METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

JANUARY

Part 1

I.--PROPERTIES OF METALS

Metallurgical Problems in Aluminium and Aluminium Alloys. G. Sachs (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 44-55; and (abstract) Z. Elektrochem., 1931, 37, 436-437).—Reviews recent progress in the preparation of single-crystal aluminium, of various aluminium alloys amenable to agehardening, and of satisfactory casting alloys of high strength.—A. R. P.

In angle of satisfactory casting alloys of high strength.—A. R. P. Retardation of the Recrystallization Power [of Bent Single-Crystal Aluminium Wires] by Bending Back. P. Beck and M. Polanyi (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 129–132).—Of. this J., 1931, 47, 514. When rods of aluminium single-crystals are bent round a circular mandrel and then bent back again to the straight position no recrystallization takes place on annealing when the percentage deformation is less than about 7%, and only a partial recrystallization when the deformation is 7–15%; in the second case new crystals form first in the parts which were on the inner and outer sides of the bent rod, leaving a central zone of unrecrystallized metal. As this bending back is unaccompanied by a reduction of the hardness induced by the original bending, it is assumed that recrystallization is dependent on the state of stress in the slip planes, whereas hardening takes place along the separation planes in which the lattice becomes subdivided by the bending operation.—A. R. P.

On the Magnetization of Single Crystals of Cobalt at High Temperatures. Kôtarô Honda and Hakar Masumoto (Sci. Rep. Tôhoku Imp. Univ., 1931, [i], 20, 323-341).—[In English.] The magnetization of single crystals of cobalt has been measured between -190° and $+390^{\circ}$ C. by the ballistic method. At room temperature, magnetization in the direction of the [0001] axis rises rapidly at first and attains an asymptotic value in a comparatively weak field. The intensity of magnetization in weak fields increases up to 230° C. and decrease at higher temperatures. The saturation value of magnetization of cobalt at absolute zero is 1446 c.g.s. units. The directions of the [1010] and [1120] axes are those of difficult magnetization. With rising temperature the magnetization increases up to 300° C. and then remains almost constant.—E. S. H.

The Sorption of Hydrogen on Copper. I.—Adsorption and the Heat of Adsorption. H.—The Rate of Solution. A. F. H. Ward (*Proc. Roy. Soc.*, 1931, [A], 133, 506-522, 522-535).—(I.)—The sorption and heats of adsorption of hydrogen on activated copper have been measured at 25° C. for successive additions of gas. The instantaneous adsorption on the surface was followed by gradual solution. The adsorption isotherm was found to be exactly reversible on decreasing the pressure. After correction for gas in solution and the heat of compression of the gas, the heats of adsorption and desorption were found to be independent of the concentration of gas on the surface, but decreased after each baking of the copper, and attained a final value of 9,000 cals./grm. mol. The isotherms were not affected by baking below the temperature of preparation of the copper (150° C.), but after sintering above this temperature the amount of gas adsorbed was decreased. (II.)— The adsorption of hydrogen on copper and the rates of diffusion into the metal

VOL. L.

1932

have been measured at various pressures over the temperature range $25^{\circ}-200^{\circ}$ C. At any temperature, the rate of diffusion into the metal is proportional to the amount of gas adsorbed on the surface. The energy of activation for the diffusion process is 14,100 cals./grm. mol. It is probable that a process of grain-boundary diffusion rather than a process of lattice diffusion occurs. The theory based on splitting of the molecules into atoms is shown to be untenable.—J. S. G. T.

Indium. Anon. (Wire and Wire Products, 1931, 6, 249).—Short note on the occurrence and properties of indium.—J. H. W.

The Recrystallization of Lead. B. Garre and A. Müller (Z. Metallkunde, 1931, 23, 236).--Abstracted from Z. anorg. Chem., 1930, 190, 120-122; see this J., 1930, 44, 454.--M. H.

Sublimation of Magnesium in a Vacuum. Waldemar Kaufmann and Philipp Siedler (36. Hauptversammlung Deut. Bunsen-Ges. : " Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 100-105; and also Z. Elektrochem., 1931, 37, 492-497) .- Magnesium can be purified by sublimation at temperatures below 650° C. in vacuo; at 600°-650° C. the sublimate consists of masses of large well-formed hexagonal crystals, but at 500° C. a network of fine fern-like crystals is obtained. Starting with technical magnesium of the I.G. Farbenindustrie A.-G. containing 99.85% magnesium, it is possible to obtain a sublimate with 99.99% magnesium in one operation; after 3 sublimations no impurities could be detected in the metal either by chemical or by spectrographic analysis. The residue from the sublimation consisted chiefly of magnesia (oxide film), silicon, iron, and manganese, with smaller quantities of copper, aluminium, and phosphorus. When the method is used for the purification of magnesium containing zinc, pure magnesium condenses in the hotter parts of the condenser and a pure magnesium-zine alloy in the cooler parts; sulphur, if present, remains in the sublimation residue as magnesium sulphide.-A. R. P.

Contributions to the Physics and Metallography of Magnesium. I.— Physical Anisotropy of Magnesium Crystals. II.—Plastic Deformation of Magnesium Crystals. III.-On Mixed Crystal Formation in Magnesium. E. Schmid [with I., E. Goens; II., G. Siebel; and III., H. Seliger and G. Siebel] (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 55-58, 58-63, 63-67; and also Z. Elektrochem., 1931, 37, 447-459).-(I.)-Cf. this J., 1931, 47, 418. The maximum modulus of elasticity of 99.95% magnesium (5130 kg./ mm.2), lies in the direction of the hexagonal axis, and the minimum (4370 kg./ mm.2) in a direction inclined at 53° 45' thereto; in neither case is the value affected by more than 1% by the presence of up to 2.3% zinc in solid solution. The coeff. of thermal expansion of magnesium is 26.4×10^{-6} parallel to the hexagonal axis and 25.6×10^{-6} perpendicular to this axis between 20° and 100° C.; the sp. electrical resistance is 3.77×10^{-6} and 4.54×10^{-6} respectively. (II.)-The mechanism of plastic deformation of magnesium rods is discussed in the light of X-ray analyses and the formation of twin lamellæ along the $(10\overline{12})$ and $(10\overline{11})$ planes. The elastic limit is strongly dependent on the angle between the direction of pull and the plane of translation. (III.) -The lattice parameters, a and c, of magnesium are decreased linearly with increasing atomic percentages of aluminium, zinc, and manganese in solid solution. The solid solubility of these metals in magnesium at the eutectic temperature is 12.1, 8.4, and 3.3%, and at room temperature about 2%, 1%, and 0%, respectively.-A. R. P.

The Permeability of Ferromagnetic Materials [Nickel and Iron] in High-Frequency Electromagnetic Fields. N. N. Malov (Z. Physik, 1931, 71, 30–38).— The magnetic permeability of nickel and iron wires in high-frequency electromagnetic fields is shown experimentally to depend on the frequency of the field. In the case of iron the mode of dependence of μ on the frequency, f, is very complicated; in the case of nickel μ is linearly related to f.—J. S. G. T.

The High-Frequency [Magnetic] Permeability of Iron and Nickel. M. J. O. Strutt (Z. Physik, 1931, 72, 557-558).—S. replies to Malov's criticism of his results (preceding abstract) and contends that all anomalous results relating to the magnetic permeability of iron and nickel for frequencies between 10^8 and 10^8 Hertz are, without exception, attributable to experimental error.

-J. S. G. T.

Hardness of Palladium. C. Johnson (*Met. Ind.*, (Lond.), 1931, 39, 401).— A note correcting the statement that palladium is softer and less permanent than platinum and rhodium. The permanence of palladium and rhodium is stated to be of the same order under normal atmospheric conditions and according to F. E. Carter, *Amer. Inst. Min. Met. Eng. Tech. Publ.*, No. 70, 1928, 1-24 (this J., 1928, 39, 461), the Brinell hardness of platinum is 50 cast, 97 hard, and 47 annealed, the corresponding numbers for palladium being 52, 109, and 49, respectively.—J. H. W.

Adsorption and Activation of Carbon Monoxide at Palladium Surfaces. Hugh S. Taylor and Paul V. McKinney (J. Amer. Chem. Soc., 1931, 53, 3604– 3624).—The results of determinations of the adsorption of carbon monoxide by palladium at various temperatures, and the resulting isotherms, are given. There is evidence of 2 forms of adsorption, that occurring at the higher temperature requiring an activation energy. Carbon monoxide does not reduce palladium oxide, and is itself a powerful inhibitor to the reduction of the oxide by hydrogen. A series of other chemical reactions on the surface of palladium was studied.—R. G.

A Revision of the Atomic Weight of Thallium. Henry Vincent Aird Briscoe, Suetaro Kikuchi, and John Buttery Peel (*Proc. Roy. Soc.*, 1931, [A], 133, 440-457).—Literature relating to previous determinations of the atomic weight of thallium is briefly reviewed. The authors have determined the ratio TICI: Ag, and the ratio used by Crookes, viz. Tl: TINO₂, has been critically examined. The final mean value of the atomic weight of thallium is $204\cdot34 \pm 0.015$, in good agreement with the value derived by Honigschmid, Birckenbach, and Kothe, viz. 204:39. Crookes's value, viz. 204:04, must be superseded by the most probable value, viz. 204:37, within 1 or 2 hundredths of a unit.

-J. S. G. T.

Departures from Lambert's Cosine Law in the Case of Incandescent Tungsten. E. Spiller (Z. Physik, 1931, 72, 215-217).—Departures from Lambert's cosine law are found to exist in the case of the emission of radiation from a heated tungsten strip. The magnitude of the departure at various angles depends on the nature of the surface of the strip, e.g. whether oxidized or not.—J. S. G. T.

The Burning-Out of Filaments Heated in Vacuo.—I. Leopold Prásnik (Z. Physik, 1931, 72, 86-94).—Cf. this J., 1931, 47, 471. P. discusses mathematically the changes of diameter and of temperature of a filament heated *in vacuo*, under constant tension, up to fracture due to burning-out.—J. S. G. T.

Some Electrical Properties of Spectroscopically Pure Zinc Crystals. A. G. Hoyem (*Phys. Rev.*, 1931, [ii], 38, 1357–1371).—Using spectroscopically pure zine (99·9999%) the Thomson coeff. has been measured by a direct method at 49.5° C. on single crystals of varying orientation. Using the same set of specimens, the thermal e.m.f. was measured against copper, from -180° to $+200^{\circ}$ C., and the Thomson coeff. for the zinc calculated by the usual Kelvin thermodynamic theory. The calculated values agreed with those determined directly, and thus confirm the thermodynamic theory; the contrary conclusion of Veleger (*Ann. Physik*, 1931, 9, 366) is considered incorrect when the results of different workers are compared. The Thomson coeff. obeys the Voigt-Thomson symmetry relation, the principal values being $\sigma_{\perp} = 0.86 \times$ 10^{-6} and $\sigma_{\rm H} = 0.34 \times 10^{-6}$ cal./coulomb./deg. The thermal electric power against copper also obeys the Voigt-Thomson symmetry relation, and the values of the Peltier coeffs. of Zn_{\perp} against $Zn_{\rm H}$ are 658 and 1080 microvolts at 49.5° C. and 125° C, respectively. The mean temperature coeff. of resistance between -170° C. and $+25^{\circ}$ C is $4\cdot058 \times 10^{-3}$, and the temperature-resistance relation is accurately-linear over this range. The Thomson coeff. and temperature coeff. of resistance were also measured for Kahlbaum's best zine, and the Thomson coeffs. again obey the Voigt-Thomson law, although with slightly higher values than for the pure zine.—W. H.-R.

The Thermal Conductivities of Certain Approximately Pure Metals and Alloys at High Temperatures. L. C. Bailey (Proc. Roy. Soc., 1931, [A], 134, 57-76).—A guard-tube method is employed for measuring the thermal conductivity of aluminium, silver, zinc, cadmium, brass, and Platinoid at temperatures between about 60° C. and 550° C. The following results, supplemented by others due to Lees, are tabulated, for the thermal conductivity K (expressed in e.g.s. units), of the respective metals and alloys at the temperatures stated (° C.). Aluminium, -170°, 0.524; -160°, 0.514; -150°, $\begin{array}{l} 0 \text{-}508; & -100^\circ, 0.492; & -50^\circ, 0.496; 0^\circ, 0.502; & +18^\circ, 0.504; 50^\circ, (0.514); \\ 100^\circ, 0.523; 150^\circ, 0.531; 200^\circ, 0.536; 250^\circ, 0.537; 300^\circ, 0.532; 350^\circ, 0.524; \\ 400^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490: silver, -170^\circ, 0.996; \\ 100^\circ, 0.517; 450^\circ, 0.508; 500^\circ, 0.499; 550^\circ, 0.490; 100^\circ, 0.596; 0.490; 100^\circ, 0.596; 0.490; 100^\circ, 0.490; 0$ $\begin{array}{c} -160^\circ, \ 0.998; \ -150^\circ, \ 1.000; \ -100^\circ, \ 1.008; \ -50^\circ, \ 0.997; \ 0^\circ, \ 0.931; \ 18^\circ, \\ 0.974; \ 50^\circ, \ 0.956; \ 100^\circ, \ 0.934; \ 150^\circ, \ 0.917; \ 200^\circ, \ 0.896; \ 250^\circ, \ 0.880; \ 300^\circ, \end{array}$ $0.864; 350^\circ, 0.853; 400^\circ, 0.844; 450^\circ, 0.851^\circ, 500^\circ, 0.870; 550^\circ, 0.901$: $zine, -170^\circ, 0.280; -160^\circ, 0.278; -150^\circ, 0.276; -100^\circ, 0.271; -50^\circ, 0.268; 0^\circ, 0.269; 18^\circ, 0.268; 50^\circ, 0.267; 100^\circ, 0.264; 150^\circ, 0.259; 200^\circ, 0.252; 250^\circ, 0.245; 300^\circ, 0.240; 350^\circ, 0.237: cadmium, -170^\circ, 0.240; -160^\circ, 0.239; -150^\circ, 0.238; -100^\circ, 0.231; -50^\circ, 0.225; 0^\circ, 0.219; 18^\circ, 0.212, 50^\circ, 0.212; 250^\circ, 0.221; 250^\circ, 0.221; 250^\circ, 0.212; 250^\circ, 0.221; 250^\circ, 0.220^\circ, 0.250^\circ, 0.250^\circ, 0.250^\circ, 0.250^\circ, 0.250^\circ, 0.220^\circ, 0.250^\circ, 0.250^$ 0.217; 50°, 0.196; 100°, 0.222; 150°, 0.224; 200°, 0.220; 250°, 0.212; 300°, 0.204: brass (copper 70, zinc 30%), -170°, 0.175; -160°, 0.181; -150° , 0.186; -100° , 0.213; -50° , 0.235; 0° , 0.254; 18° , 0.260; 50° , 0.286; 100° , 0.314; 150° , 0.337; 200° , 0.348; 250° , 0.352; 300° , 0.354; 350°, 0.354; 400°, 0.355; 450°, 0.354: Platinoid (composition approximately bbs, 0.063; 400° , 0.051° , 100° , 0.039° ; -160° , 0.040° ; -150° , 0.041° ; -100° , 0.051° ; 0° , 0.058° ; 18° , 0.060° ; 50° , 0.066° ; 100° , 0.075° ; 150° , 0.085° ; 200° , 0.094° ; 250° , 0.102° ; 300° , 0.108° ; 350° , 0.114° ; 400° , 0.118° . In the case of pure metals, the generally accepted rule that K decreases with increase of temperature does not appear to hold in all cases. For aluminium, K attains a maximum value at 225° C., after which a decrease occurs to 550° C. The values agree with those given by Schofield for a sample of greater purity (99.7% compared with 99%). The values are, however, lower than the value, 0.55, found by Griffiths for a single crystal of aluminium (99.7% purity) at 100° C. For silver, K is a minimum at about 400° C. and increases to 575° C. For zinc, K decreases continually from -170° C. to 370° C. The values agree with those found by Schofield for a specimen of 99.8% purity, but are about 18% lower than those given by Bidwell and Lewis for single crystals. For cadmium, an abrupt fall and rise of conductivity occurs at about 50° C., after which the normal steady decrease occurs. For the two alloys, the rule that the conductivity increases with increasing temperature is confirmed, but the increase is not regular. For brass, K increases rapidly and linearly with temperature up to about 125° C. and then tends to a constant value, about 0.335, up to 450° C. For Platinoid, K increases linearly and continuously with rise of temperature.—J. S. G. T. On the Influence of Small Admixtures in Metals. W. Fraenkel (Z. Metall-

On the Influence of Small Admixtures in Metals. W. Fraenkel (Z. Metallkunde, 1931, 23, 221–224).—Discusses the degree of purity of so-called pure and technical metals, and gives typical examples of the influence of small amounts of impurities and intentionally added constituents on the physical properties, melting point, mechanical properties, recrystallization (softening and grain-growth), electrical conductivity, diffusion and reaction velocity (age-hardening), and corrosion (rate of dissolution in acids), &c.—M. H.

Impurities. Anon. (Metallurgist (Suppt. to Engineer), 1931, 7, 145-146). —The advance in knowledge of the effects of small amounts of impurities in metals and the importance of development of progressively purer metals are discussed. Even with what is now regarded as a high degree of purity the quantity of atoms of impurity present is still substantial, and in the light of recent advances, notably in the preparation of very pure zine, it is desirable that work to seeure purer metals should be vigorously continued. Reference is made to the important aids of spectroscopic analysis, the H.-F. furnace and high-purity improved refractories.—R. G.

On the Nature of the Latent Heat of Fusion. Kötarö Honda and Hakar Masumoto (Sci. Rep. Töhoku Imp. Univ., 1931, [i], 20, 342-352).—[In English.] The "dynamic internal pressure" in the solid state at the melting point has been calculated for various elements on the assumption that each atom consists of a Planck's radiator or is in simple harmonic motion. The latent heat of fusion is given by the product of the dynamic pressure and the change of sp. volume during melting. It is concluded from thermodynamic considerations that a great portion of the latent heat of fusion consists of the energy of atomic rotation. For elements having a cubic lattice, (1) the dynamic internal pressure at the melting point is proportional to the square of the absolute melting point; (2) the volume increase of 1 grm.-atom due to a rise of 1° C. at the melting point is inversely proportional to the square of the absolute melting point; (3) the atomic heat of fusion is proportional to the product of the volume change of 1 grm.-atom during melting and the square of the absolute melting point.—E. S. H.

Diffusion in Metals. G. von Hevesy and W. Seith (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 136–139; and also Z. Elektrochem., 1931, 37, 528–531; discussion, 531).—The diffusion of one metal into another in the solid state is in most cases a one-sided process; thus gold diffuses very readily into lead, whereas the rate of diffusion of lead into gold is extremely small. By substituting silver, bismuth, thallium, or tin for gold the one-sidedness of the process gradually disappears as the diffusing metals become more alike in properties. Diffusion measurements form a convenient method for determining the solid solubility of one metal in another when this solubility is very small; in this way the solid solubility of silver in lead at 285° C. has been found to be 0-13 atoms %.—A. R. P.

The Behaviour of Metal Powders under Pressure. F. Skaupy and O. Kantorowicz (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 90-93; and also Z. Elektrochem., 1931, 37, 482-485; discussion, 491-492).—Cf. this J., 1931, 47, 197. The electrical resistance of a metal powder during compression is given, within rather wide limits, by the expression $1/R = C\sqrt{P} + C$, where C and c are constants depending on the metal and on its previous history. The curve connecting R and P is irreversible; in the case of tungsten powder compressed under pressures of up to 2,000 atm. the value of R for P = 0 increases with successive pressing operations and the R-P curve becomes progressively higher, *i.e.* the resistance of the metal under all pressures is increased by repetition of the pressing. After 70 pressings the value of R for 2,000 atm. is 10 times that obtained after only 1 pressing. —A. R. P.

Decrease of Sclerometric Hardness Due to the Adsorption of Active Substances at the Surface of Contact. Sclerometry and Physics of Disperse Systems. P. Rehbinder (Z. Physik, 1931, 72, 191-205).—A modification of the pendulum sclerometer due to Kusnezow is briefly described, and has been used in the determination of the decrease of hardness of crystals due to the adsorption of polar substances at the crystal surfaces. The decrease of hardness is found to be related to the decrease of surface energy due to adsorption. Values of the hardnesses of lead, bismuth, cadmium, aluminium, silver, copper, antimony, platinum, and arsenic, determined by the pendulum sclerometer, are tabulated.—J. S. G. T.

Stabilizing Metals by Magnetism. Edward G. Herbert (Metallurgia, 1931, 5, 13-16, 25) .- Periodic hardness fluctuations, which occur in metals immediately following a rotary magnetic treatment or which have been subjected to severe cold-work or to drastic thermal treatment, when damped out, can be started afresh by rotating the metal in a strong magnetic field. If a metal is placed for a short time in a constant magnetic field at the instant when it has reached a maximum or a minimum phase of its fluctuations, the effect is to stabilize it at or near the condition of maximum or minimum hardness which it has then attained. Stabilization at a maximum phase produces temporary fluctuations, and eventually stability above the previous maximum, whereas stabilization at a minimum phase produces fluctuations leading to stability below the previous minimum. These results have been obtained with steel, but it is stated that similar treatment applied to non-ferrous alloys, such as quenched Duralumin or brass after sovere work-hardening by rolling or the Cloudburst process, has produced striking and unexpected results which are not described. A short description is given of the magnet used and the method of treatment adopted in the experiments.-J. W. D.

