the book deals with the world's resources and contains a detailed description of the various deposits classified by countries together with statistical information concerning production and trade. The book, like the others in this series, contains a mine of useful information for all interested in this fascinating group of metals.—A. R. POWELL.

Tungsten. A Treatise on Its Metallurgy, Properties, and Applications. By Colin J. Smithells. Second Edition, Revised. Med. 8vo. Pp. viii + 272, with 183 illustrations. 1936. London : Chapman and Hall, Ltd. (25s. net.)

For 10 years the first edition of Dr. Smithells' book on tungsten has been the standard work of reference on this subject in the English language. The enlarged second edition contains all the good features of the first, and at the same time it covers new ground, and in particular refers to new developments which are the product of the past decade.

Although Dr. Smithells deals with the uses and manufacture of tungsten and its alloys, the book is a scientific treatise and not a work on technology. This is as it should be, for with a metal like tungsten a clear exposition of principles is much more useful to the general reader than an account of practice, and the book gives a precise account of tungsten in all its principal aspects without the confusion of innumerable technical details. The present volume is about twice the size of its predecessor, which is to be expected in view of increases in the use of tungsten and its alloys within recent years. Important additions have been made to the chapter dealing with metallography, while much new information is contained in the chapter dealing with non-ferrous alloys, which also describes a number of new industrial applications. Three new chapters have been included, written by expert colleagues of the author. Dr. A. L. Reimann deals with the thermionic properties of tungsten, while Mr. J. H. G. Monypenny writes about tungsten–iron alloys and tungsten steels. A chapter of particular interest is that contributed by Mr. T. R. Bird on hard alloys of tungsten carbide. This last chapter deals with a subject about which metallurgists as a whole are generally not well-informed, and it is specially interesting as it deals with an important development in powder metallurgy. The manufacture of hard alloys containing tungsten carbide has much in common with the manufacture of tungsten itself, and it is right that it should be dealt with in the same cover.

The book is well written, well printed, and well illustrated, and is a welcome addition to metallurgical literature.—D. HANSON.

Antimony and Bismuth. By W. E. Thorneycroft. A Text-Book of Inorganic Chemistry. Edited by J. Newton Friend. Volume VII, Part V. Med. 8vo. Pp. xxviii + 249, with 12 illustrations. 1936. London : Charles Griffin and Co., Ltd. (18s. net.)

This work is in fact an exhaustive abstract of records of researches on the metals antimony and bismuth, their alloys and compounds. The striking feature is the useful and authoritative collection of references.

The occurrence of the ores of the two metals is given and in each case a copious list of minerals containing antimony and bismuth, respectively, with informative particulars in each instance. History and extraction are noticed. The latter in sufficient detail to indicate principles rather than techniques for the producer. Secondary antimony is referred to briefly.

The physical properties of the metals are given with evident desire to provide the research worker with ample precise information, together with the source, so that original papers can be referred to and studied. The latent heat of fusion of antimony is given at 38·84 cal./grm. Values obtained for volume change on solidification of antimony are admitted to be confusing. Both of these points are of industrial interest and are the subject of discussion.

Explosive, amorphous, or β antimony is discussed. The spectrum is referred to and numerous figures relative to intensities of lines are given.

The alloys of antimony are described, but no attempt is made to provide lists of alloys with their compositions for industrial purposes. It is noted that in the case of lead–antimony alloys the eutectic is stated to contain 11·4–11·5 per cent. antimony, according to recent experiments after slow cooling. This result differs from that obtained by Miss Frances Weaver (Dr. Heywood).

The compounds of antimony and of bismuth are briefly described from both chemical and physical points of view. No words are wasted. Analytical methods for identification and estimation of both antimony and bismuth are given. Here also the effort is to point out the methods applicable rather than to give detailed instruction. No fault can be found with this provided that the investigator is a thoroughly trained and practised analyst. The original sources of the information should generally be studied.

In giving the alloys of bismuth the author very properly gives the eutectic in every case. Fusible alloys are the most usual industrial application. It should be noted that many unreliable figures are published as to melting points of fusible alloys. In all cases the eutectic should be ascertained and its melting point noted.