The Strengthening of Some Working Materials on Cold-Rolling. E. Greulich (Z. Metallkunde, 1931, 23, 91-94).—Cf. this J., 1931, 47, 13. The hardness, yield-point, and tensile strength of Monel metal, steel, Armco iron, copper, and 70:30 brass change with the reduction on cold-rolling according to an exponential law if the degree of reduction is smaller than about 30%. The strengthening factors (*i.e.*, the ratio kg./mm.²/percentage reduction) for the hardness, yield-point, and tensile strength of the materials mentioned are given. The yield-point can be regarded as the best measure of strengthening. Strengthening is least with pure metals (iron, copper), followed by brass, carbon steels, chromium-nickel steel, and Monel metal in order of increasing strength. The initial tensile strength is without influence on the degree of hardening. Equations are given for the calculation of the yield-point and tensile strength and non-ferrous alloys.—M. H.

On the Time Law of Softening of Deformed Metals. F. Sauerwald [with W. Scholz and W. Globig] (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 139-142; and also Z. Elektrochem, 1931, 37, 531-534; discussion, 534).—Pieces of copper were deformed by a blow from a falling weight at temperatures between 250° C. and 350° C. and the hardness was determined at the same temperatures over a period of 48 hrs. At 350° C. there was a rapid fall in hardness and the metal was completely softened in 5 minutes. At lower temperatures 3 stages of softening were observed, first a slow fall in hardness, then a much more rapid fall, and finally again a slow fall. These effects are attributed to differences in the rate of crystal recovery and in the rate of ness, time, and temperature could be established.—A. R. P.

Rate and Limits of Strain-Hardening of Plastic Metals. E. V. Crane (*Iron* Age, 1931, 128, 499, 543-545).—The limits to which strain-hardening, such as occurs in forming sheets, may be safely carried are described. Cold-working must not go beyond the limit of plasticity, otherwise fracture will result. Cold-working increases the elastic limit and yield-point.—J. H. W.

Why Cold-Work Changes the Properties of Metal. E. V. Crane (*Iron Age*, 1931, 128, 626-630).—The effect of cold-work, with or without intermediate annealing, on the strain-hardening of metals is discussed, and the mechanism of crystal growth under the influence of heat-treatment is described. The influence of the type of crystal lattice on the cold-working properties and the nature of slip movement caused by cold-working are also discussed.

-J. H. W.

Crackless Plasticity, a New Property of Metals. H. F. Mooro (*Iron Age*, 1931, 128, 674-677, 721).—There seems to be a property of metals which is neither strength nor ductility as shown by tensile tests, and which is nevertheless important. It is the ability to resist fairly large numbers of loads which cause very slight plastic action without starting a crack which, in subsequent service, leads to failure. This is called "crackless plasticity," and methods of studying it, including fatigue tests following a period of overstress, notched-bar impact tests, and damping of vibrations, are suggested.—J. H. W.

The Problem of the Resistance of Materials. L. Bollo (Bull. tech. Suisse Romande, 1931, 57, 100-103, 112-115) .--- B. discusses the theoretical basis of Hooke's law and its relation to the mathematical theory of elasticity, and indicates some necessary simplifications in the practical application of both. "Elastic " or " internal " potential, due to internal molecular forces, can be calculated independently of Hooke's law; the latter is shown by experimental evidence to be a logical consequence and first approximation of the law of elasticity. Important engineering applications arise with regard to live loads and the study of elastic systems. In evaluating critical deformation and the force required to produce rupture-problems respectively of elastic deformation and of resistance-certain neglected factors become fundamentally important, especially with flexible bodies and in the critical displacement of unstable systems. Deformation is not here a linear function of the external forces. The adoption of an "elastic limit" basis for specifications admits of failures owing to the rapid drop in critical load value with the dimensions of a section; with light alloys of low elastic modulus the danger of rupture is replaced by that of buckling. Limitations of the theories of Lüder and Mohr are discussed, and possible developments of the internal potential theory are indicated .-- P. M. C. R.

Elasticity and Strength. Anon. (Engineering, 1931, 132, 109-110).—A leading article dealing with the calculation of "the factor of safety." The theory which states that the factor of safety should be based on the elastic limit is not based on observations, and it has been shown that in certain circumstances material with a high elastic limit will not endure so long as a material with a lower elastic limit. The behaviour of metals under the influence of high temperatures, and the phenomena of fatigue must be borne in mind when calculating the factor of safety.—W. P. R.

On the Increase in Surface Area Due to Crystal Faces Developed by Etching. Lowi Tonks (*Phys. Rev.*, 1931, [ii], **38**, 1030–1039).—When a crystalline body is etched, or heated to such a high temperature that appreciable volatilization occurs, the surface consists of small crystal faces, and the surface area is increased. With metals this increase is of importance in emission problems. The ratio of increase in area to apparent area is called the face excess. Given the available crystal faces and the orientation of the crystal, methods are given for determining the face excess, and those faces which give the minimum face excess. Assuming random crystal orientation and minimum face excess, the face excesses where (1) cubic and dodecahedral, (2) dodecahedral only, (3) cubic only, (4) cubic, dodecahedral, and octahedral faces are available are respectively 0-129, 0-225, 0-500, and 0-0882. Case (2) was found by Langmuir (*Phys. Rev.*, 1923, [ii], 22, 375) to be obtained for a uni-crystalline tungsten rod.

-W. H.-R.

Interference in Thin Metallic Films [Colours of Sputtered Films of Metals]. Hiram W. Edwards (Phys. Rev., 1931, [ii], 38, 166-173).-When thin metallic films are sputtered upon glass or upon other metals they may appear coloured, and the colours may undergo cyclic changes as the film becomes thicker. The changes of colour with time are described for copper when sputtered under standard conditions upon glass, nickel, and aluminium. In each case the first colour to appear is yellow, followed by purple, blue, and then by yellow again. The effect is regarded as due to interference, and equations are deduced to express the change of phase as the wave train is reflected from a metal surface in air, from metal in metal, and for refraction as the wave enters the metal from air, and from metal into air after passing both ways through the film. Using the optical constants of massive metals, a fair agreement between fact and theory is obtained, but the optical constants for thin metals are not in agreement, and the discrepancies exist between the thickness of the film estimated from optical theory and from weighing the deposit. On the whole the evidence favours the interference theory .-- W. H.-R.

The Influence of Cold-Working on the Specific Heat. J. A. M. van Liempt (*Naturwiss.*, 1931, 19, 705).—The increase of sp. heat caused by cold-working previously deduced from theoretical considerations (see this J., 1928, 40, 491) has been observed experimentally in the case of copper, nickel, and lead by M. Gaudino (*Rend. Sci. fis. mat. Napoli*, 1930, 35, 204).—J. W.

The Specific Heat of Metals at Very Low Temperatures. J. N. van den Ende (*Metallwirtschaft*, 1931, 10, 676-680).—A brief summary of recent theoretical and experimental work in this field.—v. G. On the Molecular Sphere of Action of Metals. Carl Benedicks (Z. physikal. Chem., 1931, Bodenstein-Festband, 379-384).—From thermodynamical con-

On the Molecular Sphere of Action of Metals. Carl Benedicks (Z. physikal. Chem., 1931, Bodenstein-Festband, 379-384).—From thermodynamical considerations the relation between surface tension and the internal pressure should be proportional to the radius of the sphere of molecular action. From numerical data in the literature the calculated radius for a number of metals is shown to be of the same order of magnitude as the atomic radius calculated from X-ray analysis, but shows large variations corresponding with those of the sixth power of the atomic radius.—v. G.

Phenomena of Transformation of So-Called Semi-Conductors. A. Schulze (Z. Metallkunde, 1931, 23, 261-264).-(1) The electrical resistance-temperature curve of polycrystalline silicon between 0° and 1300° C. shows no discontinuous change of direction : the sp. resistance decreases from 0° C. to a flat minimum between about 150° and 250° C., then rises to a maximum between about 550° and 650° C., above which it falls to a value at 1000° C. approximating to that of a pure metal. This behaviour is ascribed to the presence of films between the crystallites which are effective only at low temperatures. This would account for the temperature coeff. of the electrical resistance between 20° and 100° C. becoming less negative as the number of crystallites decreases and positive with a single crystal. The differential dilatometric curve between 20° and 1000° C. is a straight line. These results indicate that silicon undergoes no allotropic transformation. (2) The similar behaviour of the electrical resistance of germanium as observed by Bidwell (this J., 1922, 28, 534) is also ascribed to the presence of intercrystal-line films. (3) The electrical resistance of pure titanium increases with rise in temperature, i.e. titanium behaves like a metal. A small decrease in the resistance at temperatures above 600° C. is possibly due to the precipitation of small amounts of impurities on the surface of the specimen. A polymorphic transformation does not occur, as the resistance-temperature curve shows no discontinuity. (4) According to Zwikker (this J., 1927, 37, 415) zirconium undergoes a polymorphic transformation at about 830° C .- M. H.

Electric Conductivity and Optical Absorption in Metals, Once More. Edwin H. Hall (Proc. Nat. Acad. Sci., 1931, 17, 392-401).—The question is discussed whether electrical conduction in metals is due entirely to free electrons, equal in number to the number of atoms present, or in part to electrons which are not free in the ordinary sense, but may go directly from atoms to adjacent ions. It is shown that the resistance term in Drude's fundamental equation of motion of an electron within a metal is highly artificial, and the form which this equation takes when it is applied to a conduction electron is quite as appropriate for an electron that passes directly from an atom to an adjacent ion as for a "free" electron.—E. S. H.

Electrical Conductivity and Absorption in Metals (Supplementary). Edwin H. Hall (*Proc. Nat. Acad. Sci.*, 1931, 17, 427–430).—Transit conductivity in optical experiments is dependent on the ratio wave-period/transit-period in the same general way in which, according to both the Thomson formula and the Wilson-Jeans formula, free-electron conductivity is dependent on the ratio wave-period/free-path period.—E. S. H.

The Part Played by Protons in the Conduction of Electricity by Metals. II.— Measurements of Resistance. Alfred Coehn and Hans Jürgens (Z. Physik, 1931, 71, 179-204).—The motion of hydrogen under the influence of an electric field applied to wires of palladium and palladium alloys affords an interpretation of the observed changes of resistance of the wires with temperature and with the degree of saturation of the wires with hydrogen.—J. S. G. T.

The Hall Effect in Liquid Metals. J. Kikoin and Ibrahim Fakidow (Z. *Physik*, 1931, 71, 393–402).—A review of the literature of the possible existence of the Hall effect in liquid metals reveals that the conclusion that such an effect is practically non-existent in this case has no real foundation, either theoretical or practical. In the case of sodium–potassiun alloys, the existence of an effect of the anticipated order of magnitude and of the correct sign (—) is definitely established by K. and F. In the case of mercury the effect is immeasurably small.—J. S. G. T.

Thermal Analogy of the Barkhausen Effect. B. Del Nunzio (Atti R. Accad. Lincei (Roma), 1930, [vi], 12, 125–129; C. Abs., 1931, 25, 3884).— Measurements of the magnetization of nickel at temperatures between 0° and 400° C. in a constant magnetic field show that the magnetization falls slowly up to 300° C., and then abruptly to almost zero near the Curie point, (357° C.). —S. G.

Block Structure and Hysteresis Phenomena. Francis Bitter (*Phys. Rev.*, 1931, [ii], 37, 1176-1177).—A preliminary note of work to be presented to the American Physical Society. The author's previous suggestion (*Phys. Rev.*, 1931, [ii], 37, 91; this J., 1931, 47, 198), that the regions of spontaneous magnetization of the Weiss-Heisenberg theory are connected with the block structure postulated by Zwicky, has been developed and a brief description of a magnetization curve is given.—W. H.-R.

Magnetization and the Magneto-Caloric Effect. Francis Bitter (*Phys. Rev.*, 1931, [ii], **38**, 528-548).—(1) The nature of the magnetization process in ferromagnetic metals is discussed from the point of view of the "Block Theory" of Zwicky. Several considerations suggest that the blocks contain roughly 10⁵ atoms. They are magnetized in accordance with the Weiss-Heisenberg theory, the energy as a function of the direction of magnetization being determined by the crystalline field (Powell, *Proc. Roy. Soc.*, 1930, [A], **130**, 167; this J., 1931, 47, 72) by the presence of strains, and by the internal and external magnetized into larger clusters which give rise to the Barkhausen effect. Magnetization consists of two processes, a rotation of the magnetization of the Barkhausen clusters as a whole, and of individual blocks separately. As the temperature approaches the Curie point, the Barkhausen clusters become smaller, and break up at T = 0, whilst at T = 0, magnetization of the blocks disappears. (2) A detailed discussion is given

of the nature of the mechanism of the magneto-caloric effect (the evolution of heat accompanying a change in the magnetization of a ferromagnetic substance as distinct from the irreversible evolution of heat referred to as hysteresis).—W. H.-R.

The Temperature Variation of Intrinsic Magnetization and Associated Properties of Ferromagnetics. Edmund C. Stoner (Phil. Mag., 1931, [vii], 12, 737-763).-The relation of intrinsic magnetization to other properties of ferromagnetics is briefly discussed, and evidence for regarding ferromagnetism at room temperature as due to the interchange reaction of electron spins is summarized. Values are calculated for the variation with temperature, T, over the whole range from absolute zero to the Curie point, 0, of the magnetization, and the associated sp. heat and thermoelectric power of an idealized ferromagnetic, *i.e.* one in which magnetic properties are due entirely to electron spin interaction. A comparison of the observed characteristics of nickel as compared with those of an idealized ferromagnetic for which q, the number of effective spins per atom, equals 0.6 shows that, except for slight deviations at low temperatures, there is fair agreement up to about T/0 = 0.8. Above this, as T approaches θ , the ratio of the observed to the calculated magnetization increases up to about 1.3. The rate of change of sp. heat is also considerably greater than that calculated. The calculated total change of energy between 0° and 0° falls within the experimental limits. The observed sp. heat of electricity at 0 is of the same sign as that calculated, and agrees closely in magnitude, but the change of thermoelectric power (with respect to platinum) between T/0 = 1 and 0.9 is about half that calculated. A more complete interpretation of properties below θ can be given by taking account of interactions other than those between spin moments. A qualitative interpretation of the differences between nickel and the idealized ferromagnetic is given.-J. S. G. T.

II.-PROPERTIES OF ALLOYS

Thermal Conductivity, Electrical Conductivity, and Lorenz Number of Some Light Alloys. W. Mannchen (Z. Metallkunde, 1931, 23, 193-196).—The thermal conductivity λ (in cal. per cm. per 1° C. per sec.) and electrical conductivity κ (in reciprocal $\Omega \times 10^{-4}$) at -187° , 0°, 100°, and 203° C. has been determined for aluminium, magnesium, and the following alloys in the chill-cast condition: binary aluminium alloys with 8% and 15% copper, 8%, 12%, and 14% magnesium, and 20% silicon; binary magnesium alloys with 6%, 8%, and 12% aluminium, 8% and 15% copper, 8% zinc, 8% cadmium, 0.5-3.5% manganese, 0.7% and 1.5% silicon, and 8% and 12% cerium; ternary magnesium-rich alloys with aluminium and silicon; "Y"-alloy; KS-Seewasser alloy; &c. The original should be consulted for details of the results;

the mean error is 3-4%. The Lorenz number $L = \frac{\lambda}{H \times {}^{\circ} K}$ is generally larger

for alloys than for pure metals. In some cases, however, (aluminium-copper alloys and magnesium-manganese alloys, &c.), it is considerably smaller than that of the pure metal.—M. H.

The Influence of Stretching after Quenching on the Age-Hardening Process. W. Fraenkel (Z. Metallkunde, 1931, 23, 172–176).—(1) The Brinell hardness of an aluminium alloy with 4% copper and 1% silicon aged for 24 hrs. at 130° C. after quenching from 500° C. and subsequent reduction in thickness of 0, 1, 2, 5, 20, and 40%, is increased by 27, 24, 21, 16, 10, and 5 kg./mm.², respectively, *i.e.* the greater the amount of cold-work after quenching the smaller is the increase in hardness during ageing. The total increase in hardness by cold-work and by age-hardening is, however, greater the higher the degree of reduction. On the other hand, ageing followed by cold-work increases the hardness more than does cold-work followed by ageing; e.g. the Brinell hardness is 102 after a 40% reduction followed by ageing and 126 after ageing followed by a 40% reduction. The increase in the yield-point of this alloy on ageing follows the hardening effect. (2) Similar results were obtained with Duralumin. (3) The effect of stretching on the increase in hardness by ageing is much greater in the case of aluminium alloys with 6-8% zinc and 0.1% lithium : a reduction of 20% results in a nearly complete suppression of age-hardening. After a reduction of 0, 20, 40, and 60% and subsequent ageing at room temperature the alloy with 6% zinc, 0.1% lithium has a hardness of 48, 41, 46, and 51, respectively, and after ageing and subsequent reduction of 20, 40, and 60% a hardness of 68, 74, and 77. (4) The increase in the electrical resistance of quenched Duralumin by ageing at room temperature is reduced by cold-deformation after quenching. (5) The rate of agehardening (as determined by measurements of the hardness and electrical resistance) of Duralumin is increased by cold-deformation after quenching. (6) Stress is without influence on the increase in the electrical resistance of Duralumin during ageing at room temperature.-M. H.

Equilibrium Relations in Antimony-Aluminium Alloys of High Purity. E. H. Dix, F. Keller, and L. A. Willey (Z. Metallkunde, 1931, 23, 249).— Abstracted from Amer. Inst. Min. Met. Eng. Tech. Publ. No. 356, 1930, 1-9, and Trans. Amer. Inst. Min. Met. Eng., Inst. Metals Div., 1931, 396-402; see this J., 1931, 47, 9.—M. H.

Aluminium-Iron Alloys. C. A. Robak (Met. Ind. (Lond.), 1930, 36, 167). --Extract from Indust. and Eng. Chem. quoting a report in Industritidningen Norden.--J. H. W.

The Constitution of the Aluminium-Rich Aluminium-Iron-Silicon Alloys. V. Fuss (Z. Metallkunde, 1931, 23, 231-236; and (abstract) Z. ges. Giesserei Praxis: Das Metall, 1930, 51, 200).-The microstructures of various aluminium-iron-silicon alloys containing 95%, 88%, and 76% aluminium, and of alloys belonging to the sections Al-Fe₂Si, Al-FeSi, and Al_3 Fe-Si have been examined. The two first-named sections are not quasi-binary, i.e., the compounds Fe₂Si and FeSi cannot exist in commercial aluminium. The section Al₃Fe-Si is quasi-binary; a ternary compound exists which is found within a limited range of concentration by a peritectic reaction of Al₂Fe with the melt containing 31% silicon and 69% Al₃Fe. The ternary compound contains about 25% silicon and 75% Al₃Fe (this alloy is practically homogeneous after prolonged annealing), corresponding with the formula AleFe2Si3. The AlaFe,Si3-Si eutectic contains about 33% silicon and 67% AlaFe. The composition of commercial aluminium lies in the ternary system Al-Al₃Fe-Si; alloys lying on the Al₃Fe side of the section Al-Al₆Fe,Si₃ contain Al₃Fe and Al₆Fe₂Si₃ and those on the silicon side Al₆Fe₂Si₃ and free silicon embedded in each case in aluminium-rich solid solution, *i.e.* commercial aluminium consists of aluminium-rich solid solution, with inclusions of Al_aFe₂Si₂, and either Al_aFe or free silicon according to the iron and silicon content. A solidification diagram is given of the system Al-AlaFe-Si showing 4 different parts of the liquidus surface corresponding with the primary crystallization of aluminiumrich solid solution, Al₃Fe, Al₆Fe₂Si₃, and silicon, respectively. The ternary eutectic contains about 87% aluminium, 12.5% silicon, 0.5% iron, and melts at about 570° C. AlaFe, Sia is only very slightly soluble in solid aluminium. -M. H.

Chlumin, a New Light Aluminium Alloy. Ichiro Iitaka (Proc. Imp. Acad. Tokyo, 1931, 7, 161-164).—[In English.] Chlumin is an aluminium alloy containing eliromium with a little magnesium and iron; it is much more resistant to corrosion than Silumin, "Y" alloy, Duralumin, or pure aluminium, and presents no difficulties in casting. The cast alloy has better mechanical properties than Silumin or "Y" alloy, and can be readily rolled, drawn, and forged. The cold-worked alloy has mechanical properties as good as those of Duralumin, but does not require heat-treatment and does not harden on keeping at room temperature.—A. R. P.

Röntgenographic Determination of the Solubility of Magnesium in Aluminium. E. Schmid and G. Siebel (Z. Metallkunde, 1931, 23, 202-204).— The solid solubility of magnesium in aluminium determined by lattice measurements of alloys with 0.95-22% magnesium (containing 0.09-0.11% iron and 0.05-0.09% silicon) after quenching from 445° C. and annealing at $150^{\circ}-421^{\circ}$ C. is 2-95%, 3.38%, 4.38%, 6.25%, 9.05%, 12.05%, 15.00%, and 15.35% at 150° , 200°, 250°, 300°, 350°, 400°, 445°, and 451° C. (eutectic temperature), respectively. Results are in good agreement with those of Dix and Keller (cf. this J., 1929, 41, 438).—M. H.

[M.V.C.] New Light Alloy has Remarkable Properties. A. C. Blackall (*Canad. Mach.*, 1931, 42, (22), 24).—A new aluminium-silicon alloy, M.V.C., is produced by the Metropolitan-Vickers Electrical Co., Manchester. The makers claim for it a sp. gr. below that of aluminium, high tensile strength and ductility, an appearance resembling chromium plating when polished, and high resistance to tarnish and corrosion. It is produced as castings, rolled sheets, drawn tubes or rod, spinnings, stampings, and pressings. The cost of machining is low.—P. M. C. R.

[M.V.C.] A New Aluminium Alloy. Anon. (Met. Ind. (Lond.), 1931, 39, 392).—A new light alloy produced by the Metropolitan-Viekers Electrical Company and designated M.V.C. is a pure alloy of aluminium and silicon, produced by special modification, giving a fine-grained structure and a silky fracture. The ultimate tensile strength is given as 9–11 tons/in.² sand-cast and 11–13 tons/in.² chill-cast. It is so ductile that it can be rolled, drawn, spun, forged, pressed, or stamped, even in thin sections, and it is said to be very resistant to corrosion by sea-water.—J. H. W.

Improvement of Alloys, with Especial Reference to Researches on Light Metals and on Alloys of Beryllium. G. Masing (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 22-36; and also Z. Elektrochem., 1931, 37, 414-428; discussion, 428-429).—Recent work on the effects of cold-work and heat-treatment on the mechanical, electrical, and magnetic properties and on the lattice constants of various metals and alloys is reviewed and discussed, special attention being devoted to Duralumin, and copper-aluminium, beryllium-copper and copper-gold alloys, and to the mechanism of agehardening of these alloys.—A. R. P.

Heats of Solution, Heats of Formation, and Free Energies of Formation of Cadmium Amalgams. Charles Edwin Teeter (J. Amer. Chem. Soc., 1931, 53, 3927-3940).—The experimental work carried out was a repetition, with refined methods, of Frevert's investigation of the heats of solution of cadmiumrich amalgams. The calculated heats of formation, using the data of Smith on the temperature coeff. of e.m.f. for cells containing cadmium amalgams do not agree with the calorimetric results. The liquidus curve obtained by Bijl is confirmed and the metallography of the amalgams is briefly discussed. —R. G.

The System Calcium-Bismuth. Edmund Kurzynice (Bull. Internat. Acad. Polonaise, 1931, A, 31-58).—The alloys were prepared by fusion of the constituents in an iron crucible in an atmosphere of argon. Two compounds were found in the system, viz. Ca₃Bi₂, heat of formation at 21.5° C., 51.6 kg.-cal./ mol., melting point 928° C., and CaBi₃ formed by a peritectic reaction at 506° C., Ca₃Bi₂ + liquid — CaBi₃. The former compound forms a cutectic with calcium, melting point 785° C., and considerably increases the brittleness of the alloys. All the alloys are attacked by moist air, which forms a useful etching agent for revealing the microstructure.—A. R. P.

The Chromium-Iron Equilibrium Diagram. [F.] Wever and [W.] Jellinghaus (*Metallurgist* (Suppt. to Engineer), 1931, 7, 139-140).—A summary of a paper by W. and J. in *Mitt. K.-W.-Inst. Eisenforschung*, 1931, 13, 143.

-R. G.

Alloys of Iron Research. X.-The Chromium-Iron Constitutional Diagram. Frank Adcock (Iron Steel Inst. Advance Copy, 1931, 1-48).-About 40 alloys were prepared from electrolytic chromium and electrolytic iron of high purity and were treated with hydrogen to reduce the oxygen content. They were vacuum-melted in thoria-lined alumina crucibles in a valve-energized coreless induction furnace, and subsequently vacuum-annealed for 12 hrs. at 1300°-1350° C. Much difficulty was experienced in etching the specimens for micro-examination owing to passivity, but, after being activated by a boiling solution of 1% sulphuric acid, they could be satisfactorily etched electro-lytically with Vilella's reagent. For the liquidus, thermocouples were used for the lower ranges and an optical pyrometer for higher temperatures. Some difficulties were experienced owing to distillation of chromium at high temperatures and subsequent segregation. The solidus was determined with wellannealed samples up to 70% chromium, but the curve obtained is regarded as tentative. The y-loop at the iron-rich end of the diagram was exhaustively and accurately determined. The magnetic changes were investigated by thermal curves and magnetic methods for the range 0-80% chromium and preheat-treatment was found to alter the temperatures of magnetic changes. The Brinell hardness, electrical resistivity, and density of the alloys were recorded, and appendices give results of X-ray investigation and of magnetic properties at room temperature. As a result of this research, it is concluded that chromium and iron form a continuous series of solid solutions, the liquidus

rising to 1830° C. for the freezing point of chromium.—J. H. W. Dilatometric Study of Chromium-Nickel-Iron Alloys. Vsevolod N. Krivobok and Maxwell Gensamer (Amer. Inst. Min. Met. Eng. Tech. Publ. No. 434, 1931, 1-23).—The paper refers to the effect of previous low-temperature treatment on the Rockwell hardness at normal temperatures. The dilatometric method was selected to secure data which would provide an explanation of the causes of the changes in mechanical and other properties. Results on alloys cooled from room temperature to -190° C. and also observations in the range 1000° C. to -190° C. are given. It is established that, for a given nickel content, the amount of carbon that will produce hardening is limited to a rather narrow range, but as the nickel content decreases and carbon increases, this range becomes broader. The data from the dilatometric study are in good agreement with the existing constitutional diagrams. The temperature of transformation depends on the carbon and nickel contents. Certain chromium and chromium-nickel steels in the "stainless" range can be hardened by rapidly cooling to room temperature and then immersing in a liquid—say solid carbon dioxide and acetone-well below room temperature. The increase in hardness is due to the decomposition of austenite at low temperatures. The progress of the phase change is a function of temperature. Only a few minutes are necessary to establish a quasi-equilibrium between the retained metastable austenite and the chromium-nickel ferrite and carbides at any temperature. The addition of nickel to 18% chromium-iron alloys lowers the temperature at which the γ to α transformation occurs on cooling.

Further investigation is contemplated.—W. A. C. N.
Cast "Aluminium-Bronzes." IV.—Theory of Shrinkage. W. Claus and F. Goederitz (*Giesserei*, 1931, 18, 319-326).—Cf. this J., 1930, 43, 456; and 1931, 47, 408. A theoretical explanation is given of the observed shrinkage phenomena in cast binary aluminium- and tin-bronzes based on the assumption that the metal in the mould solidifies in a succession of layers from the surface inwards. This theory is discussed with reference to three ideal cases

in which (i) the shrinkages of liquid and solid metal are the same, (ii) the solid metals shrinks twice as much as the liquid, and (iii) the liquid shrinks twice as much as the solid. The ideal process is, however, modified in practice by intercrystalline liquation, the presence of adsorbed gases, the orientation of the crystallites, and variations in the rate of solidification. Large pipes are formed when the cooling conditions are unfavourable, such as is the case with castings made in vertical sand moulds, especially when green-sand is used.—A. R. P.

[Hibbo] New Aluminium-Bronze Alloy. Anon. (Met. Ind. (Lond.), 1931, 39, 436).—Short note on the properties of "Hibbo," a new "aluminiumbronze" containing iron alloyed by a secret process. The alloy is said to have high tensile strength, hardness, fatigue, ductility, elongation, toughness, and resistance to corrosion and to be lighter than ordinary bronze.—J. H. W.

Batterium Alloy. Anon. (Mech. World, 1931, 90, 410).—Cf. this J., 1931, 47, 532. A non-corrodible alloy, consisting of copper 89%, aluminium 9%, nickel and other metals 2%, has been introduced by Batterium Metal and Vislok, Ltd., Market Harborough. It is claimed to be suitable for the construction of all types of plant used in the chemical industries and is supplied in all the usual worked and cast forms. Its properties are as follows: sp. gr. 7.67; melting point 1035° C.; tensile strength 35-45 tons/in.²; thermal coeff. of expansion 0.0000162 per 1° C.; Brinell hardness number 168-168; clongation on 2 in. 35-48%; electrical resistivity 13.21 microhms c.c. at 20° C.; relative electrical conductivity 15.21% of copper; electrical temperature coeff. 0.08% per 1° C.—F. J.

Beryllium-Copper Alloys. Edmund R. Thews (Canad. Chem. and Met., 1931, 15, 51-53).—Recent work on beryllium-copper alloys and their heattreatment is summarized and reviewed. By age-hardening alloys with 1-3% beryllium the elastic limit can be increased by 700% and the bending strength by 200% without reducing the resistance to corrosion below that of a good bronze. Addition of small quantities of phosphorus accelerates and intensifies the age-hardening process. "Beryllium-bronzes" give sound castings free from all porosity, have a high electrical conductivity, and, when heat-treated, make good non-magnetic springs. Beryllium is an efficient desulphurizer for copper and copper alloys.—A. R. P.

The Measurement of the Resistance of [Manganin] Wires for High-Frequency [Currents]. K. Kreielsheimer (Z. Physik, 1931, 71, 260-272).—A Wheatstone bridge arrangement for the measurement of the high-frequency resistance and self-induction of Manganin wires for high-frequency oscillations of wave-lengths 45-250 m. is described.—J. S. G. T.

Internal Stresses in Brass Tubes. A. Křeček (Z. Metallkunde, 1931, 23, 178–185).—The determination of the magnitude of internal stress in 63:37 brass tubes according to the drawing operation, &c., has shown that even very small finishing drawings which are necessary to straighten or brace the tube produce dangerous internal stresses. Internal stress decreases with the degree of hardness. With hardened and well-annealed material eracking of the tube takes place after a reduction in diameter of 1.5% and 5%, respectively. With a simultaneous reduction in wall thickness the internal stress considerably decreases. Tubes which have no tendency to erack can be manufactured from well-annealed material if a small reduction in diameter is combined with a large reduction in wall thickness. The time before eracking occurs is no criterion of the magnitude of the internal stress,—M, H.

Increasing the Endurance Limits of [Brass and Lautal] Threads by Surface Pressures. H. Jsemer (*Metallwirtschaft*, 1931, 10, 714–717),—By compressing the surface of threaded rods of brass and Lautal the endurance strength to alternate bending stresses can be increased by 20-30%,—v. G.

Large Non-Ferrous Castings. Wesley Lambert (Met. Ind. (Lond.), 1931, 38, 111-112).—Abstract of a paper read before the Manchester Metallurgical Society. The properties and structure of manganese-brass containing 50-60% copper, up to 8% manganese, up to 5% nickel, up to 2% iron, up to 1.5% tin, up to 5% aluminium, with the remainder zinc, and the applications of this class of alloy are described.—J. H. W.

A Simplified Method of Manufacturing Special [Nickel- and Manganese-] Brasses. Auguste Le Thomas (*Rev. Met.*, 1931, 28, 518-523).—The brasses considered are those containing nickel and manganese. The alloys are considered from the point of view of the coeff. of zinc equivalence of the added elements. The brass of the desired equivalent content of copper and zinc is melted with addition of a brass containing the additional elements in correct ratio, but in greater amounts than those desired in the final alloy. The character of the brass is checked by microscopical examination of small cast samples and by testing small cast bars in torsion.—H. S.

The German Silver Alloys. Edmund R. Thews (Met. Ind. (Lond.), 1931, 39, 243-245, 315-316, 363-366).—German silver alloys, under various trade names, are nickel-brasses containing nickel 5-33, zine 13-35, and copper 50-70%. The effects of each of these constituents on the physical and mechanical properties of the alloys are discussed. Lead is frequently added to improve the cutting properties of the alloys. Tin in excess is liable to be injurious, but in small quantities it increases the density and allows of a much higher polish; it is best added as phosphor-tin. Silver is added, up to 25%, for advertising purposes only. Aluminium up to 2% produces a dense structure; more than this tends to brittleness. Cadmium has an effect similar to that of lead, but is more expensive. Tungsten has a favourable effect on the electrical properties but an unfavourable effect on the mechanical properties, and is not usually added to nickel-brasses. The chemical composition, properties, and applications of these alloys and the three principal methods of manufacturing them are described.—J. H. W.

Considerations of Some Industrial Bronzes. Anon. (Z. ges. Giesserei-Praxis: Das Metall, 1931, 52, 102–104, 107–108).—The composition, preparation, and physical and mechanical properties of a large number of industrial bronzes, many known only under trade names, are described. The compositions range from copper 5.7–94.4, tin 0–86.7, lead 0–15, antimony 0–10, zinc 0–3, and nickel, arsenic, or phosphorus 0–0.8%.—J. H. W.

Nickel Additions Affect Bearing Wear Resistance. James Brinn (Foundry, 1931, 59, (16), 40-41).—The addition of nickel up to 1.0% has little effect on the properties of the bearing alloy containing copper 80, tin 10, and lead 10%. The addition of 2% of nickel to this alloy, or pouring it into chill moulds results in shorter life of the bearings. Practical service tests and research investigations indicate that the improvement in grain structure and Brinell hardness due to these causes lessens the resistance to wear. Nickel promotes uniformity of distribution of the lead particles, but increases the tendency of the alloy to oxidize, both in the crucible and in the mould. Sand-cast bearings of the regular 80: 10: 10 alloy made under proper foundry conditions are the most desirable from the service point of view.—F. J.

Electrical Properties of Dilute Solid Solutions. I.—Gold Alloys. J. O. Linde (Ann. Physik, 1931, [v], 10, 52-70).—The electrical resistance of carefully prepared, very pure, annealed gold alloys has been measured between -190° and $+20^{\circ}$ C.; the results confirm Norbury's rule that the atomic increase in resistance is greater the greater the distance between the elements in the periodic system. Exceptions occur only with elements of the transition group, especially those of the iron group, e.g. the gold-chromium and goldcobalt alloys show deviations from Matthiessen's law. The results show that the solid solubility of indium in gold is at least 1.7 atoms % and that of rhodium at least 0.6 atom %, whereas ruthenium, iridium, and osmium are not appreciably soluble in gold.—v. G.

The Superconductivity of Gold-Bismuth [Alloys]. W. J. de Haas and F. Jurriaanse (*Naturwiss.*, 1931, 19, 706).—The superconductivity of goldbismuth alloys is attributed to the presence of a previously unknown constituent which appears to be the tetragonal compound AuBi. Neither gold nor bismuth alone shows superconductivity, hence the lattice structure is of considerable importance for this phenomenon.—J. W.

Investigations on Gold-Copper Alloys by Means of the Diffraction of Fast-Moving Electrons. O. Eisenhut and E. Kaupp (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 74-80).—An apparatus is described and illustrated for the examination of thin films of metal deposited on mica by distillation in vacuo using the electron emission from a hot cathode. The method admits of a ready determination of the lattice parameter with an accuracy almost equal to that obtained in the usual X-ray analysis. Results obtained with the method indicate that it is very doubtful whether, even with slow distillation, monatomic films can be prepared. By depositing films of gold and copper on top of one another and annealing, it is possible to follow the formation of solid solutions. The rate of formation of homogeneous solid solutions is a function of the temperature, and for films 10-6 cm. thick the time required t (minutes) is related to the absolute temperature (T) by the equation t =1015. e-T/16, i.e. the rate is doubled by an increase of 10° C. With a 1:1 atomic ratio gold-copper films on mica develop a tetragonal structure with superstructure lines after annealing for 1 minute at 225°-400° C.; at temperatures between 450° and 500° C. this tetragonal structure is converted into a lattice with a structure of the zinc blende type AB having a = 5.40 A. Goldaluminium alloys with a 1: 1 atomic ratio also develop a zinc blende structure, a = 6.04 A. on annealing above 400° C.—A. R. P.

The Electrical Conductivity of Gold-Nickel Alloys. G. Grube and F. Vaupel (Z. physikal. Chem., 1931, Bodenstein-Festband, 187-197).—Temperature-resistivity curves for gold-nickel alloys confirm Fraenkel and Stern's equilibrium diagram (this J., 1926, 36, 444; 1927, 38, 421), but not that of Heike and Kessner (this J., 1929, 42, 453). Below 850° C. the homogeneous solid solution phase with 5-85% nickel decomposes into a mixture of two saturated solid solutions. The transformation of nickel falls with increasing gold content from 390° C. with pure nickel to 350° C. in the heterogeneous field.—v. G.

Contributions to the Systematic Study of Affinities. LIII.—Affinity of Phosphorus for Gold and Silver. Haakon Haraldsen and Wilhelm Biltz (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 110–116).—Gold and phosphorus form only one phosphide Au₂P₃, which forms no solid solutions with gold. Silver forms 2 phosphides AgP₃ and AgP₂, which have a limited range of solid solutions between themselves but form no solid solutions with silver. The densities, dissociation pressures, and heats of formation of these phosphides have been determined.—A. R. P.

New White Gold. Anon. (Met. Ind. (Lond.), 1931, 39, 458).—Short note. 18 carat gold alloyed mainly with palladium and a little silver is recommended for enamelling. Its colour is not quite so good as that of nickel-gold, but it is much softer, can be easily annealed, and takes enamel much better. —J. H. W.

The Miscibility Gap in the Systems Lead-Copper and Lead-Copper-Tin. S. Briesemeister (Z. Metallkunde, 1931, 23, 225-230).--(1) The miscibility gap in liquid copper-lead alloys has been fixed by analysis of samples taken at about 1000°, 988°, and 972° C. from the upper layer of a liquid alloy con-

taining 35% copper. The maximum (critical point) of the curve of the formation of two liquid layers lies at 35% copper and 1000° C. (45° C. above the liquidus temperature), *i.e.* above 1000° C. all copper-lead alloys form a homogeneous liquid. (2) The miscibility gap is considerably widened by the addition of tin, possibly, owing to the presence of Cu₃Sn in the melt. Tin raises the critical point of the copper-lead system to 1130°-1140° C. with 35% copper, 50% lead, and 15% tin. Isothermal curves of the formation of two liquid layers are given for 835°, 955°, 1005°, 1060°, and 1110° C. The formation of two layers can be avoided by chill-casting at temperatures above the miscibility gap after careful stirring.-M. H.

[Boroto] Bearing Metal Containing Graphite. Anon. (Met. Ind. (Lond.), 1931, 39, 390).-Boroto is a bearing metal containing graphite in colloidal form. The graphite enables the alloy to retain the lubricating oil and at the same time to produce a good antifriction surface. Boroto bearing metal can be made in any desired white-metal alloy. In practice, 5 brands are marketed, all being considerably cheaper than high tin-base bearing metals. The brands range from an alloy having a Brinell hardness of 17-18 and a resistance to pressure of 600 kg./cm.², suitable for light, high-speed work, to one having a Brinell hardness of 35 and a resistance to pressure of 1150 kg./cm.², suitable for extra-high friction speeds and bearing pressures. The working life of these alloys is said to exceed that of other metals .-- J. H. W.

On Cadmium in High-Lead Bearing Metals. K. L. Ackermann (Metallwirtschaft, 1931, 10, 593-597) .- In the ternary system lead-cadmium-antimony the cadmium is present as CdSb, which forms a quasi-binary eutectic with 91% lead, but no solid solutions, even after addition of tin. Cadmium-leadantimony alloys are too soft with less than 5% antimony and too brittle with more than 4% cadmium to be used as bearing metals. With less than 4% cadmium the action of the cadmium is similar to that of tin. Addition of 59 tin and 5% cadmium to lead-antimony alloys increases the impact strength and hardness. The wear by friction in the bearings is greater with cadmium-bearing alloys than with those containing tin. In copper-antimony-cadmium alloys the copper exists as the compound Cu₂Sb; in the rapidly cooled alloys the metastable compound Cd₃Sb₂ occurs, but on slowly cooling this is decomposed into CdSb and cadmium. In these alloys, too, an addition of tin results in better tensile properties than does an addition of cadmium.-v. G.

Technology and Uses of Elektron. Walther Schmidt (36. Hauptversammlung Deut. Bunsen-Ges. : " Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 116-125) .- The physical and mechanical properties of 5 casting and 7 die-casting alloys of the Elektron type are tabulated and examples are given of their uses in the aircraft and automobile industries. Prior to alloying, the magnesium is purified by fusion in iron pots under a layer of magnesium chloride, fluorspar, and magnesia; iron may be removed by addition of about 3% of manganese, followed by slow cooling, whereby the iron settles to the bottom of the pot as an iron-manganese alloy, leaving about 2% of manganese in the upper magnesium layer. This manganesemagnesium alloy has a high resistance to corrosion, and is readily workable by forging, rolling, or pressing above 300° C.-A. R. P.

Elektron. Anon. (Bull. tech. Suisse Romande, 1931, 57, 281-282).-The sp. gr. of Elektron, and its ultimate stress in the form of sheet, stampings, sand- and chill-castings, and die-castings, are given. The applications of Elektron to the oil industry, aero and automobile work, the textile industry, where the increased size of machines has necessitated reduction of dead weight, and to other factory machinery are enumerated.-P. M. C. R.

[Elektron] Magnesium Alloy Finds Varied Uses in Germany. Anon. (Iron Age, 1931, 128, 1240).-Elektron has a sp. weight of 1.8 and a tensile strength BLIO?