The book is intensely informative and useful. It should be at the service of every scientific metallurgist or chemist engaged in work connected with antimony or bismuth, or their compounds or alloys. Its interest for the foundryman engaged in the preparation or handling of alloys will be less obvious to him.—A. H. MUNDEY.

La Corrosion en Métallurgie. Milieu aqueux, atmosphérique et marin. Par C. Grard. 17 × 25 cm. Pp. xii + 345, with 59 figures in the text and 3 colour plates. 1936. Paris : Berger-Levrault. (50 francs.)

This volume will be appreciated, not only by those acquainted with the published work of the Commission Française de Corrosion de l'Aéronautique but by a wider circle of readers of the world's modern books on corrosion, the number of which is indeed not large. After a short introduction indicating the complexity of the problem of corrosion and organizations engaged on studies of corrosion, General Grard gives us in about 50 pages a refreshing survey of present knowledge on constitution of matter, physical chemistry of aqueous solutions and solution potential.

The next part of the book deals with the effects and causes of corrosion, sections being devoted to galvanic couples, " Evans " couples (differential aeration), activation and passivation, homogeneity and heterogeneity, biological phenomena, factors and causes. In the next part, under the heading " auto-protection," the author discusses corrosion of iron, steels, cast irons, copper and copper alloys, aluminium and aluminium alloys, magnesium and magnesium alloys. Part IV, in 36 pages, surveys briefly methods of protection against corrosion, and more space might fittingly have been assigned to this important part of the work. The next part deals with corrosion tests.

It is somewhat surprising that machining of tensile test-pieces of sheet material to shape before corrosion test rather than machining of the test-pieces from the sheets after corrosion test is recommended, in view of the fact, demonstrated by Portevin and confirmed by other investigators, that the pre-machined test-piece suffers exaggerated attack on the edges during corrosion test.—H. SUTTON.

Elektronentheorie der Metalle. Von Herbert Fröhlich. (Struktur und Eigenschaften der Materie, Band VIII.) 14 × 22 cm. Pp. vii + 386, with 71 illustrations. 1936. Berlin : Julius Springer. (Geh., R.M. 27 ; geb., R.M. 28.80.)

Practically all the properties of metals can nowadays be interpreted in terms of the electron theory. The electron, like love, is everywhere ! This book has been written for those experimental physicists interested, more especially, in the physics of the metals, and who have not, possibly, followed the subject of the electron theory of metals in course of its development. The subjects discussed include the mathematical theory, so far as this is required, electrical and thermal conductivities, thermoelectric effects, semi-conductors, metallic combination, ferro- and para-magnetism and the structures of alloys. Adequate subject- and name-indexes are provided. The book presupposes the possession, on the part of the reader, of a knowledge of partial differential equations, and something more than a nodding acquaintance with the vector presentation of electromagnetic theory. It will therefore commend itself, more particularly to physicists having a preference for the mathematical aspects of the subject. To such I wholeheartedly commend the work. It is well printed on good paper, but not very well stitched together. Its high price will prevent it having the wide circulation it deserves.

—J. S. G. THOMAS.

The Mechanical Testing of Metals and Alloys. The Theory and Practice of Standardized Mechanical Testing. By P. Field Foster. Demy 8vo. Pp. ix + 287, with 206 illustrations. 1936. London : Sir Isaac Pitman and Sons, Ltd. (15s. net.)

In his preface to this book Mr. Foster states that his purpose in writing it was to provide a book which coupled descriptions of modern testing equipment with its mode of use and which at the same time embraced in a practical way the theory underlying present-day developments in the testing of metals and their alloys. This is scarcely a novel idea, but Mr. Foster has certainly produced a distinctly useful book. It is true that specialists will find little that is really new in this work, particularly as it endeavours to cover in a single chapter or less such subjects as elasticity, structure of metals, hardness testing, fatigue of metals, influence of high temperature, &c., on which specialist treatises are already available (and probably in the Library of the Institute). However, we are not all specialists, at any rate not all in the same branch of knowledge, and those who wish to gain quick general information on various aspects of modern mechanical testing will find the book of value, particularly in regard to descriptions of testing machines and equipment, and in the application of tests which have been standardized by the British Standards Institution. Necessarily, there are omissions, but for a book which endeavours to cover the whole subject of mechanical testing of metals in 250 pages, these are surprisingly few, and undoubtedly the author has used his available space to good purpose and produced a book of practical value with many well-chosen illustrations.