POLITECHNIK

VOL. L.

(rolled) of 35,000-60,000 lb./in.². It is inflammable at above 625° C., and turnings become ignited when the alloy is machined at high speeds. —J. H. W.

Nickel-Chromium and Iron-Nickel-Chromium Alloys. Anon. (Metallurgist (Suppt. to Engineer), 1931, 7, 134-136).—A review of recent work dealing mainly with the work of Wever and Jellinghaus, Mitt. K.-W.-Inst. Eisenforschung, 1931, 13, 93-108. See this J., 1931, 47, 522.—R. G.

Some Developments in High-Temperature Alloys in the Nickel-Cobalt-Iron System. C. R. Austin and G. P. Halliwell (Amer. Inst. Min. Met. Eng. Tech. Publ. No. 430, 1931, 1-21).-The investigation deals with the development of the "Konel" series of alloys, which are essentially nickel-cobalt-iron with small quantities of other elements, principally about 2.5% of titanium. The mechanical properties at high temperatures (600° C.) have been studied, using the tensile test and the Howard Scott bending test. In the latter the degree of plastic deformation in a metal strip loaded by bending is evaluated in terms of the maximum strain applied. Its value lies in the quickness with which properties equivalent to the tensile proportional limit and the creep limit may be determined. All the alloys were age-hardened before testing. High values for the proportional limit at 600° C. have been recorded. An alloy containing nickel 46.1, cobalt 24.86, iron 7.02, titanium 2.19, and chromium 18.74% has a proportional limit of 57,500 lb. at 600° C., an elongation of 21.5%, and a reduction in area of 21.7%. Substitution of cobalt for some nickel appears to increase the ductility without loss of strength. About 80% of the maximum ageing hardness was obtained with most of the alloys by heating at 650° C. for 72 hrs. Certain of the alloys, however, showed no marked age-hardening properties, and it is suggested that the predominating factor in determining this is the titanium addition. Ageing persists over long periods at relatively high temperatures .- W. A. C. N.

On the Magnetic Properties of Perminvar. Heinrich Kühlewein (Wiss. Veröff. Siemens-Konzern, 1931, 10, (2), 72-88).—The hysteresis curves of numerous alloys in the Elmen range of composition have been determined; the shapes of the curves vary regularly with the composition from the normal hysteresis loop (nickel 40, iron 40, cobalt 20%) to the "three-line type" (nickel 35, iron 20, cobalt 45%) in which a short horizontal section is followed by a long vertical section terminating in a rapidly falling smooth curve. An increase in the Perminvar character of the alloys is obtained by annealing at higher temperatures or by increasing the cobalt content, but in both cases annealing must be followed by slow cooling. Alloys with approximately a 1: 1 nickel-iron ratio show Perminvar characteristies on the addition of 1-3% of cobalt. The special magnetic properties of Perminvar alloys is attributed to stresses set up by the precipitation of small quantities of impurities during the annealing treatment.—A. R. P.

Magnetic Properties of Copper-Nickel Alloys. E. H. Williams (*Phys. Rev.*, 1931, [ii], 38, 828-831).—The magnetic susceptibilities of copper-nickel alloys have been measured at temperatures up to 575° C. Alloys up to about 0.8% of nickel are diamagnetic, those from 1 to 55% of nickel are paramagnetic, and above 55% of nickel the ferromagnetism increases rapidly. The paramagnetic alloys from 1 to 30% of nickel do not obey the usual paramagnetic temperature law, but show maximum susceptibilities at temperatures between 300° and 400° C., which is in the neighbourhood of the Curie point for pure nickel. For alloys containing 40% of nickel, or more, the susceptibility decreases with temperature. [*Note by Abstractor.*—The alloys were prepared in an induction furnace, but were apparently not given further annealing, and W. states that ropeat experiments on a sample after it had been heated to 600° C. invariably gave higher susceptibilities than the original values.]

-W. H.-R.

On Nickel-Copper Alloys at Low Temperatures. A. Krupkowski and W. J. de Haas (Z. Metallkunde, 1931, 23, 196).—Abstracted from Proc. K. Akad. Wet. Amsterdam, 1930, 32, 912–920, 921–929; cf. this J., 1930, 43, 479.

-M. H.

Characteristics and Properties of Monel Metal. Anon. (Metallurgia, 1931, 5, 23-25).—A description of the properties of Monel metal in which a brief reference is made to its composition, and its strength in the cast and rolled conditions. Tests are given both at temperatures from 15° to 800° C., and also on rods of varying sectional size and shape. A table of physical properties is given and the influence of acerated solutions of sulphuric acid on the corrosion rate of the metal is considered. A description is also given of the melting and casting; mechanical treatment, annealing, and pickling; and of the soldering, brazing, and welding of this alloy together with its various applications.

-J. W. D.

Centrifugally Cast Monel Metal. J. E. Hurst (*Met. Ind.* (*Lond.*), 1931, 39, 171-172).—A full list is given of the physical properties of Monel metal, consisting of nickel 68%, copper 29%, and 3% of added metals, chiefly manganese, iron, and carefully controlled quantities of carbon, sulphur, and silicon. The annealing range is given as 700°-870° C., the hot-working range as 980°-1150° C., and the upper limit for continuous working in an oxidizing atmosphere as 500° C. The alloy is normally magnetic, but loses this property temporarily above 100°-150° C. The pouring temperature is 1500° C., and 2 oz. magnesium per 100 lb. metal are added as a deoxidizer. The alloy is very amenable to centrifugal casting, and still more so is an alloy formed by adding about 2.75% silicon to the remelted Monel metal. The yield-stress of this silicon alloy is between 43 and 50 tons/in.², as compared with 25-35 tons/in.² for Monel metal.—J. H. W.

Example of an Unstable State in Iron-Nickel Alloys Which Cannot be Brought to Reaction even at 1000° C. L. Anastasiadis and W. Guertler (Z. Metallkunde, 1931, 23, 189–190).—In continuation of the work by Gossels (cf. this J., 1929, 42, 461) the hysteresis of the $\alpha = \gamma$ transformation (cubic body-centred = cubic face-centred) which takes place in iron-nickel alloys containing up to 35% nickel, was studied by measurement of the electrical resistance of alloys with 15% and 25% nickel. No improvement of the reversibility of the transformation was attainable whatever changes in heating and cooling were made. Results point to the existence of a metastable state of equilibrium even at temperatures above 600° C.—M. H.

Researches on the Rotation of Permalloy and Soft Iron by Magnetization and the Nature of the Elementary Magnet. S. J. Barnett (Proc. Amer. Acad. Arts Sci., 1931, 66, 273-348).—If µ₀ is the magnetic moment of the elementary magnet in a ferro-magnetic substance, and Mo its angular momentum, the gyromagnetic ratio is defined by $\rho = M_0/\mu_0$. For an elementary magnet consisting of a Rutherford-Bohr magneton, or electron moving in an orbit about a nucleus, $\rho = 2m/e$, whilst for a Lorentz electron spinning on a diameter, $\rho = m/e$. The values of ρ for iron and permalloy have been determined as $(1.037 \pm 0.003) \times m/e$, and $(1.049 \pm 0.003) \times m/e$, respectively. The difference between the two values is definitely within the experimental error, and suggests that the chief magnetic element in ferromagnetic substances is the spinning electron with $\rho = m/e$, but with an additional contribution due to orbital motion. The method used was that of rotation by magnetization, experiments being made both with the magnetizing coil wound rigidly on the rotor, and with the coil fixed to the earth. Most of the paper deals with the experimental methods used to avoid secondary effects. The differences of 4-5% between these and earlier results are due to the failure of previous investigators to eliminate effects of magneto-striction, residual magnetization, and inequality of half cycles of current.-W. H.-R.

Ferromagnetism and Phase Configuration in the Binary System, Nickel-Manganese. Seiji Kaya and A. Kussmann (Z. Physik, 1931, 72, 293-309) .-Nickel-manganese alloys containing 12-40% of manganese are ordinarily either feebly ferromagnetic or paramagnetic, but by long heat-treatment below 450° C. can be transformed into a strongly ferromagnetic state. In the case of such alloys containing about 23% of manganese, the saturation value of the magnetization is increased about 25 times by such heat-treatment, and is then about 20% greater than that of pure nickel. Simultaneously, the electrical conductivity of the alloys increases considerably. These anomalous magnetic and cleetrical characteristics of the alloys disappear when the alloys are annealed at high temperatures and are subsequently quenched. The transformation from the feebly magnetic to the ferromagnetic state of the alloys occurs in the homogeneous phase without recrystallization, and is attributable to the orderly distribution of both kinds of atoms in a space lattice corresponding with the stoichiometric composition Ni₃Mn (23.7% Mn). The course of this transformation and the phase diagram relating to alloys containing up to 40% of manganese is established by magnetic, clectrical, metallographic, and X-ray measurements.-J. S. G. T.

An Exceptional Isotherm at 0° of the System : Palladium-Hydrogen. Louis J. Gillespie and John H. Perry (J. Physical Chem., 1931, 35, 3367-3370). —A pressure-composition isotherm at 0° C., probably representing an extension of the first rising isotherm into a metastable region, is discussed. The highest pressure observed is 110 mm. of mercury, corresponding with about 0.95 atom of hydrogen per atom of palladium.—J. S. G. T.

The Arsenides of the Platinum Metals. Lothar Wohler and K. F. A. Ewald (Z. anorg. Chem., 1931, 199, 57-64).—Cf. this J. 1930, 43, 481, and 1931, 47, 523. The preparation of arsenides of iridium IrAs₂, rhodium RhAs₂, ruthenium RuAs₂, platinum PtAs₂, and palladium PdAs₂ is described.—M. H.

The Platinum-Iridium Alloys.—I.-II. Ernest A. Smith (Metallurgist (Suppt. to Engineer), 1931, 7, 102–103, 120–121).—A description of the properties and uses of platinum and iridium, and their alloys.—R. G.

Contributions to the Systematic Study of Affinities. LII.—Affinity of Sulphur for Rhenium.—I. Robert Juza and Wilhelm Biltz (36. Hauptversammlung Deut. Bunsen-Ges. : "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 106-109).—The lowest sulphide of rhenium which can exist in an atmosphere of sulphur vapour is the disulphide; this dissociates at 1189° C. into rhenium and sulphur. Rhenium disulphide has the molybdenum disulphide type of lattice and has only a slight solid solubility for the metal.—A. R. P.

The Separation of Constituents and Changes of Properties Exhibited by Supersaturated Silver-Copper Alloys. N. Ageew, M. Hansen, and G. Sachs (*Mitt. Material., Sonderheft* 18, 1931, 3-15).—See this J., 1931, 47, 78.—J. W.

The Quasi-Binary Section Silver-Cuprous Oxide in the System Silver-Copper-Oxygen. J. A. A. Leroux and K. W. Fröhlich (Z. Metallkunde, 1931, 23, 250-254).—The quasi-binary system silver-cuprous oxido has been investigated by thermal and micrographical analysis. The melting point of cuprous oxide lies above 1226° C. There is a large miscibility gap in the liquid state between 5% and about 83% silver at 1134° C. (i.e. the temperature of the non-variable equilibrium : melt containing 5% silver = cuprous oxide-rich solid solution with about 2.7% silver + melt with 83% silver). Silver retains about 0.3% cuprous oxide in solid solution. The eutectic contains 97.7-97.9% silver and melts at 941° C. As little as 0.5% cuprous oxide causes the so-called "hydrogen sickness" on annealing in hydrogen by the reaction $Cu_2O + H_2 = 2 Cu + H_2O$. When alloys rich in cuprous oxide are annealed at 1000° C. the latter decomposes into cupric oxide and copper, the former being scorified by the material of the crucible (porcelain) and the latter becoming a constituent of the alloy.—M. H.

On the Behaviour on Melting and Solidifying of Silver-Copper Alloys Containing Oxygen. H. Moser and K. W. Fröhlich (*Metallwirtschaft*, 1931, 10, 533-535).—The ternary system silver-copper-cuprous oxide has been examined by micrographical and thermal methods. At 1250° C. about 25% of cuprous oxide will dissolve in liquid silver-copper alloys. The ternary eutectic melts at 776° C. and contains 66.5% silver, 32.8% copper, and 0.7% cuprous oxide. The composition of the binary eutectic in the copper-silver system (71.6% silver, 28.4% copper) is thus considerably changed by even small quantities of cuprous oxide, and hence the structure of the solid alloys is correspondingly altered.—v. G.

The Influence of Oxygen on the Workability of Technical Silver-Copper Alloys. E. Raub (*Metallwirtschaft*, 1931, 10, 769-773).—Cuprous oxide is formed as a surface layer on annealing silver-copper alloys, and is forced into the interior during subsequent working, thereby causing brittleness and fractures and a poor appearance of the surface after polishing. In subsequent silver-plating of the surface the euprous oxide causes the formation of pores, and it is therefore recommended to use electrolytic and not scrap copper in making the alloys and to add 0.05% cadmium as a deoxidizer in remelting silver-copper alloy scrap. The use of phosphor-copper as a deoxidizer leads to difficulty in the subsequent silver-plating. In melting and annealing the alloys the metal should be covered with wood charcoal.—v. G.

The System Silver-Copper-Manganese. M. Keinert (Z. physikal. Chem., 1931, [A], 156, 291-303).—The phase diagram of the ternary system silvercopper-manganese has been outlined by the microscopical examination of 18 furnace-cooled alloys covering the whole range of concentration. The region of immiscibility in the liquid state derived from the miscibility gap in the silver-manganese system lies within a copper content of less than about 32% and a manganese content of more than about 28%. Only 2 constituents exist: solid solutions of copper and manganese in all proportions containing small amounts of silver and silver-rich solid solutions with a small copper and manganese content. Owing to the decrease of solid solubility of copper and manganese in silver with fall in temperature the silver-rich alloys can be hardened at 280° C. after quenching from 750° C. (Note by abstractor : Results are discussed on the assumption that copper and manganese form a continuous series of solid solutions; cf. however, T. Ishiwara, Sci. Rep. Tohoku Imp. Univ., 1930, [1], 19, 499-519; this J., 1931, 47, 268).—M. H.

An Electrochemical Investigation of Solid Silver-Gold Alloys. Arne Ölander (J. Amer. Chem. Soc., 1931, 53, 3577–3588).—The results are given of potential measurements on silver-gold alloys at such high temperature that sufficient diffusion in the crystal lattice to maintain thermodynamic equilibrium would be expected. The cell Ag/AgCl,KCl/(Ag,Au) was employed. A tentative phase diagram of the silver-gold system is given. There exists a phase of low entropy below 800° C. from 0 to 18 atomic % of gold. Another less marked seems to exist above 50 atomic % gold.—R. G.

Properties of Strontium-Tin Alloys. K. W. Ray (Z. Metallkunde, 1931, 23, 273).—Abstracted from Indust. and Eng. Chem., 1930, 22, 519-522; cf. this J., 1930, 44, 515-516.—M. H.

The Physical and Radiating Properties of Tantalum Carbide. K. Becker and H. Ewest (Tech.-wiss. Abhandl. Osram-Konzern, 1931, 2, 230-236).— From Z. tech. Physik, 1930, 11, 148, 216; see this J., 1931, 47, 14.—v. G.

Free Energies of Formation and Heats of Formation of Thallium Amalgams. Charles Edwin Teeter (J. Amer. Chem. Soc., 1931, 53, 3917-3926).—The results of calculations from available data are given. In the main the heats of formation of thallium amalgams are positive.—R. G. The Equilibrium Diagram of the Tin-Antimony System and the Crystal Structure of the β -Solid Solution. Keizo Iwasé, Nobutosi Aoki, and Atomi Ósawa (*Sci. Rep. Téhoku Imp. Univ.*, 1931, [i], **20**, 353-368).—[In English.] The equilibrium diagram of the antimony-tin system has been revised by thermal, electrical resistance, X-ray, and microscopical methods. The change occurring at about 320° C. is due to an allotropic change between β_1 and β_2 . The crystal structure of β_2 is a simple cubic lattice—a very unusual structure for an intermetallic compound.—E. S. H.

Pewter and Its Manufacture. B. Egcberg (Monthly Rev. Amer. Electroplater's Soc., 1931, 18, (6), 34-42).—American pewter usually consists of 91% tin, 7.5% antimony, and 1.5% copper. The best pouring temperature is 345° -370° C., and the alloy should be well stirred with steam, a green sapling, or with ammonium chloride prior to casting. The alloy is cast by bottom pouring into plates of dimensions $8 \times 12 \times 1$ in., which are then cold-rolled to the desired size. This rolling causes the alloying constituents to be precipitated from solid solution, and hence the rolled alloy becomes softer; on subsequent annealing the constituents again dissolve and the annealed alloy becomes harder and stronger.—A. R. P.

A Study of the Constitution of the Iron-Tin Alloys. C. A. Edwards and A. Precee (Iron Steel Inst. Advance Copy, 1931, 1-27) .- The equilibrium diagram of the iron-tin system, using Armco iron and chemically pure tin, was determined from thermal critical points. Considerable difficulty was encountered owing to the very slow rate at which equilibrium was reached. Owing to the high degree of segregation in allovs containing more than 30% tin, it was necessary to prepare a special series of alloys for micro-examination, and these were chilled from a very high temperature. Melting under hydrogen or nitrogen resulted in blowholes. Iron was therefore melted without protection, the highly-oxidized slag skimmed off, the required amount of aluminium added to remove the remaining oxygen, and finally molten tin was added. Definite thermal arrests were obtained for alloys of 60% tin and upwards at 800°, 760°, and 496° C., but these were shown to be due to incomplete equilibrium. The equilibrium diagram shows the existence of 3 compounds: Fe₂Sn, stable between 760° and 900° C.; Fe₂Sn, stable below 800° C., and Fe₂Sn₂, existing below 496° C. A very pure sample of the last was prepared. The solution of tin in solid iron increases with temperature up to 760° C. and then decreases with further increase of temperature. A range of limited miscibility is shown to occur, but no evidence of the existence of Fe₃Sn, claimed by Wever and Reinecken, was obtained .- J. H. W.

The Diffusion of Tin into Iron with Special Reference to the Formation of Columnar Crystals. C. O. Bannister and W. D. Jones (Iron Steel Inst. Advance Copy, 1931, 1-23).-The alloys produced by the diffusion of tin into iron fall into 3 classes depending on whether they have been heated below 900° C., between 900° and about 1100° C., or above 1100° C. In the first case, no evidence of diffusion of tin into iron was found, but a layer of FeSn, compound is formed. In the second case, etching showed that a band of columnar crystals began at the tin interface and passed for a short distance into the main mass of iron, and towards the ferrite end of these crystals an ill-defined line parallel to the tin edge was shown and also a fringe of the compound FeSn. This is called the "diffusion line." In the third case, the band of columnar crystals and the diffusion line occur, but no fringe of FeSn, is shown, the interior of the alloy consisting entirely of dendritic masses of FeSn, and solid solution. An explanation is put forward for these phenomena on the grounds that the columnar crystals are formed only by heating above the Ac₃ point when tin is present. The diffusion of tin was further investigated quantitatively. The depth of penetration was found to follow Weiss's law, $(y - y')^2 = mt$, where y and y' are distances from the origin of zones of constant concentration, t is

the time, and m a constant. The rate of diffusion was found to be given by an empirical expression also due to Weiss: $V = n(a^{T} - 1)$, where V is the rate of diffusion, T the absolute temperature, and n and a are experimentally determined constants.—J. H. W.

On the System Tungsten-Carbon. K. Becker (*Tech.-wiss. Abhandl. Osram-Konzern*, 1931, 2, 221-229).—From Z. Metallkunde, 1928, 20, 437; see this J., 1929, 41, 465.—v. G.

The Constitution of Tungsten Carbides. K. Becker (Tech.-wiss. Abhandl. Osram-Konzern, 1931, 2, 218).—From Z. Elektrochem., 1928, 34, 640; see this J., 1930, 44, 519.—v. G.

Cemented Tungsten Carbide; A Study of the Action of the Cementing Material. L. L. Wyman and F. C. Kelley (*Trans. Amer. Inst. Min. Met. Eng.*, *Inst. Metals Div.*, 1931, 208-226.—See this J., 1930, 44, 518, and following abstract.—S. G.

Discussion on Wyman and Kelley's Paper on " Cemented Tungsten Carbide ; A Study of the Action of the Cementing Material." Z. Jeffrics. W. P. Sykes. L. L. Wyman (Trans. Amer. Inst. Min. Met. Eng., Inst. Metals Div., 1931, 226-229).—Cf. preceding abstract. J. points out that in cemented alloys equilibrium obtains in whole or in part of the cement only, and that overheating during cementation cannot be rectified by heat-treatment. S. puts forward a tentative equilibrium of part of the cobalt-tungsten-carbon system. In the pseudo-binary series cobalt-W2C the characteristic "herringbone" second phase appears to be W2CCo2, which has a typical etching reaction and X-ray diffraction pattern. This β -phase forms a pseudo-binary eutcetic with cobalt-rich solid solution. In alloys with 10-30% tungsten and more carbon than that required to form W₂C, rapid cooling from 1500° C, results in the production of areas of a ternary eutectic of W2CCo2, graphite, and cobaltrich solid solution; on annealing these alloys at 1100°-1200° C. for several hours, WC is formed from the β -phase and graphite, whereas slower cooling from 1500° C. results in the formation of a eutectic of WC and cobalt in which the WC occurs as rods or needles. W. states that the herring-bone structure in alloys made under manufacturing conditions extends from 27.5 to 35% W.C. whereas the arrowhead structure extends from 30 to 45% WC .- A. R. P.

A Metallographic Investigation of the Ternary Alloys of the Iron-Carbon-Tungsten System. III.—The Equilibrium Diagram of the Iron-Tungsten-Carbon System. Shuzo Takeda (*Tech. Rep. Tohoku Imp. Univ.*, 1931, 10, 42-92).—[In English.] (See abstract from another source, this J., 1931, 47, 526, 534. A complete equilibrium diagram of the system is reproduced as a space model, and many partial diagrams of portions of the system are also included. In the pseudo-binary system Fe₂C-W the metastable double carbide τ_i contains 1.8% carbon and 70% tungsten.—A. R. P.

The Course of the Activation of Thoriated Tungsten and Thoriated Molybdenum. A. Gehrts (Z. tech. Physik, 1931, 12, 66–71).—The calculated course of the activation of thoriated tungsten and molybdenum cathodes can be brought into agreement with that found experimentally, without recourse to the hypothesis of an induced vaporization, by assuming that the thorium atoms diffuse out of the inside of the wire to the surface along the grain boundaries, and not through the crystal lattice. The grain-refining action of an addition of thoria to tungsten wires can be explained by adsorption and wandering of reduced thorium along the crystal boundaries.—J. W.

Zine Casting Alloys. B. Brown (*Mech. World*, 1931, 90, 63).—A few notes are given on zinc die-casting alloys, in which it is essential that the zinc should have a high degree of purity. Although not strong, these alloys can be casily soldered and tinned, or plated, and protection afforded in a suitable way prevents the galvanic action between tin or aluminium and zinc, in the presence of water or other electrolytes. A small percentage of aluminium (not exceeding 0.3%) may be added to a zinc-tin alloy, but the addition of tin to a zincaluminium alloy causes ageing and disintegration. A very good alloy of the former type is tin, 8%; copper, 4%; aluminium, 0.2%; zinc, remainder; it has a tensile strength of 8 tons/in.² and a compressive strength of nearly 16 tons/in.². The usual composition of zinc-aluminium alloys is: aluminium, 4%; copper, 3%; zinc, remainder. The harmful effect of impurities is lessened by the addition of 0.10% magnesium.—F. J.

III.-CORROSION AND PROTECTION

CORROSION

Behaviour of Pure Aluminium Towards Acids and Bases. M. Centnerszwer [with I. Eicher] (36. Hauptversammlung Deut. Bunsen-Ges. : "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 206-211; and also Z. Elektrochem., 1931, 37, 598-603).—Pure aluminium (99·95%) is not dissolved by 2N-sulphuric acid nor by $1\cdot5N$ -nitric acid, and its rate of dissolution in more concentrated nitric acid is very small. In hydrochloric acid the rate of dissolution (r) depends on the concentration (C) of the acid and can be determined by measuring the volume of hydrogen evolved only when C = 4N; in unstirted acid r = 0.405 C^{3.6} at 25° C. and r = 0.223 C^{5.086} at 35° C., hence the temperature coeff. of the reaction between 25° and 35° C. is 7. In alkali solutions the rate of dissolution is proportional to the square root of the concentration of hydroxyl ions, and is thus little different from that of technical 99% aluminium.—A. R. P.

The Dissolution of Aluminium in Alkaline Solutions. G. Schikorr (36. Hauptversammlung Deut. Bunsen-Ges. : "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 218-221; and also Z. Elektrochem., 1931, 37, 610-613).—The dissolution of aluminium in solutions of caustic alkalis is preceded by an induction period which is longer the lower the alkali concentration. When a deficiency of alkali over that required to dissolve all the metal is present, the rate of evolution of hydrogen rises to a maximum, then falls almost to zero for some time, and finally rises again simultaneously with the hydrolysis of the aluminate previously formed with the deposition of aluminium hydroxide and regeneration of the alkali. The purity of the metal has no effect on the above series of reactions.—A. R. P.

Methods for Determining the Corrosion Resistance of Aluminium and Aluminium Alloys. Anon. (Indust. Chemist, 1931, 7, 378-380).—An English translation of the tentative standards elaborated by the aluminium board of the German Reichsausschuss für Metallschutz.—E. S. H.

The Ability of Silumin to Withstand Corrosion in Acid and Alkaline Solutions. O. Spengler and J. Wigand (Z. Ver. deut. Zuckerind., 1931, 81, 260-266; C. Abs., 1931, 25, 4509).-Silumin (13% silicon, 87% aluminium) bars were tested on a laboratory scale for corrosion at 30° and at 80° C. in the following solutions : (1) distilled water, $p_{\rm H} 4.5$; (2) 40% c.p. sucrose solution, $p_{\rm H} 5.0$; (3) thin juice, 1 saturation, 17° Brix, $p_{\rm H} 9.5$, natural alkalinity 0.03%; (4) molasses 55° Brix, free from invert sugar and alkali; (5) 0.1N-sulphuric acid; and (6) 0.1N-hydrochloric acid. The results are shown graphically, weight increase or decrease per m.2 per day versus time in days being plotted. At the lower temperature Silumin is but very slightly attacked. The results for the 3 sugar solutions are surprisingly close together in spite of the widely differing purities, ° Brix, and p_H values. The p_H remained constant throughout the time of the experiment. In the distilled water oxidation caused a slight increase in weight at the start. In the acid solutions (5) and (6) the rate of loss in weight is appreciable, the value increasing at the start and then remaining constant. At the higher temperature, the rate of loss of weight increases rapidly for sugar solution (2); this is due to the change in $p_{\rm H}$ of the solution from 5-0 to 3-2. In (3) the rate of weight decrease fell off with the time, the $p_{\rm H}$ changing from 9.5 to 6.5. Here Silumin seemed susceptible to attack in alkaline solution and became resistant only near the neutral point. In molasses the high rate of weight decrease increased with the time, and this is especially striking because of the high ° Brix, and because the sample remained alkaline throughout the experiment. The corrosion is due to the action of salts. In hydrochloric acid and sulphuric acid the initial very high rate of loss of weight falls off very rapidly in consequence of the formation of a protective film.—S. G.

The Solubility of Metals in Milk. I.—The Solubility of Copper under Various Conditions. H. T. Gebhardt and H. H. Sommer (J. Dairy Sci., 1931, 14, 416-446).—Previous work is described and discordant results are attributed to lack of agitation and inadequate control of temperature and dissolved gases. A method of procedure is described which takes these into account, and results are given showing the effect of acidity, dissolved gases, and temperature on the solubility of copper in milk. The oxidation-reduction potential of milk was found to be related to the solution rate of copper and the various factors which affect it. The conclusion is reached that copper solution in milk is a typical case of metal corrosion in dilute acid solution.—H. W. G. H.

[Resistance of] Copper and its Alloys to Corrosion. Am. Matagrin (Industrie chimique, 1931, 18, 386-389).—Cf. this J., 1931, 47, 273, 434. An account of the properties of copper-zine alloys, especially towards corrosion. No new material is presented.—E. S. H.

Example of Internal Corrosion of Brass. G. Mandran (Aciers spéciaux, 1931, 6, 293-294).—Some brass bolts that had been in place for 15 yrs. were found, on removal, to be covered with a light copper-coloured skin over a porous coppery layer with a brass core. The outside skin assayed: copper 96, iron 0.56, and zine 3.2%; the coppery layer, copper 67, iron 0.38, zine 32.5%, and the brass core, copper 57.5, iron 0.42, zine 41.8%. The core showed a normal 60:40 brass structure under the microscope, and the intermediate layer a solid solution, α , and some black threads of β . There was no steel near the bolts. This is considered to be a case of internal corrosion of galvanic origin between the copper and the zine constituents of the brass. The mechanism of the phenomenon is explained from this point of view.

-J. H. W.

Cable Sheath Damage and Protection. A Report of the Underground Systems Committee, Engineering National Section [of the National Electric Light Association]. ---- (Nat. Elect. Light Assoc. Publ. No. 127, 1931, 1-16). -The experiences of 35 American electric supply companies as regards damage to, and methods of protecting, their underground cables are summarized. Where possibility of exposures of the sheaths to fire or arcs exists, cement, asbestos, or asbestos-cement mixtures are used to protect the cables. Considerable chemical corrosion has been found to occur in freshly laid concrete ducts, due to the presence of soluble hydroxides; this trouble has been overcome by allowing the concrete to mature for 1-3 months before laying the cable, by steaming it for 48 hrs. or by exposing it to carbon dioxide for some days, or by coating it and the outside of the cable with grease. Damage to cable sheaths by stray direct currents is generally obviated by maintaining the sheath at a negative potential to its surroundings; in two cases corrosion has been found to be due to alternating-current electrolysis. Examples of various corroded cables are shown and briefly discussed .- A. R. P.

Contribution to [the Knowledge of] the Corrosion of Lead Cables. B. Garre (*Elektrotech. Zeit.*, 1931, 52, 1418).—The cause of corrosion of a lead cable sheathing was traced to the action of the phenol in the impregnated paper and jute wrapping of the sheathing.—M. H. On the Formation of Sulphide Films on Silver and Silver Alloys. Kurt Fischbeck (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 201-206).—The sulphide film on silver and copper immersed in sodium polysulphide solution increases in thickness according to the equation $y = \sqrt{2kt}$, where y is the thickness, k is a constant, and t the time of exposure. Addition of silver to copper has no effect on the rate of sulphide film formation until 50% silver is present; between 50% and 60% silver the rate falls rapidly with increasing silver content, but again remains constant between 60% and 93% silver; after which it falls to the rate for pure silver. The rate of film formation of cadmiumsilver alloys is practically the same as that of pure silver up to about 30 atoms % cadmium; with 30 atoms % cadmium the rate of thickening of the film is proportional to the time. Alloys with 40 atoms % or more cadmium are resistant to sulphide solutions.—A. R. P.

Rate of Dissolution of Thallium in Acids. M. Centnerszwer [with S. Lewi] (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 211–218).—Thallium dissolves in nitrie acid at a rate which increases with the concentration of the acid to a maximum at 0.25N, then steadily decreases with further increase in the acid concentration. The temperature coeff. of the reaction increases with rise in temperature to a maximum of 4.4. Stirring of the acid increases the rate of dissolution of the metal. Thallium dissolves only very slowly in hydrochlorie and in sulphurie acid at a rate which is almost independent of the acid concentration, and, in the case of hydrochlorie acid, is approximately the same as its rate of dissolution in water.—A. R. P.

Corrosion of Tinplate with Preserves [Artificially] Coloured Green. Paul Nehring and Eduard Nehring (Konserven-Industrie, 1931, 18, 199-201, 214-215; Chem. Zentr., 1931, 102, II., 3396).—The corrosion of lacquered and of unlacquered tinned cans containing green vegetables is ascribed to the presence of copper sulphate, which is added to preserve the green colour. The mechanism of the reaction is discussed and some practical examples are quoted. —A. R. P.

The Effect of Hydrogen-Ion Concentration on the Corrosion of Tin. J. M. Bryan (Trans. Faraday Soc., 1931, 27, 606-620).-The rate of corrosion of tin in citric acid solutions has been studied with a view to determine the cause of corrosion of tin cans used in fruit packing. Oxygen or an oxidizing agent is necessary to induce corrosion; in the presence of oxygen the rate of corrosion decreases with increasing $p_{\rm H}$ from 3.1 to 5.5, and most of the tin in solution is present in the stannic form. Addition of ferrous citrate to the corroding solution accelerates the rate of corrosion of tin in air, especially at $p_{\rm H}$ 3.0; this is attributed to the catalytic action of iron as an oxygen carrier. In the absence of oxygen, tin dissolves readily in a 0.5% solution of citric acid containing ferric citrate, at such a rate that there is almost a linear proportion between the concentration of ferric salt and the amount of tin dissolved. Increase in $p_{\rm H}$ retards the initial rate of attack, but the final corrosion is greater at low than at high acidity, owing to the retardation of the rate of oxidation of stannous salt by the ferric salt and the consequent increase in the efficiency of the available oxygen.-A. R. P.

Effect of Temperature on the Corrosion of Zinc. G. L. Cox (Indust. and Eng. Chem., 1931, 23, 902–904).—The testing apparatus for testing the corrosion of zinc in distilled water; continually saturated with air, is described and illustrated. Corrosion is greatly affected by temperature, the rate rising to a maximum at 65° C, thence falling rapidly up to 100° C. The most important factor appears to be the physical nature of the film of corrosionproducts, e.g., at 20° C. it is gelatinous and adherent; at 65° C. it is completely granular and non-adherent; at 100° C. it is very dense, very adherent, and difficult to remove mechanically. Other factors are rate of transfer of dissolved oxygen and oxygen concentration of the corroding medium.—F. J.

Corrosion Plays a Minor Part in Radiator Solder-Seam Failure. William H. Wilson (Automotive Ind., 1931, 65, 84–87).—Conditions of radiator corrosion are reproduced in special circulating apparatus in order to study the effects of cooling and anti-freezing media. The temperature was maintained at 190°-200° F. (88°-93° C.) for a run of a weck of $5\frac{1}{3}$ days. The test lasted 1400 hrs. with frequent visual examination and periodic removal of fluid for analysis. With tap water, brass cores showed leaks after 300 hrs., whilst the solder and the copper cores were practically unaffected. Vibration and road shock are thus indicated as causes of solder failure in service. Corrosion of all parts was minimized by the use of a non-electrolyte as anti-freezer, although a high saline concentration may neutralize beneficial effects. Chlorides and magnesium salts were most active corrosive agents. Dissolved oxygen diminishes efficiency by causing rust deposits, which grease from overlubrication of the water-pump helps to bind. Aeration increases corrosion.

-P. M. C. R.

On the Dissolution of Metals in Acids. J. N. Brönsted and N. L. Ross Kane (J. Amer. Chem. Soc., 1931, 53, 3624-3644).—Earlier theories are reviewed. In order to eliminate errors due to heterogeneity in the metal, the process studied in the present work was the dissolution of sodium from sodium amalgam in aqueous solutions and in the presence of buffer compounds. It is concluded that the dissolution of a pure metal in an acid is most probably the result of a chemical reaction between an electron of the metal and a molecule of the acid at the interface of solution and metal. The velocity of solution of sodium from amalgam in solutions of acids was found to be directly proportional to the square root of the sodium concentration. —R. G.

Concerning Corrosion [in Brewery Plant]. D. M. Stewardson (J. Inst. Brewing, 1931, 37, 360-365).—The electrolytic nature of corrosion is emphasized and some corrosion problems in breweries are described. Wort coppers suffer mainly from erosion by furnace gases. Trouble is experienced in certain refrigerators where foreign copper is used, owing to the presence of excessive amounts of impurities, especially lead. Copper tubes in attemporators, &c., form pinholes when precipitated salts from the water are allowed to adhere to the walls. Copper fermenting vessels do not suffer much corrosion, but aluminium is not so satisfactory for these vessels. It is important to insulate them from their concrete supports.—H. W. G. H.

The Theory of Metallic Corrosion in the Light of Quantitative Measurements. V.-The Corrosion of Iron and Mild Steel. G. D. Bengough, A. R. Lee, and F. Wormwell (Proc. Roy. Soc., 1931, [A], 134, 308-343) .--- Cf. this J., 1930, 43, 499, and 1931, 47, 343. The oxygen absorption method developed for measuring the corrosion of zine is adapted for iron and steel. Two types of corrosion-time curves have been obtained in potassium chloride solutions, viz. an exponential type for weak solutions and a linear type for strong solutions; each is associated with a characteristic type of corrosion product. Hydrogen was evolved in all solutions and the proportion of the total corrosion due to this type of action was considerable in all solutions stronger than N/1000; the hydrogen evolution-time curves were similar to the corresponding oxygen absorption-time curves. Micrographic observations showed that the characteristic distribution of corrosion over completely immersed horizontal specimens was determined neither by the initial air-formed film nor by any differential aeration that could occur in stagnant solutions, but mainly by the distribution of a particular form of precipitated corrosion product. The deposits of rust which are usually supposed to act as oxygen screens and stimulate corrosion by differential aeration do not so behave in any solution

stronger than N/1000 potassium chloride; the rust was found to consist almost entirely of mixtures of ferric oxide and stable magnetic oxide. In very weak solutions, in the presence of oxygen the rust was usually built up into coherent mounds acting as oxygen screens which gradually reduced corrosion rates. Some of the authors' conclusions thus differ from those reached by Evans, Bannister, and Britton. Highly purified iron gave nearly the same rate of corrosion as mild steel in N/10 potassium chloride solution, but the rate of evolution of hydrogen was less in the former case. In conductivity water both corroded much faster than zinc, but much more slowly in N/10 potassium chloride. These differences are mainly attributable to the different properties of the corrosion products.—J. S. G. T.

The Corrosion of Metals. Alfred Stansfield (Engineering J., 1931, 14, 441-446).—The electrolytic theory of corrosion is outlined, and the absence of corrosion in homogeneous solid solutions, such as are formed in Monel metal, is discussed. It is shown that even a pure metal or a homogeneous alloy will corrode when in contact with a corrosive solution of variable concentration.—H. F. G.

Corrosion Tester. Anon. (Chem. and Met. Eng., 1931, 38, 477).—A new device for the quick testing of metals and alloys under actual operating conditions as developed by Cloyd M. Chapman is described and illustrated. It consists of a yoke and stuffing box attached to a standard gate valve, thus providing a means of projecting an alloy steel spindle through the valve into the interior of the vessel in which the test is to be made. Specimens are suitably attached to the end of the spindle and withdrawn for examination when required.—F. J.

Costly Rust of Metal Supply can be Prevented if Temperature is Kept Above Dew-Point in Storage Room. Joseph Geschelin (*Automotive Ind.*, 1931, 64, 256-260).—Loss due to atmospheric corrosion can be minimized if materials likely to be affected are stored at a temperature slightly above the dew-point. Adequate provision for this involves the intelligent study of humidity data. In storage arrangements, circulation of air is as important as heating. Suitable types and arrangements of heating plant are discussed.—P. M. C. R.

Discussion on Vernon's Paper on "A Laboratory Study of the Atmospheric Corrosion of Metals." W. H. J. Vernon. R.S. Hutton. W.S. Patterson. U. R. Evans. A. R. Lee. A. R. Martin. J. C. Hudson. J. H. Coste (*Trans.* Faraday Soc., 1931, 27, 582-594).—Cf. this J., 1931, 47, 481. In atmospheres of 99% relative humidity maximum corrosion of copper occurs with 0.5%sulphur dioxide and minimum at 0.85% sulphur dioxide in the air, the corrosion product in the first case being basic, and in the second normal copper sulphate. It is pointed out that theoretically there should be an earlier minimum in the corrosion curve at a very low concentration of sulphur dioxide, and that this should correspond with the formation of the most basic sulphate of copper, viz. CuSO₄,3Cu(OH)₂. In moist air containing only carbon dioxide and free from sulphur and chlorine compounds, copper undergoes practically no change over long periods. The remainder of the discussion deals chiefly with details of the experiments and with certain deductions drawn therefrom.—A. R. P.

Discussion on Vernon's Paper on "An Air Thermostat for Quantitative Laboratory Work." U. R. Evans. A. R. Lee. J. H. Coste. W. H. J. Vernon (*Trans. Faraday Soc.*, 1931, 27, 577-582).—Cf. this J., 1931, 47, 531. The discussion ranges round the possible sources of error in temperature measurements and on the effects of heat transfer by direct radiation from the lamps used for heating.—A. R. P.

Seasonal Variation in Rate of Impingement Corrosion. Alan Morris (Amer. Inst. Min. Met. Eng. Tech. Publ. No. 431, 1931, 1-9).—It was found that, on performing corrosion tests with an apparatus similar to that used for the Corrosion Research of the Institute of Metals, various degrees of penetration were obtained, according to the season of the year. Increased corrosion was coincident with the giving off of an unpleasant odour from the water supply in warm weather. It is suggested that possible causes of the seasonal variation in corrosion are the presence of dissolved gases, increase in temperature, and the presence of fermentation products of micro-organisms.

-W. A. C. N.

Some Aspects of Boiler-Water Chemistry. H. E. Jones (J. Inst. Chemistry, 1931, (3), 160–164).—A lecture to the Huddersfield Section of the Institute of Chemistry, dealing with problems of scale-formation and caustic embrittlement of boiler metal. Caustic embrittlement is observed with the best steels, and there is a close connection between its occurrence and the composition of the feed-water. Caustic embrittlement is inhibited by the addition of sodium sulphate, but sodium phosphate is recommended as being more effective.

-E. S. H.

The Present Status of Corrosion Theory. R. Podhorsky (Arhiv. Hem. Farm., 1931, 5, 89-107; C. Abs., 1931, 25, 4836).—A brief account of the present theories on the origin and process of corrosion of metals is given, mainly from the point of view of electrochemical theory.—S. G.

Corrosion- and Heat-Resistant Alloys. C. E. Plummer and R. K. Atkin (Factory and Indust. Management, 1931, 82, (1), 2 pp. suppt.; Eng. Index, 1931).—A classified list showing the composition of each alloy, and a wide range of products with a key to the manufacturers.—S. G.