—G. A. HANKINS.

Materials Testing—Theory and Practice. By Irving H. Cowdrey and Ralph G. Adams. Second Edition. Pp. vii + 144, with 62 illustrations. 1935. New York : John Wiley and Sons, Inc. ($1.75) ; London : Chapman and Hall, Ltd. (8s. 6d.).

This is the second edition (the first edition was dated 1925) of a small book by two members of the staff of the Massachusetts Institute of Technology and appears to be based on experience gained in lectures and class work. Accordingly, the subject-matter is largely concerned with the general elementary principles of the subject of materials testing treated in a normal manner ; U.S.A. tests for cement, sand, concrete, and timber are dealt with in addition to tests on metals. The book will probably be found more suitable to the needs of the younger students than to those of the practising testing engineer or experienced metallurgist.—G. A. HANKINS.

La Soudure Électrique à l'Arc et la Soudure à l'Hydrogène Atomique. Par Maurice Lebrun. Préface de Léon Guillet. 16 × 24 cm. Pp. 173, with 135 illustrations. 1935. Paris : Office Central de l'Acétylène et de la Soudure Autogène, 32 Boulevard de la Chapelle. (15 francs.)

The first two chapters of this little book deal with the transfer of molten metal in the arc and the characteristics of electrodes, an empirical formula being determined for the current capacity of an electrode in terms of the diameters of core and coating and a constant depending on the material. Special types of electrode for welding alloy steels, cast-iron, copper and its alloys, and for cutting, are discussed. Arc-welding of aluminium is not recommended. The remainder of the book is devoted to the control and testing of welds, welding machines, and applications—solely ferrous.

There is little to be found of specific interest to the non-ferrous welder, for whom there are more useful works.—H. W. G. HIGNETT.

The Sheet-Metal Worker's Instructor. Practical Rules for Describing the Various Patterns Required for Zinc, Sheet Iron, Copper and Tin-Plate Workers. By Reuben Henry Warn. Seventh Edition by Joseph G. Horner. Cr. 8vo. Pp. vii + 224, with 412 illustrations. 1936. London : The Technical Press, Ltd. (6s. net.)

Chapters 1 to 7 of this little book are devoted to the geometry and mensuration involved in developing the shapes used in sheet-metal work. Chapter 8, dealing with the materials employed, contains the usual inaccurate statements which appear when technical information is given in a style euphemistically known as " non-technical." For example, on p. 168, appear the words, " . . . the effect of excessive drawing out is to lessen the tenacity by overcoming the cohesive strength, and replacing the fibrous condition by the crystalline." Surely it is unethical to print such rubbish for apprentices to read. Chapter 10, on joints, omits to mention welding, but devotes considerable space to the obsolete cramped and brazed seam.

The chapters on geometry (which the reviewer has not read) and the tables in the appendix may be useful to somebody ; but they are not worth 6s.—H. W. G. HIGNETT.

Analytische Chemie der Edelmetalle. Von Alfred Wogrinz. (" Die Chemische Analyse." Herausgegeben von Wilhelm Böttger. Band XXXVI.) Med. 8vo. Pp. ix + 141, with 14 illustrations. 1936. Stuttgart : Ferdinand Enke. (Geh., R.M. 13 ; geb., R.M. 14.80.)

The book is divided into three sections, dealing respectively with silver (50 pp.), gold (32 pp.), and the platinum metals (44 pp.) ; in addition there is a useful appendix containing data on the physical, mechanical, and electrical properties of the precious metals arranged in a number of tables. In the analytical sections dry and wet methods of determining the metals are described in detail, qualitative and quantitative microchemical methods being also included. Finally, procedures are given for separating the metals from one another and from base metals, together with some examples of the application of these methods to commercial products—bullion, jewellery alloys, and dental alloys in particular.