PROTECTION

Corrosion Prevention. Lessiter C. Milburn (Soc. Automotive Eng., Pre-print, 1931, April, 1-14).—Deals with corrosion prevention of light alloys used in aircraft. A small amount of corrosion can produce an important decrease in strength, and a margin of safety cannot be applied in anticipation of corrosion. The chief methods of corrosion prevention are: (1) protective coatings which may consist of paints, oils, chemical and electro-chemical coatings, and metallic coatings; (2) prevention by design and manufacturing processes. As protective coatings, red oxide of iron and zinc chromate absorb free oxygen and tend to reduce oxidation of the underlying surface. Bright sunlight has a destructive action on paint, and powdered aluminium pigments reflect the actinic rays of sunlight, and hence preserve the paint vehicle. Bituminous paints are waterproof, and have proved satisfactory for protection against sea water. The insides of gasoline tanks are protected by painting with bakelite varnish. No very great success has yet been attained in electrodeposition of zinc or cadmium on aluminium, but work has been carried out on "spraying" a metal surface on to aluminium. Methods of heat-treatment of the aluminium alloys may affect their corrosion-resisting properties; constancy and uniformity of temperature in the heat-treatment furnace are essential, otherwise certain parts of the structure being heat-treated will have a lowered resistance to corrosion .- W. P. R.

Surface Protection of Light Metals. Th. Leib and Fr. Kolke (Korrosion u. Metallschutz, 1931, 7, 3-11).—The increasing use of light metals in the aireraft, shipping, and transport industries is due in a large measure to the discovery of satisfactory methods of preventing corrosion of light metal structures by coating them with resistant films. The Bengough and Jirotka processes of coating aluminium with oxide films are described, and the composition of numerous varnishes and lacquers for increasing the strength and permanence of these films is given, together with results of tests on their efficiency.—A. R. P.

Electrolytic Production of Protective Oxide Films on Aluminium. H. Röhrig (36. Hauptversammlung Deut. Bunsen-Ges. : "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 329-332; and also Z. Elektrochem., 1931, 37, 721-724; discussion, 724).—A review of recent work.—A. R. P.

Eloxal, the New Method of Protecting the Surface of Aluminium. Wolfgang Sternberg (Werksleiter, 1931, 5, 336-337).—The Eloxal method for the electrolytic production of protective oxide layers on aluminium and its alloys is described.—v. G.

A New and Complete Protection for Steel Tubes. Anon. (Gas World, 1931, 95, 271-273).—The properties of Herolith and Tornesit, two proprietary articles employed by the Mannesmann Company (Düsseldorf, Germany) for the protection of steel tubes against corrosion and electrolytic action, are described and illustrated. Herolith is a condensation product of phenol and formaldehyde; Tornesit is essentially a derivative of indiarubber treated with solvents.—J. S. G. T.

Advances in Metal Spraying Processes. A. Salmony (Werksleiter, 1931, 5, 382-384).—The development and applications of the process are reviewed and a new electrical spraying pistol is described in which an are is formed between two metal wires and the molten metal is blown out of the pistol by a jet of compressed air. The wires are continuously fed into the are as fast as the ends are melted; in this way chromium, molybdenum, and tungsten may be sprayed.—v. G.

Effects of Carbon and Iron in Blue Powder on Sherardizing. [Abridged.] Masawo Kuroda (Sci. Papers Inst. Phys. Chem. Res. Tokyo, 1931, 16, (315), 125-126).—[In English.] The effects of the addition of carbon or iron to the blue powder used in the sherardizing process have been studied for a zine layer deposited on iron. The addition of carbon is beneficial, and shows its maximum effect at 2% carbon, when the velocity with which the zine layer is formed is increased by 50%. The addition of iron is harmful; reports to the contrary may be due to the fact that the iron particles readily adhere to the zine layer, and unless they are removed, the increase in weight is much greater than that due to the zine.—W. H.-R.

Chemical Methods of Testing [Galvanized and Plated] Zinc Coatings on Sheet Metal and Wires. E. H. Schulz [with Creutzfeldt, Hauttmann, Holthaus, and Püngel] (Stahl u. Eisen, 1930, 50, 1017-1022; and (summary) Metallurgist (Suppt. to Engineer), 1930, 6, 131-132).-Known methods of testing galvanized and zinc-plated iron and steel wires and sheets are critically discussed. The evenness of a zine coating is readily and sufficiently accurately determined by immersion in a 20% solution of copper sulphate. The total zine in the deposit is satisfactorily determined by Bauer's (arsenical sulphuric acid), by Aupperle's (hydrochloric acid-antimony trichloride) and by Creutzfeldt's (dilute sulphuric or hydrochloric acid containing an inhibitor) method. Known methods of determining porosity are all uncertain. Shorttime corrosion tests are best made in an atmosphere containing 5% of carbon dioxide and 1% of sulphur dioxide, or by means of the salt-spray test using a solution containing 2.5% of sodium chloride and 5.3% of ammonium chloride. The nature of the zine deposit may be determined by immersion of the sheet in sulphuric acid containing (a) potassium ferricyanide (Bauer) or (b) potassium thiocyanate; hot-galvanized coatings produced (a) a Prussian blue or (b) a red colour.-J. W.

A Pure Zinc Galvanizing Process. L. D. Whitehead (Wire and Wire Products, 1931, 6, 223-225).—First paper of a discussion on hot-galvanizing v. electro-galvanizing by L. D. Whitehead and G. K. Rylands. One of the disadvantages of hot-galvanizing is contamination of the zinc bath with iron and the consequent lowering of the resistance of the coating to corrosion, and the liability to peel owing to embrittlement; also a thicker coat is required to give the same corrosion-resistance as an electro-galvanized deposit which has not the above disadvantage. Further, with electro-galvanizing, the effects of tensile and torsional tests can be kept within closer limits, and although the colour of the coating is dull at first, it brightens after a time. This process gives better results with the electro-potential, salt spray, and Precee tests, and is not associated with the production of noxious fumes (see following abstract). —J. H. W.

Wire Galvanizing Processes. Geoffrey K. Rylands (*Wire and Wire Products*, 1931, **6**, 328-332, 344).—Cf. preceding abstract. The results of a series of tests between commercial electro-galvanized wires and similar wires that had been hot-galvanized are given. The results of the Preece test (dipping in a neutral solution of copper sulphate at 60° F. (16° C.) showed the former to be superior, especially in the finer gauges. Both wires stood the wrapping test (round a mandrel equal to their own diameter) satisfactorily. When the wires were subjected to the wrapping test followed by the Preece test, the electro-galvanized wires failed badly, and also showed less resistance to acid corrosion than the hot-galvanized wires. Electro-potential tests were indeterminate. The hot-galvanized wire possessed appreciably the thicker coat of the two, and under the microscope is seen to have a superior structure.

-J. H. W.

Electro-Galvanizing. L. D. Whitehead (*Wire and Wire Products*, 1931, 6 396-401).—Detailed criticism of the claims for hot-galvanized wire set out by G. K. Rylands (see preceding abstract) is put forward. The results of spectroscopic tests on ordinary hot-galvanized wire, Crapo galvanized wire, and electro-galvanized wire are given to show the superiority of the electro-galvanized wire, and a series of tests to determine the true value of the various methods of coating is suggested.—J. H. W.

Galvanizing. W. H. Spowers, Jr. (*Wire and Wire Products*, 1931, 6, 360-361, 372-373).—Read before the Wire Association (U.S.A.). Outlines the latest improvements in galvanizing methods and indicates the trend of galvanizing requirements in the near future.—J. H. W.

An Important New Improved Process of Galvanic Tinning of Iron Sheet. Anon. (Z. ges. Giesserei-Praxis: Das Metall, 1931, 52, 74–76).—A survey of the recognized methods of galvanic tinning using alkaline baths is made. These methods are not uniformly successful, and a new process is described in which acid baths are more successfully employed. Data of the current strength and density and of the kind of anodes used are given.—J. H. W.

The Flexibility of Zinc Coatings. H. Bablik (*Met. Ind.* (*Lond.*), 1931, 38, 204).—Abstract of a paper published in Z. *Metallkunde*, 1930, 22, 171–173. See this J., 1930, 43, 547.—J. H. W.

Scum Caused by Aluminium in Hot-Dipped Zinc Coatings. Wallace G. Imhoff (*Iron Age*, 1931, 128, 432–433, 461–462).—Blue scum in the galvanizing bath is caused by excess aluminium, and the amount of aluminium used must be carefully regulated according to the conditions of the bath. The effect of the correct amount of aluminium is to brighten the coating, to reduce the quantity of zinc ashes formed, and to assist the alloying action between the zinc and the iron base. Since the bath will hold a larger amount of aluminium at low than at high temperatures, careful control of the temperature of working is also necessary. The effect of the scum is to prevent adequate protection by the zinc and to reduce adhesion of the zinc to the base. The bath must be kept fluid when aluminium is used.—J. H. W.

The Use of Tin in the Galvanizing Bath. Wallace G. Imhoff (*Heat-Treating and Forging*, 1931, 17, 675–678).—Tin is used in galvanizing in widely different amounts, according to the conditions and other constituents of the bath. It increases the brightness of the zinc coating markedly, and tends to cleanse the bath of oxides, scurf, and dirt. In excess, it produces a yellow tarnish. Small amounts increase the fluidity, but large additions render the coating

brittle and liable to flake. The underlying steel base must be of good quality when tin is used in the bath.-J. H. W.

Perfect Electric Furnace for Galvanizing Wire. Anon. (Canad. Found., 1931, 22, 11).—Wire is drawn through an electrically-heated furnace with a capacity of about 35 tons of molten zine and having automatic temperature control. Zine is deposited on the wire, giving very good bonding between the base metal and the zine coating. It is claimed that the galvanized wire produced by this process can be wrapped round its own diameter without the zine coating becoming fractured or separated from the steel wire, and that the wire has uniform tensile strength, temper, and ductility.—J. H. W.

the wire has uniform tensile strength, temper, and ductility.—J. H. W. Cadmium and Zine Plating as Corrosion Preventives.—I. S. Wernick (Mctallurgist (Suppt. to Engineer), 1931, 7, 143-144).—Cadmium plating, now not more costly than nickel plating, is being reinvestigated, and the limits of application more closely defined. Cadmium is electro-negative to iron in most media, but the potential difference is small, and it may not always prove to be anodic in practice. The effects of various factors on the properties and behaviour of cadmium coatings are briefly described.—R. G.

Cadmium and Zinc Plating as Corrosion Preventives.—II. S. Wernick (Metallurgist (Suppt. to Engineer), 1931, 7, 147–148).—Cf. preceding abstract. Tests to determine the relative protective effects of cadmium and zine coatings are described. Other properties of deposits of the two metals, such as colour, effects of methods of depositing, chemical properties, and finish are reviewed. —R. G.

The Porosity of Electroplated Chromium Coatings. W. Blum, W. P. Barrows, and A. Brenner (U.S. Bur. Stand. J. Research, 1931, 7, 697-711; Research Paper No. 368).—Various methods for detecting porosity of chromium coatings were found to yield consistent results. Very thin deposits contain round pores. As the thickness is increased the porosity decreases to a minimum, after which an increase in thickness is usually accompanied by the formation of cracks, either parallel or random. The well-known copper deposition method for detecting the porosity depends on the fact that copper will deposit only in pores or cracks and not on the chromium. This test was made semi-quantitative by measuring either the average apparent current density or the weight of copper deposited in 2 minutes at 0.2 v. The following conclusions are based on such measurements. Their practical significance will be determined by exposure tests now in progress. The porosity usually increases on standing. This increase is accelerated by heating to 200° C. Changes in the composition of the solution have no marked effect on the porosity. An increase in the temperature of deposition, for example to 65° C. instead of the usual temperature of 45° C., greatly decreases the porosity, especially of thick coatings. At any given temperature the porosity is increased by raising the current density. Deposits on nickel are less porous than those on other base metals. This difference is at least partly due to the greater ease of securing a bright finish on nickel prior to the chromium plating.

-S. G.

IV.-STRUCTURE

(Metallography; Macrography; Crystal Structure)

Limiting Domains of Metallography. K. Schröter (Z. Metallkunde, 1931, 23, 197-201).—The preparation of samples for the microscopical examination of materials used in the manufacture of tungsten filament lamps is described. The grain-size of tungsten powder can be measured by the microscopical examination of a polished section of the block obtained by heating a mixture of 1 part of the powder with 3 parts of copper powder at 1250° C. in an atmosphere of hydrogen. Specimens for the microscopical investigation of the grain growth of pressed tungsten powder during the sintering process at

Structure

 3000° C. are prepared by dipping the porous tungsten rod into molten copper. For the examination of tungsten wires down to 0.01 mm, the wire is electrolytically coppered, embedded in Syrian asphalt containing a small amount of paraffin, and etched with a solution of ammonium sulphide. This method is also well suited for the microscopical examination of the marginal layers of thin wires of other metals, *e.g.* of nickel-plated iron wires. Copper wires are nickel-plated and then embedded. Samples of glass are chemically coated with silver, electrolytically coppered, embedded in tin solder, and etched with hydrofluoric acid. The paper contains a large number of photomicrographs. —-M. H.

The Recrystallization [of Metals on Annealing]. G. Tammann (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 37-44; and also Z. Elektrochem., 1931, 37, 429-436).—A review of our present knowledge of the mechanism of recrystallization covering the following points: the state of a crystallite conglomerate after plastic deformation, the nature of the intermediate films between deformed crystals, displacement of the grain boundaries during recrystallization, the growth of very large crystals after small deformations, the change in the orientation of the crystallites of cold-deformed metals with rise of temperature, and the variations of grain-size in recrystallized metals and in the interior of cast metals.—A. R. P.

X-Ray Investigation of Lattice Disturbances in Light Metals. J. Hengstenberg and H. Mark (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle." 1931, 132–136).— (I.)—Age-hardening of Duralumin at room temperature. See this J., 1931, 47, 347. (11.)—Measurements of the lattice distortion of Elektron. X-ray examination of stretched Elektron wires show that the intensities of the reflections from some planes are considerably reduced by stretching, whereas those from other planes are almost or entirely unaffected. This behaviour is attributed to the occurrence of a specially oriented displacement of the atoms in the crystal lattice.—A. R. P.

The Aluminium-Manganese System of Alloys. A. J. Bradley and Phyllis Jones (Phil. Mag., 1931, [vii], 12, 1137-1152).-The X-ray powder method of spectroscopy has been applied to a general survey of the structures of the aluminium-manganese system of alloys. The impurity of the alloys examined was small at the aluminium end of the series, but increased up to about 1%at the manganese end. Seven different phases, summarized in the form of a preliminary equilibrium diagram, were found to exist. The phase P_2 is an intermetallic compound Al, Mn existing in equilibrium with aluminium on the one hand and with P₃ on the other, up to a temperature of at least 600° C. The phase P₃ is, in all probability, represented by the formula Al₃Mn. It occurs as pseudo-tetragonal needle-shaped crystals. The compound Al, Mn does not exist at a temperature of 570° C. P, is a solid solution existing beyond the range 50% manganese on the one hand and beyond 59% man-ganese on the other. It is stable up to at least 860° C. on the aluminium-rich side and up to 1000° C. on the manganese side. The boundary at the manganese end of the range is curved towards the aluminium end at 1000° C. A phase based on the β form of manganese exists over a wide range of compositions. The compound Mn₃Al does not occur up to 1000° C. The addition of aluminium to manganese lowers the $\alpha\beta$ transformation point to such an extent that the β modification becomes stable at room temperature. A twophase range of the α and β phases is indicated at room temperature for a low aluminium content; the boundary lines given here are merely tentative, the limiting compositions being somewhat arbitrary.-J. S. G. T.

The Crystal Structure of Some Carbides and Borides. M. von Stackelberg (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde VOL. L. D und ihre Anwendungen auf Leichtmetalle," 1931, 150-152).—Cf. this J., 1931, 47, 387. The following table gives the lattice structure, and density (d) of carbides and borides of the alkali, alkaline-earth, and rare-earth metals.

	Lattice.	a.	с.	c/a.	đ.		Lattice.	a,	с,	c/a.	d.
$\begin{array}{c} CaC_2 \\ SrC_2 \\ BaC_2 \\ LaC_2 \\ CeC_2 \\ PrC_2 \end{array}$	A A A A A	5.48 5.81 6.22 5.54 5.48 5.44	6.37 6.68 7.06 6.55 6.48 6.41	1.161 1.150 1.134 1.18 1.18 1.18	$\begin{array}{r} 2 \cdot 21 \\ 3 \cdot 26 \\ 3 \cdot 90 \\ 5 \cdot 35 \\ 5 \cdot 56 \\ 5 \cdot 73 \end{array}$	$\begin{array}{c} ThC_2\\ NaHC_2\\ KHC_2\\ Bc_2C\\ CaB_6\\ SrB_6 \end{array}$	A A C D D	5.85 5.40 6.05 4.33 4.14 4.19	5-28 8-17 8-42	0.90 1.51 1.39	9·34 1·33 1·37 2·43 2·44 3·42
NdC_{2} SmC_{2} YC_{2}	A A B	5·39 5·31 3·79	6-36 6-28 6-58	1.18 1.18 1.18 1.74	6.0 6.50 4.58	BaB ₆ LaB ₆ CeB ₆	D D D D	4.13 4.13 4.13			4·25 4·77 4·80

A Tetragonal face-centred lattice, 4 molecules in elementary cell.

B Hexagonal lattice, 2 molecules in elementary cell.

C Cubic lattice, 4 molecules in elementary cell.

D Cubic lattice, 1 molecule in elementary cell.

-A. R. P.

The Effect of Chemical Combination on the X-Ray Spectra of Copper. E. A. Owen and T. E. Williams (Proc. Roy. Soc., 1931, [A], 132, 282-295) .- The position of the $K\alpha_1\alpha_2$ doublet of copper in the X-ray spectra of copper and various copper compounds, including Cu₂O, CuO, Cu₃P, Cu₃Sn, CuAl₂, Cu₂Sb, Cu_3As , $CuZn(\varepsilon)$, and $CuZn(\alpha + \beta)$, has been investigated. In all these cases no change was found in the wave-length of the $K\alpha_1$ line or in the separation of the lines in the doublet, but it is pointed out that whereas these results are probably true for the intermetallic compounds and solutions, decomposition of the oxides occurs when they are placed on the target of an X-ray tube. The K absorption edge corresponds with the wave-length 1377-4 X.U. in copper, cuprous salts, intermetallic compounds, and solid solutions. In inorganic cupric salts the edge shifts, on the average, 1.1 X.U. towards the shorter wavelengths. The results indicate that if a chemical bond exists in the intermetallic compounds, not more than one electron is supplied in each case by the copper atom. The chemical forces called into play in the intermetallic compounds remove an electron from the *M* group. It is probable that some of the sub-stances examined are not intermetallic compounds, although generally regarded as such. The copper atom in intermetallic compounds must be in the cuprous state. This result agrees with the conclusions of Padoa and of Hume-Rothery. -J. S. G. T.

An X-Ray Investigation of Some Copper-Aluminium Alloys. G. D. Preston (*Phil. Mag.*, 1931, [vii], **12**, 980-993).—The structures of copper-aluminium alloys containing 20-30 (wt.)% of Cu are investigated in order to clear up discrepancies in results obtained by Jette, Phragmén, and Westgren (this J., 1924, **31**, 193) and by Stockdale (*ibid.*, p. 275). Two new phases have been determined. The cubic γ phase (Cu₈Al₄) is shown to have a homogeneity range extending from 31% to 35-5% (atomic) of aluminium. This is followed by a hexagonal phase and by an orthorhombic phase which is probably CuAl. This hexagonal phase certainly exists over an extended range of temperature, and probably does not decompose during cooling to room temperature. The difficulty of obtaining equilibrium at temperatures below 500° C. leaves this point in doubt. The orthorhombic phase, identified by Westgren and Phragmén as CuAl, although details are lacking, exists at 600° C., but probably undergoes transformation on cooling to room temperature. Certain broad conclusions, not inconsistent with Rosenhain's view of the nature of inter-

metallic compounds, can be deduced from the results. The numerical relationships between the parameters of the cubic γ phase and of the hexagonal and orthorhombic structures, to which may be added the body-centred cubic β phase, described by Persson and by Obinata, are probably an expression of the constancy of "atomic radii" on passage from phase to phase. The similarity of X-ray diffraction patterns characterizing the phases implies that the atoms lie at or near to the points of a body-centred cubic lattice of side about 288 A. Differences of symmetry arise from a change in the arrangement of the 2 kinds of atom associated with the points of the lattice. In the range of composition discussed the state of affairs is, in some respects, analogous to the structure of silicates as given by Bragg and West.—J. S. G. T.

On the Rolling Texture of Cadmium. E. Schmid and G. Wassermann (*Metallwirtschaft*, 1931, 10, 735-736).—The rolling texture of cadmium is very similar to that of zine. The greater number of the crystallites lie with the principal hexagonal axis in the plane of the normal to the sheet and the rolling direction and inclined at $30^{\circ} \pm 10^{\circ}$ to the normal to the sheet. The inclination with zine is about 20°. The small difference is probably due to the fact that in rolling cadmium a certain amount of recrystallization cannot be avoided.—v. G.

X-Ray Study of the Copper End of the Copper-Silver System. Cyril Stanley Smith (Indust. and Eng. Chem., 1931, 23, 969-970).—The claim recently made by Drier (Indust. and Eng. Chem., 1931, 23, 404; this J., 1931, 47, 387) that 0.003% silver in copper had been detected in the diffraction pattern obtained, and that, on this basis, silver is insoluble in copper, is opposed in a letter to the Editor. S. shows that the diffraction pattern produced by copper with the molybdenum K_B radiation is almost identical with that produced by silver with the K_a radiation, and that Drier, who used a molybdenum target, probably mistook such a spectrum for that of silver.—F. J.

X-Ray Study of the Copper End of the Copper-Silver System. R. W. Drier (Indust. and Eng. Chem., 1931, 23, 970).—A reply to Smith's criticism (see preceding abstract). Whilst admitting that the spectral lines formerly attributed to silver are possibly due to a MoK_B reflection from the copper lattice, D. suggests that they are more probably partially due to such cause, as the X-ray spectrum of spectroscopically silver-free copper gave no evidence of the silver lattice. D. quotes from the literature to show there is disagreement concerning the solubility of silver in copper.—F. J.

X-Ray Analysis of the Gold-Antimory and Silver-Tin Systems. O. Nial, A. Almin, and A. Westgren (Z. physikal. Chem., 1931, [B], 14, 81-90).—In the gold-antimony system the results of Vogel (Z. anorg. Chem., 1906, 50, 145) on the equilibrium diagram and of Oftedal (Z. physikal. Chem., 1928, [A], 135, 291; this J., 1928, 40, 576) on the lattice structure of AuSb₂ have been confirmed. The mutual solid solubility of the 3 phases is small at 300° C., but at higher temperatures gold retains 1 atomic-% of antimony in solid solution. The equilibrium diagram of the silver-tin system proposed by Murphy (this J., 1926, 35, 107) has been confirmed. The lattice parameter of silver is increased by solution of tin from 4.077 A. to 4.125 A. with a = 2.925 A., c = 4.774 A., c/a = 1.634 at the silver end (13.3 atomic-% tin) and a = 2.953 A., c = 4.771 A., c/a = 1.616 at the tin side (19.7 atomic-% tin). The ε -phase has a lattice which differs only slightly from that of the ε -phase; it is rhombic with $a_1 = 2.985$ A., $a_2 = 5.154$ A. and $a_3 =$ 4.771 A. with 24 atomic-% tin.—v. G. The Hall Effect and Lattice Constants of Gold-Silver Alloys. L. S. Ornstein

The Hall Effect and Lattice Constants of Gold-Silver Alloys. L. S. Ornstein and W. Ch. van Geel (Z. Physik, 1931, 72, 488-491).—A correlation of the Hall effect in the gold-silver series of alloys shows almost exact parallelism between the magnitude of the effect in the various alloys and their respective lattice constants as determined by Sachs and Weerts. The Hall coeff. is linearly related to the lattice constant, and attains a minimum value corresponding with about 38% of silver; the minimum value of the lattice constant corresponds with about 35% of silver.—J. S. G. T.

sponds with about 35% of silver.—J. S. G. T. **X-Ray Analysis of Gold-Tin Alloys.** Sten Stenbeck and A. Westgren (Z. *physikal. Chem.*, 1931, [B], 14, 91-96).—In the gold-tin system the existence of the phases AuSn, AuSn₂, and AuSn₄ previously recorded by Vogel (Z. *anorg. Chem.*, 1905, 46, 60) is confirmed, and a new β -phase has been detected in alloys with 12-16 atomic-% tin. The lattice parameter of gold increases from 4.070 to 4.098 A. with 7.5 atomic-% tin. The β -phase has a closepacked hexagonal lattice, a = 2.896 A., c = 4.776 A., c/a = 1.649 at the gold end and a = 2.932 A., c = 4.761 A., c/a = 1.624 at the tin side; both kinds of atoms are probably statistically distributed at the lattice points. The AuSn phase has a nickel arsenide type of lattice, a = 4.314 A., c = 5.512 A., c/a = 1.278. The rontgenograms of the other phases could not be explained.—v. G.

An X-Ray Study of the Alloys of Silver with Bismuth, Antimony, and Arsenic. -I. S. J. Broderick and W. F. Ehret (J. Physical Chem., 1931, 35, 2627-2636).-An X-ray examination of the silver-bismuth system supports the thermal diagram due to Petrenko. No compound, Ag, Bi, reported by Mathicssen, was found. The maximum solubility of bismuth in silver is about 5.5%. The lattice parameter within this phase is increased from 4.076 A. for pure silver to 4.087 A, for the saturated phase. The result of the X-ray examination of the silver-antimony system does not confirm the thermal diagram due to Petrenko. The maximum solubility of antimony in silver is about 6%. The lattice parameter in this phase is increased from 4.076 A. for pure silver to 4.109 A. for the saturated phase. In the region between 11 and 16% antimony there exists a homogeneous hexagonal close-packed phase. The size of the unit cell at 89% silver is $a_1 = 2.920$ A., $a_3 = 4.774$ A. and $a_3/a_1 =$ 1-632. Another homogeneous phase which is either rhombic or deformed cubic is present in the region between 72 and 78% silver. The size of the unit cell at 74.2% silver is $a_1 = 3.000$ A., $a_2 = 5.178$ A., $a_3 = 4.830$ A.

-J. S. G. T.

An X-Ray Study of the Alloys of Silver with Bismuth, Antimony, and Arsenic. —II. S. J. Broderick and W. F. Ehret (*J. Physical Chem.*, 1931, 35, 3322-3329).—An X-ray investigation of the crystal structure of the silver-arsenic system supports, in the main, the thermal diagram due to Heike and Leroux (*Z. anorg. Chem.*, 1915, 92, 119; this *J.*, 1916, 15, 352). The solubility of arsenic in silver is approximately 5% by weight. Within this phase the lattice parameter is increased from 4.076 A. for pure silver to 4.080 A. for the saturated phase. Silver is practically insoluble in arsenic. A β phase containing about 7.5% of arsenic appears at high temperatures. Its structure is hexagonal close-packed with an axial ratio equal to 1.633. The side of the elementary parallelopiped forming the unit cell is 2.891 A. and its height 4.722 A. The homogeneity range of the phase is very narrow, being included within 89% and 93-2% of silver. The crystal structures found for the alloys of silver with arsenie, bismuth, and antimony and related systems are discussed with regard to (1) structure analysis, (2) atomic sizes, (3) valency-atom ratios, (4) contraction on forming intermetallic phases.—J. S. G. T.

X-Ray Evidence of Grain-Growth and Recovery in Tungsten Wires Derived from [X-Ray Analysis by] the Debye-Scherrer Method. K. Becker (Tech.-Wiss. Abhandl. Osram-Konzern, 1930, 1, 179-192).—From Z. Physik, 1927, 42, 226-245. See this J., 1927, 38, 475.—v. G.

X-Ray Determination of Alloy Equilibrium Diagrams. Arne F. Westgren (Trans. Amer. Inst. Min. Met. Eng., Inst. Metals Div., 1931, 13-38).—Tenth Annual Institute of Metals Division Lecture, describing recent work on the X-ray analysis of binary metallic systems and pointing out the structure analogies which have been observed.—A. R. P.

The Electrical Conductivity and Structure of Thin Metal Films. I.—Present State of Knowledge; General Connection between Electrical Conductivity and Structure. W. Reinders and L. Hamburger (Ann. Physik, 1931, (v), 10, 649-669).—Cf. this J., 1931, 47, 484. An attempt has been made to calculate from statistical assumptions the variations in the thickness of films prepared by condensation of metal vapours. The results show that with an average monatomic film one-third of the surface is uncovered and another third is covered with 2 or more atoms. The structure is therefore very porous, and more probably amorphous than crystalline. The high sp. resistance of the films is partly due to their porosity and partly to a reduction of the mean free path of the atoms owing to a reduction of the crystal symmetry with decreasing thickness. The negative temperature coeff. of many thin films is explained on the assumption that owing to the greater movement caused by heating the transfer of conductivity electrons is facilitated.—v. G.

The Electrical Conductivity and Structure of Thin Metal Films. II.— Functional Relations between Specific Resistance and Film Thickness (Refractory Metal Sublimates and Low Temperatures). III.—Specific Resistance and Structure as Functions of the Temperature. IV.—Some Applications. L. Hamburger (Ann. Physik, 1931, (v), 10, 789-824, 905-926; 1931, (v), 11, 40-52).—The electrical conductivity and the temperature coeff. of electrical conductivity of very thin metal films are discussed in relation to the atomic distribution in and structure of the films. The importance of the study of thin films for the understanding of the mechanism of various processes, e.g. reerystallization and ageing of metals, photo-electric phenomena, &c., is pointed out.—v. G.

[Contribution] To the Knowledge of the Atomic State in Metal Lattices from Magnetic Measurements. E. Vogt (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 68-74; discussion, 74).—The deviation of the atomic susceptibility curves of gold-silver, gold-copper, gold-palladium, platinumpalladium, and gold-platinum alloys from the theoretical curves based on the law of mixtures is discussed and explained by means of the electronic theory of the metallic state.—A. R. P.

Texture of Metals after Cold Deformation. Franz Wever (Trans. Amer. Inst. Min. Met. Eng., Inst. Metals Div., 1931, 51-75; discussion, 75-77).--Recent work on the X-ray examination of the texture of metals after coldwork is reviewed, a new method of describing conditions of statistical anisotropy by means of pole figures is described, and the conversion of the X-ray patterns to pole figures by means of graphic charts is illustrated with reference to the deformation under different conditions of cubic metals. In the discussion a method of photographing directly the pole figures of deformation structures is described.--A. R. P.

The Temperature Coefficient of Crystal Plasticity.—II. W. Fahrenhorst and E. Schmid (*Mitt. Material., Sonderheft* 18, 1931, 26–30).—See this J., 1931, 47, 26.—J. W.

The Causes of the Broadening of the Lines in Powder and Rotating Crystal Photographs with X-Rays. U. Dehlinger (Z. Metallkunde, 1931, 23, 147-149). —The broadening of the lines of monochromatic X-ray photographs has been calculated and observed in the following cases: (1) Slow variations $\pm \Delta a$ of the normal lattice constant, a, caused by differences in concentration of solid solution, by elastic distortions due to external loading or by internal stresses produce a change in the Bragg reflexion angle ∂ of $\Delta \partial = \mp \Delta a/a$. tan ∂ ; (2) When the single grains of a polycrystalline specimen are smaller than about 0.1μ the extinction in the direction adjacent to the Bragg angle is not complete. The broadening of the lines is thus connected regularly with the grain-size, and absorption plays a part; (3) Non-homogeneous distortions of the lattice caused by changes in the state of stress or concentration in portions smaller than 0.5μ must be considered in their action on the X-ray photograph to be an overlapping of (1) and (2). The size of the particles in the intermediate state of the alloys AuGu and AuGu₃ with ordered atomic distribution can be calculated from the broadening of their superstructure lines, and at the same time their coherence with the unordered region of the crystallites is established from the fact that the other interference lines remain apparently sharp. Hidden elastic lattice distortions can be considered as wave-like bendings or periodic distortions and thus calculated. They alone explain the broadening of the lines after cold-work which in spite of the presence of Heyn's stretching stresses does not occur with pure aluminium and zinc.—J. W.

The Growth of Metal Crystals in Metal Vapour. M. Straumanis (Z. physikal. Chem., 1931, [B], 13, 316–337).—When an evacuated tube containing a drop of metal is hung in a furnace in such a manner that the metal distils to the upper, cooler part of the tube, large crystals of the metal grow at the parts of the tube at which the temperature is equal to the melting point of the metal. The basal planes of the crystals are parallel to the glass walls and the crystals are formed of layers $0.8-1 \mu$ thick parallel to the basal plane. The sides of the crystals have a step-like formation and generally form a pyramidal plane at an angle of 45° to the base. On further heating the crystals disappear in a manner similar to their formation.—v. G.

Constitutional Formulæ of Crystallized Substances. H. Rheinboldt (Z. anorg. Chem., 1931, 200, 168-172).—Instead of the empirical formulæ based on the atomic ratio special constitutional formulæ for the crystallized state are proposed based on the results of crystal structure analysis; the symbols of the components of the crystal lattice (*i.e.* atoms, ions, atomic groups) are enclosed in square brackets and characterized by their co-ordination numbers. Special symbols may be added for the atomic lattice, ionic lattice, layer lattice, and lattice type.—M. H.

Theory of Arranged Mixed Phases. II.—Mechanism of Diffusion. Carl Wagner (Z. physikal. Chem., 1931, Bodenstein-Festband, 177–186).—Expressions for the diffusion of the components in regularly arranged mixed phases (e.g. intermetallic compounds) are derived from considerations based on the theory of Wagner and Schottky (this J., 1931, 47, 347).—v. G.

Atomic Physics and the Science of Metals. E. Piwowarsky (Metallwirtschaft, 1931, 10, 689-695).—A review of our knowledge of the lattice structures of metals and alloys and of the regularities in them.—v. G.

The Diffraction of Electrons by Single Crystals. G. P. Thomson (*Proc. Roy. Soc.*, 1931, [A], 133, 1-25).—Experiments on the diffraction of electrons of 30-50 kv. by single crystals of copper and silver give results showing a widely extended pattern of diffraction spots, which can be accounted for by supposing that the etched crystal surface is composed of a number of lumps of dimensions of the order 10^{-6} cm. These may, in some cases, be the portions left between adjacent etching pits. No evidence was obtained of reflection by "forbidden" crystal planes or of half-order spectra. Experiments on copper electrolytically deposited on a single crystal of copper showed (1) a strong tendency for the definition of the underlying copper, and (2) a marked difference of spacing, and the appearance of spots not characteristic of the ordinary face-centred structure of copper.—J. S. G. T.

Principles Determining the Arrangement of Atoms and Ions in Crystals. M. L. Huggins (J. Physical Chem., 1931, 35, 1270-1280).—Fundamental principles of crystal growth, viz., repetition of the crystal cell, electrical neutrality of the cell, close-packing, &c., are briefly referred to.—J. S. G. T.

Analysis

A New Radiometallographic Laboratory. Jean J. Trillat (*Rev. Aluminium*, 1931, 8, 1357–1363).—The application of X-ray analysis to the study of metals is discussed, and the equipment of a new laboratory for this purpose at Bourget, France, is described.—J. H. W.

V.-ANALYSIS

Special Problems in the Spectrographic Analysis of Metals. G. Scheibe (*Metallwirtschaft*, 1931, 10, 723-724).—Attention is directed to the utility of spectrographic analysis for the rapid and accurate testing of alloys.—v. G.

Estimation of Metals in Solution by means of their Spark Spectra. F. Twyman and C. Stansfield Hitchen (*Proc. Roy. Soc.*, 1931, [A], 133, 72–92).— Experiments undertaken to extend to liquids the accuracy of quantitative analysis recently attained by the spectrography of alloys are detailed. The method essentially consists in producing "wedge-spectra" in which the length of a line is a measure of its intensity and hence of the amount of the element to which it is due. Experimental results relating to Cu, Zn, Bi, Co, and Ni, are tabulated and discussed.—J. S. G. T.

Precipitation by Means of H₂S. Lester Meyer (*Chemist-Analyst*, 1931, 20, (4), 20).—The solution is placed in a conical flask closed with a rubber stopper carrying the H₂S tube, which reaches to just above the top of the solution, and a second shorter tube which can be closed with a clip or plug. As soon as the air in the flask has been displaced by H₂S, the short tube is closed and the solution shaken occasionally; in this way waste of gas is avoided, the solution is saturated rapidly under slight pressure, and precipitation of the sulphides is quick and efficient.—A. R. P.

Cadmium as a Reducing Agent for Trivalent Iron. James Brinn (*Chemist-Analyst*, 1931, 20, (4), 7).—Reduction of the $Fe_2(SO_4)_3$ solution with a bent stick of Cd for 20 minutes is recommended instead of the usual granulated Zn method.—A. R. P.

Estimation of Copper and Nickel in Steel. W. L. Knoyle (Swansea Tech. Coll. Metallurgical Soc. Papers, 1930).-Instructions are given for the estimation of Cu and Ni in steel by a number of methods, including precipitation by ZnS. The calorimetric method is advocated for estimating Cu in steel containing less than 0.1% of this element. For convenience and time-saving, the glyoxime precipitate can be burnt to the oxide and weighed as such. К. believes that when Co or Mn is present in comparatively large percentages in steel, the estimation of Ni by the dimethyl-glyoxime method must be slightly modified. With high Mn content, the ordinary method is followed until the solution of the steel containing the citric acid is made faintly alkaline with NH,OH. At this stage, 5 c.c. of glacial CH, CO, H are added, the solution is brought to a temperature of 60° C., and sufficient dimethyl-glyoxime added to make the liquid faintly ammoniacal. The treatment of the precipitate from this stage onward is similar to the usual method. With more than 3% of Co, the Ni results are high. If the precipitation is carried out in the cold (20° C.), and the solution is allowed to stand for 4 hrs., with occasional agitation, K. states that the precipitation will be free from contamination by Co. Another suggested method is to dissolve the cobalt-contaminated precipitate in 20 c.c. of aqua regia, boil to decompose the glyoxime precipitate, dilute and re-precipitate.-R. Gr.

A Note on the Precipitation of Nickel and Cobalt as Sulphides in Qualitative Analysis. C. E. White (J. Chem. Education, 1931, 8, 1968).—Short note. If nickel or cobalt is precipitated from ammoniacal solutions with H_2 S or $(NH_4)_2$ S, colloidal NiS or CoS is frequently formed. According to Haring, Westfall, and Leatherman (J. Amer. Chem. Soc., 1930, 52, 5135–5141), both these elements give compact and easily filterable precipitates in an ammonium acetate solution at a p_H of 4.4 or slightly lower.—J. H. W.

VI.-LABORATORY APPARATUS, INSTRUMENTS, &c.

[See also "Testing " and " Pyrometry."]

Metallography with Polarized Light. J. S. G. Primrose (Metallurgia, 1931, 5, 9–11).—Details are given of the construction of the Reichert opaque illuminator, which can be used with both polarized and non-polarized incident light. In using such an illuminator it must be adjusted to be perpendicular to the plane of symmetry of the microscope, and the lighting system must be properly centralized. The micro-specimen, free from scratches, must be mounted exactly at right angles to the axis of the microscope. The objective, free from strains, in a short mount, corrected without cover glass, must be firmly seated. The inclined-stand type of microscope is recommended with this illuminator, but other forms of stands may also be adapted. Various fields for investigation using polarized light are indicated.—J. W. D.

Metallographic Polishing Machine. E. Leitz (Instrument World, 1931, 4, 118).—A 5-spindle machine designed primarily for laboratories in which a large number of specimens have to be prepared, is described. The entire grinding and polishing operations are carried out on one machine. The machine requires about 0.6 H.P. to drive it and the discs make 500– 600 r.p.m., the carborundum disc rotating about 3 times as fast as this. 2- and 1-spindle machines are also available.—J. S. G. T.

A British Metallurgical Microscope. Anon. (Indian Eng., 1931, 89, 469). —A small type of inverted metallurgical microscope on the principle of the Beck-Hadfield model is described. Advantages are a strong coarse adjustment and a very delicate fine adjustment, together with improved arrangements for visual observation.—P. M. C. R.

Electric Furnace for Tensile Tests at High Temperatures. O. Beckmann (*Metallwirtschaft*, 1931, 10, 725-726).—A furnace for making tensile as well as endurance tests under constant load in a tensile machine at temperatures up to 1000° C. is described together with a mirror arrangement for the measurement of small elongations.—v. G.

On a New Electrical Apparatus for the Measurement of Small Displacements. Siggfried Reisch (Z. Hochfrequenztech., 1931, 38, 101-111).—The displacement to be measured moves a condenser plate and the changes in the capacity of the condenser are magnified by means of a circuit wherein the current flowing is linearly proportional to the displacement. The use of the method for the measurement of stresses, especially of rapidly changing forces causing small displacements, and for the measurement of the diameter of very thin wires is shortly described.—v. G.

An Easily Constructed Electrolytic Apparatus. Ross L. Harbough (Chemist-Analyst, 1031, 20, (4), 22).—The solution is stirred by means of a rotating Pt anode fixed to a glass tube inside a second larger tube which acts as a bearer; the inner tube has at its upper end a large cork provided with vanes, against which a stream of compressed air is blown. Contact is made with the anode by filling the inner tube with mercury into which a wire from the battery dips.—A. R. P.

A Method of Measuring Magnetic Susceptibilities. P. Kapitza and W. L. Webster (*Proc. Roy. Soc.*, 1931, [A], 132, 442-459).—A balance for measuring magnetic susceptibilities, utilizing the principle of measuring the magnetization of the body by the force of reaction on the magnet producing the inhomogeneous magnetic field employed, and not the force on the substance under examination, is described. The theory and construction of the balance, as well as means of avoiding difficulties in its use, are given in detail. This method has advantages over others hitherto employed; for instance the material under examination can be subjected to any change of physical conditions without interference with the measurements.—J. S. G. T.