The arrangement of the text matter is good and the descriptions of the various procedures are adequate for practical requirements. In general the methods described are up to date in the silver and gold sections, but those in the platinum metal sections have mainly only an historical interest and do not represent modern practice. The procedures of Deville and Debray and of Leidié and Quennessen have long since been superseded by more exact methods of separation, such as those developed at the U.S. Bureau of Standards. The book, nevertheless, should be useful to analysts who are called upon to do occasional precious metal determinations, and should provide students with a valuable insight into this somewhat difficult and specialized branch of analytical chemistry.—A. R. POWELL.

Colorimetric Methods of Analysis, Including Some Turbidimetric and Nephelo-metric Methods. Volume I.—Inorganic. By Foster Dee Snell and Cornelia T. Snell. Second Edition. Med. 8vo. Pp. xxiii + 766, with 109 illustrations. 1936. London : Chapman & Hall, Ltd. (45s. net.)

During recent years an increasing amount of attention has been paid to the use of colorimetric methods for the determination of small quantities of both inorganic and organic substances, especially in microchemical work. In this book the authors have rendered a considerable service to analysts by collecting and classifying the methods which have been developed for the colorimetric determination of inorganic substances, including, of course, all the metals which form coloured compounds or complexes. Full working details are given in all cases, and the possible accuracy of, and sources of error in, the methods are fully discussed with adequate references to the journal literature. All the methods of value which have been published up to the end of 1934 appear to have been included ; thus no less than 22 distinct methods are given for copper, many of which depend on the use of complex organic reagents. The early chapters of the book contain an exhaustive description of the apparatus of colorimetry and a lucid account of the technique with a lengthy discussion of the accuracy possible.

The whole book is well written and should prove invaluable not only to students but also to practising analysts.—A. R. POWELL.

Tables of Physical and Chemical Constants and Some Mathematical Functions. By G. W. C. Kaye and T. H. Laby. Eighth Edition. Roy. 8vo. Pp. 162. 1936. London : Longmans, Green & Co. (14s. net.)

The first edition of Kaye and Laby (the book, not the well-known physicists) appeared in 1911 ; I well remember how its publication was welcomed. Now the eighth edition has appeared, and there seems to be no reason why an eighty-eighth edition should not appear in due course. The book is one to which the much over-worked term " indispensable " can truly be applied. No words of mine are needed to recommend the new edition to metallurgists, chemists, and physicists throughout the world. They will know that the book makes available in handy form the most reliable physical and chemical data on all sorts of subjects. I can imagine a judge of the High Court enquiring What or who, is or are, Kaye and Laby ? Every physicist will know. I anticipate a scramble for the new edition. Its price is very reasonable.

—J. S. G. THOMAS.

Who's Who, 1937. Eighty-Ninth Year of Issue. Post 8vo. Pp. lxii + 3722. London : A. & C. Black, Ltd. (60s.)

The " Coronation Year " issue of " Who's Who " was published too early to allow of the excellent " Selection of Royal portraits " with which the book opens to be brought into line with the consequences of the momentous events of December 10.

However, any out-of-dateness in this direction does not affect the value of the major portion of this priceless boon to the man of affairs. Here are included about 40,000 " thumb-nail " biographies of men and women who count in both hemispheres. Whether it be that, in the past year, deaths of those previously figuring in the annual have been more numerous, or accessions to its pages fewer, the number of pages in the current edition is, for the first time for many years, slightly reduced—from 3730 in 1936 to 3722 in 1937. At this rate it will require a lengthy slimming process appreciably to reduce the volume's bulk from its present unwieldly thickness of three and a half inches to the more handy size that was Who's Who's when—nearly 30 years ago—this " annual biographical dictionary " (as the publishers tersely describe it) first came on his desk to lighten the labours and broaden the outlook of—THE EDITOR.