Physical and Mechanical Testing and Radiology 41

Simple Method of Demonstrating and Investigating the Peltier Effect. U. Ph. Lely (Z. Physik, 1931, 70, 562-563; and (English translation) Phil. Mag., 1931, [vii], 12, 488-490).—Simple lecture apparatus comprising a rod of iron (diam. 7 mm., length 10 cm.) arranged between two similar rods of copper and included in a galvanometer circuit, for the demonstration of the Peltier effect is described. The rods are first heated by an electric current, which is then interrupted and the galvanometer deflections are observed.

-J. S. G. T.

The Hilger X-Ray Crystallograph and the Cubic-Crystal Analyzer. S. Zeidenfeld (*Proc. Phys. Soc. (Lond.)*, 1931, 43, 512-523).—A description is given of an X-ray crystallograph designed on the principle used by Sceman and Bohlin in which the slit, specimen to be analyzed, and photographic film are disposed along the circumference of a circular camera. Typical crystallograms obtainable are shown. The cubic-crystal analyzer is described, and some examples demonstrating its use are given.—S. G.

An X-Ray Apparatus for Powder Analysis. G. Grime (J. Sci. Instruments, 1931, 8, 197–190).—In the usual arrangement of X-ray powder apparatus, the tube is clamped to a separate stand, and set up beside the spectrograph. The defects are that the relative positions are easily disturbed, the tube cannot be removed without throwing out of alignment, and fine adjustment to receive the most intense X-ray beam is difficult. To overcome these defects an apparatus is described in which the tube and spectrograph are mounted on a single rigid stand permitting removal and accurate replacement of the tube. The camera and tube are movable, and provided with scales, and 2 sets of photographs at different scale readings enable the setting for maximum intensity to be determined.—W. H.-R.

New Standard Method for the Precise Determination of the [Crystal] Lattice Constants of Polycrystalline Materials. F. Regler (*Physikal. Z.*, 1931, 32, 680– 687).—Apparatus and method for precision X-ray measurements of crystal structure, applicable to wires or powdered materials are described and discussed. The apparatus is of the Debye-Scherrer type, and precision measurements can be made even if the beam of primary X-rays is not exactly parallel.

-J. S. G. T.

Measurement of the [Radio-] Activity of Radioactive Substances by Means of the Torsion Balance. J. Zahradniček (*Physikal. Z.*, 1931, 32, 630-634).— A form of torsion balance, resembling somewhat that employed by Cavendish in the determination of the constant of gravitation, and its application to the determination of the radioactivity of materials, are described.—J. S. G. T.

VII.—PHYSICAL AND MECHANICAL TESTING AND RADIOLOGY

Mechanical Properties of Metals at High Temperatures. J. Galibourg (Science et Industrie, 1931, 15, 455-462).—A summary is first given of important work on the following types of high-temperature test: hardness, shock, torsion, bending, fatigue, and friction. G. then considers tensile testing (a) by shock, (b) under the conditions of the normal test at room temperature, (c) under constant load. Experimental methods for the latter are described, and observed effects are summarized. The question of limiting loads is discussed, and an attempt is made to co-ordinate the results obtained by various groups of workers. A bibliography is given.—P. M. C. R.

An Experimental Study of the Mutual Abrasion of Metals. Anon. (Science et Industrie, 1931, 15, 399-400).—Abridged from an article by H. W. Swift, Engineering, 1931, 131, 783-785. Abrasives so rapidly lose their efficiency that the use of a standard abrasive is impracticable; S. therefore measures the friction of the metal to be tested against the material with which it is to be used in practice. A description, with drawings, is given of an apparatus which, it is claimed, eliminates spring, and secures easy application and equal distribution of load, easy renewal of the abrading surface, and convenience in taking the actual measurements. S. has tabulated the wear and friction coeff. between numerous metals and alloys, and comments on the uses of such a table to designers. The effect of hardness on the coeff. of wear and friction is discussed.—P. M. C. R.

Notes on the Proof Stress. E. Skerry (*Aircraft Eng.*, 1931, 3, (29), 162).— Proof stress is a stress value which can be accurately determined, and which is rapidly becoming an almost universal criterion of properties of materials. The term is applied to the greatest load per in.², which, when applied for 15 seconds and removed, produces a permanent extension of not more than 0.1% of the gauge length (in some cases 0.5% of the gauge length is used).

-H. S.

Foppl-Pertz Machine Determines the Damping Capacity of Materials. Anon. (Automotive Ind., 1931, 65, 426–427).—Describes a method developed by the Wöhler Institute for measuring internal friction. One end of the test-piece being rigidly clamped, torsional stress is applied to the other by a cross-bar, the position of which is maintained by adjustable electro-magnets. The oscillations produced on breaking the circuit are recorded by a stylograph on a chart moved by elockwork. The apparatus is suspended from the ceiling by a long line. The importance of internal friction data in parts subjected to vibration in service is emphasized. The method may render possible some estimate of stress ranges met with in use; it refers to the whole volume of tested material, and may be used to study stress concentrations due to flaws. —P. M. C. R.

Improvement to Tensile Testing Machines [for Testing Wires]. M. C. Marsh (J. Sci. Instruments, 1931, 8, 233–234).—A note. In testing wires, difficulty is often encountered by the sample breaking at the elamps. This may be overcome by attaching rigidly to each elamp a steel pin so that the wire makes one or more revolutions round it before entering the elamp. The tension of the wire entering the clamp is greatly reduced, the ratio being 1 to $e^{-2\pi n\mu}$, where μ is the coeff. of friction, and n the number of revolutions round the pin. There is therefore little chance of the wire breaking between the pin and elamp.—W. H.-R.

Notes on the Hardness Testing of Metals. Anon. (Burn's Eng. Mag., 1930, 24, 417-421; 1930, 25, 11-14).—The Vickers hardness test, using the diamond pyramid indenter, is claimed to provide an absolute measure of resistance to permanent indentation, and to give closely proportional readings with varying loads. The same indenter and a single scale are employed for all materials. The load is gradually applied, with standardized timing and easy control, and the indenter hence gives long service. The margin of error in reading is very small, but the open scale admits of the comparison of small differences in hardness. The form of the indenter eliminates errors in reading due to "draw" or "cratering," which do not occur at the points between which readings are taken. The method is said to be applicable to curved surfaces and to small parts.—P. M. C. R.

Notched and Corrosion Endurance Strength. P. Ludwik (Metallwirtschaft, 1931, 10, 705-710).—Tensile and hardness tests and endurance bending and torsion tests with and without notches and with and without the simultaneous action of corrosion (from sea-water or tap water) have been made on numerous steels and other metals and alloys. Notching reduces by about 30% the endurance (bending) strength of Legal, Lautal, annealed Duralumin, K.S.-Seewasser, and Elektron, but is without effect on the endurance of aged Duralumin, copper, brass, bronze, and Silumin, although the latter, probably because of the notch action of internal inhomogeneities, has a very low endur-

Physical and Mechanical Testing and Radiology 43

ance limit. A thickening of the test-piece is more dangerous than a notch when it has sharp edges. Corrosion is very deleterious in the case of light metals, reducing the endurance limit by as much as 40%, but is without action in the cases of copper, brass, and bronze. The torsion endurance limit with all rolled and forged metals is 0.575 (\pm 6%), as great as the limit under bending stresses. The corresponding value for cast metals (Silumin) is about 0.8. The action of notches in torsion tests is similar to, but numerically smaller than, that in bending tests.—v. G.

The Phenomenon of Fatigue in Metals; Special Methods of Determining the Fatigue Limit. P. Vernotte (Science et Industrie, 1931, 15, 223-229).— A consideration of the mechanical properties of metals leads V. to identify the fatigue limit with the true elastic limit, and to abandon the unmanageably slow methods of fatigue testing in favour of elastic limit determinations. The method preferred involves the differential measurement of permanent set under tensile stress; very small test-pieces are employed, and optical methods of measurement are necessary. Extreme smoothness in applying and removing the load, and great care in avoiding local heating and concomitant expansion, are essential. A full description of the method and a diagram of the adjustments are given. Thermal methods of study are slower, more complex, and liable to error through "creep." In an appendix V. considers some effects of flaws and heterogeneity, with especial reference to alternate bending stresses.—P. M. C. R.

Universal Testing Machine for Alternating Endurance Tests. K. Rathke (Z.V.d.I., 1931, 75, 1289).—A new machine for the testing of metals under alternating tensile and compression loading with any desired preliminary static load is described. The application of the load and its measurement are effected hydraulically. The maximum and minimum load can be correctly measured by means of suitable mechanical devices.—v. G.

New Testing Machines for the Determination of the Alternate Bending Strength for Rotating Bending. W. Schwinning and E. Dorgerloh (Z. Metallkunde, 1931, 23, 186-188).—A detailed description of simple testing machines for the determination of the alternate bending strength of wires (1.8-5 mm. in diam.) as well as thicker test-pieces.—M. H.

RADIOLOGY

Determination of Internal Stresses in Metals by Means of X-Rays. R. Drahokoupil (Z.V.d.I., 1930, 74, 1422).—An arrangement is described for making Debye–Scherrer rontgenographs of the surface regions of large pieces of metal; from the photographs conclusions can be reached as to the stresses present.—v. G.

X-Ray Tests in Workshop Practice.—II. C. Kantner and A. Herr (Metallwirtschaft, 1931, 10, 717-720, 736-740).—The use of X-ray shadowgrams in detecting faults in gas welds in copper (locomotive fireboxes) and oxyhydrogen and electric welds in rolling stock, bridge construction, &c., is described. A number of practical hints are given for the examination of welds in awkward positions, e.g. in corners, and various types of welding faults which can be detected by X-rays are mentioned. A transportable X-ray outfit built in a railway wagon together with a current generator and dark room is described.—v. G.

X-Ray Analysis in Foundry Practice. S. T. Konobievsky (*Liteinoe delo* (*Foundry Practice*), 1930, (4), 13-14).—[In Russian.] Cases of the application of X-ray analysis to works practice are briefly reviewed.—N. A.

X-Rays and Industry. Anon. (Mech. World, 1931, 90, 275-276).—Editorial article on the report of a committee under the chairmanship of Sir William Bragg appointed in 1927, by the Department of Scientific and Industrial Research, to investigate the industrial applications of X-ray analysis.—F. J.

VIII.-PYROMETRY

An Intercomparison of the High-Temperature Scale. W. E. Forsythe (*Phys. Rev.*, 1931, [ii], 38, 1247–1253).—Several tungsten lamps that had been carefully aged and calibrated were sent to different laboratories, and the temperatures of the lamps were measured for specified currents with a disappearing filament optical pyrometer using red glass as a monochromatic screen. Very good agreement was found in this inter-comparison, the maximum difference being only a few degrees over the range $1400^{\circ}-2700^{\circ}$ K. The precautions needed to make the readings comparable because a non-black body was used, are pointed out. The institutions concerned were the Physikalisch-Technische Reichsanstalt in Berlin, the Laboratoire Central in Paris, the Phillips Glowlamp works at Eindhoven, the Osram Lamp Company at Berlin, and the laboratory at Nela Park. Previous comparisons with the U.S. Bureau of Standards, the National Physical Laboratory (England), the Aboratory of the University of Wisconsin are also included.—W. H.-R.

Cambridge Thermo-Electric Pyrometers. Anon. (Instrument World, 1931, 4, (42), 115–116).—A form of magnetic suspension in which the whole moving system of the galvanometer employed with a pyrometer floats in the field of the galvanometer magnet is briefly described. Reference is also made to an automatic cold-junction thermostat and a compensator.—J. S. G. T.

Potentiometer Pyrometer. Anon. (Chem. and Met. Eng., 1931, 38, 419– 420).—Indicating, recording, and controlling models of a new potentiometer pyrometer have been announced by the Brown Instrument Co., Philadelphia, Pa., U.S.A. This instrument, which is a null type potentiometer in which any unbalanced condition operates through mechanism to rebalance the potentiometer circuit and return the galvanometer to the zero position, is briefly described.—F. J.

Measuring Temperature in the Foundry. M. Clain (Fonderie moderne, 1931, 25, 363-365).—Descriptions of the construction of thermo-electric, total radiation, and disappearing filament types of pyrometer are given and the principles on which they work are explained.—J. H. W.

Flame Temperatures. W. T. David, W. Davies, and J. Jordan (*Phil. Mag.*, 1931, [vii], 12, 1043–1057).—Temperatures attained during the explosive combination of gaseous mixtures in closed vessels have been measured by fine platinum-rhodium wires. For mixtures of carbon monoxide and hydrogen with air, the rate of increase of the measured temperature with mixture strength is less than that of the calculated temperatures. For hydrogen mixtures, the measured temperatures in the weaker mixtures are considerably above the calculated temperatures. This result is probably not attributable to occlusion of hydrogen by the metal of the resistance thermometer used. The mechanism of the explosion is briefly discussed.—J. S. G. T.

Free Vane Air-Operated Recorder Controller. Anon. (Blast-Fur. and Steel Plant, 1931, 19, 1479-1480).—Describes the air-operated recording controller made by the Bristol Company of America. The main feature is the control system, in which two air jets opposite each other impinge upon a free vane which floats between the two air streams at right angles. The vane is attached to, and actuated by, a measuring element of a pressure recording system. The vane varies the amount of air which escapes from the jets, thus effecting control by means of the usual Bristol air pressure system.

-R. Gr.

IX.-ELECTROMETALLURGY AND ELECTROCHEMISTRY

ELECTRODEPOSITION

Chromium Plating. W. H. Rowe (Monthly Rev. Amer. Electroplaters' Soc., 1931, 18, (6), 51-56).—R. describes his experience in chromium plating during a period of 6 yrs. He recommends a bath containing 375 grm./l. of chromic acid and 3.5 grm./l. of sulphuric acid used at $37^{\circ}-42^{\circ}$ C. with a current density of 100 amp./ft.² and with 6% antimonial lead anodes. The effects of varying the temperature and sulphuric acid content of the bath are discussed at some length. Excess of sulphates should be remedied by dilution with water, and addition of more chromic acid if necessary rather than by partial removal by means of barium carbonate.—A. R. P.

Electrolytic Chromium Plating of Light Metals. A. Kocnig (36. Hauptversammlung Deut. Bunsen-Ges.: "Fortschritte der Metallkunde und ihre Anwendungen auf Leichtmetalle," 1931, 326-327; and also Z. Elektrochem., 1931, 37, 718-719; discussion, 720-721).—The deposition of a preliminary coating of nickel on aluminium alloys prior to chromium plating is not to be recommended, as the nickel readily becomes brittle by adsorption of hydrogen in the chromium plating bath, and the combined coating then ceases to be resistant towards alkali solutions. Direct plating in the usual chromium bath followed by gentle heating of the articles to remove occluded hydrogen yields a satisfactory chromium protective coating on all the usual aluminium alloys. For good adhesion it is essential that the aluminium surface be thoroughly cleaned and slightly roughened; this is best effected by plating first with a thin coat of nickel and then removing the nickel by means of dilute nitric acid.—A. R. P.

Industrial Chromium Plating. K. Altmannsberger (Metallwaren-Ind. u. Galvano-Tech., 1931, 29, 167-169).—The maximum throwing power of chromium plating baths is obtained with 250 grm./l. of chromic acid, but the maximum current range (3:5-10 amp./dm.²) in which bright deposits are obtained occurs in a bath containing 350 grm./l. of chromic acid. Throwing power and current yield are in both cases reduced by increasing the sulphate content (calculated as sulphuric acid) above $1\cdot2\%$ of the chromic acid content.—A. R. P.

How to Improve Durability of Chromium Plate. R. J. Piersol (Chem. and Met. Eng., 1931, 38, 386-389) .- The competition due to stainless alloys has been beneficial to the quality of chromium plating. The preparation of the article, which includes its design, selection of the foundation metal, cleaning of the piece, and use of an intermediate plate for rust is studied. The importance of the technique of chromium plating is also emphasized, the advantages of using automatic equipment being specially mentioned. Much of the inferior chromium plate is due to lack of scientific planning of the article to be plated, the plating department and organization of the operating personnel. Commercial chromium plate averages less than 0.00001 in. in thickness, thus necessitating caution in polishing to prevent wearing through the The tendency of chromium plate to be non-uniform in thickness, with film. no chromium in recesses and an excess on projections is attributed to : (a) an increased current efficiency with an increased current density; (b) no increase of polarization with an increased current density; and (c) a limiting value of current density below which there is no deposition of chromium. Bright deposits are obtainable only over a narrow range of current density. Other properties are described. Zincification of the chromium is the reason for the lack of durability of chromium-plating direct on brass. Electric cleaning has overcome the difficulty of the intermediate plate peeling from the foundation metal, whilst lack of porosity in the former is perhaps the basic law of most

importance in obtaining superior chromium plate. A plating time of 15 to 30 minutes is recommended for chromium plates which are ductile, free from excessive lateral stresses and non-porous.—F. J.

Thick Chromium Plate Through Judicious Operating Control. R. J. Piersol (Chem. and Met. Eng., 1931, 38, 445–448).—Thick chromium deposits possess abrasive hardness, and resistance both to corrosion and to high temperature. They should be dense (free from occluded hydrogen) and have a minimum of internal stresses. Direct plating on the foundation metal is the established practice, the adhesion being better and the hard foundation improving resistance to wear. Hardness of the deposit is affected by current density and temperature of bath, also by any factor which influences the relative rate of formation of free chromic ions, e.g., concentration of chromic acid, amount of sulphate, percentage of trivalent chromium, and added ingredients such as iron. Many operating details are discussed. Some important applications of chromium plating are described, e.g., moulds for Bakelite calendar rolls for paper making, lehr rolls for plate-glass annealing furnaces, and propellers in clay-mixing machines.—F. J.

furnaces, and propellers in clay-mixing machines.—F. J. Chromium Plating in the Patent Literature. Richard Justh and Fritz Markhoff (*Metallwaren-Ind. u. Galvano-Tech.*, 1931, 29, 237-244).—A list of patents on chromium plating taken out in Great Britain, France, Germany, and the United States is given, classified into 13 sections with brief notes of the scope of overy patent.—A. R. P.

Determination of Sulphuric Acid in Chromium [Plating] Baths. Alfred Wogrinz (Metallwaren-Ind. u. Galvano-Tech., 1931, 29, 312).—The method involving reduction of the chromic acid with alcohol followed by precipitation of the sulphuric acid with barium chloride gives low results. Accurate results are obtained by direct precipitation of the diluted solution with barium chloride, fusion of the precipitate with sodium carbonate, dissolution of the melt in water, acidification of the filtered solution with hydrochloric acid, reduction of any chromic acid with alcohol, and reprecipitation of the sulphuric acid with barium chloride.—A. R. P.

The Nickel Electrolyte and Its Importance for the Nickel Anode. Anon. (Melallwaren-Ind. u. Galvano-Tech., 1931, 29, 333-334).—The importance of using nickel anodes which are dissolved regularly and evenly at a rate corresponding with the deposition of nickel is emphasized. For rapid nickelplating baths hammered electrodes of nearly pure nickel are recommended. —A. R. P.

Cyanides in Relation to Silver and Gold Solutions. E. J. Dobbs (*Met. Ind.* (*Lond.*), 1931, 39, 352).—Abstract of a paper read before the Electrochemical Society. See this J., 1931, 47, 549.—J. H. W.

The Analysis of Cyanide Silver-Plating Solutions. R. M. Wick (U.S. Bur. Stand. J. Research, 1931, 7, 913-933; Research Paper No. 384).—Methods for the analysis of cyanide silver-plating solutions were studied, including the determination of free cyanide, total cyanide, carbonate, chloride, ammonia, silver, iron, copper, and mercury. Electrometric titrations showed that the Liebig method for alkali cyanide is correct for less than 0.2%. Addition of iodide makes the method still more accurate and overcomes the effects of impurities on the titration. The non-arrangement of the Liebig and Hannay methods was studied by electrometric titrations, which showed that the visual Hannay method gives high results, although the electrometric Hannay titration is accurate. The determination of total cyanide was accomplished by distillation with sulphuric acid, and of total effective cyanide by titration with iodine. Silver may be separated as silver sulphide, by precipitation with zine, or by decomposition with acid, after which a determination by any standard method is applicable. Carbonate may be determined by precipitation as barium carbonate, filtering, and titrating with acid or by titrating a sample with acid after adding silver nitrate to combine with the free cyanide. The usual method for the determination of chloride involves prolonged treatment with nitric acid, which converts the precipitated silver cyanide to silver chloride. A new method for separating chloride was investigated, in which the silver is precipitated as sulphide and the iron is removed by precipitation as manganous ferrocyanide. The chloride in the filtrate can be determined by the usual methods. Iron and copper can be determined by the regular analytical methods after decomposition of the plating solution with sulphuric acid. Mercury can be determined by precipitation as sulphide along with silver sulphide. The mercuric sulphide is extracted from the mixed sulphide precipitate with sodium hydroxide, reprecipitated, and weighed. A new method was developed for the determination of ammonia in cyanide solutions, in which the free cyanide is converted to the silver complex preparatory to the usual distillation. Direct distillation is not satisfactory because ammonia is formed by decomposition of alkali cyanide at elevated temperatures.—S. G.

Throwing Power of Plating Solutions with Particular Reference to Certain Zine Plating Solutions. B. K. Braund (Trans. Faraday Soc., 1931, 27, 661-674).-The throwing power under various conditions has been determined for zine plating baths of the following compositions: (a) N-zine sulphate, 0.25*N*-sodium acetate, 1 grm./l. gum arabic, and sulphuric acid to $r_{\rm H}$ 4.0; (b) 2*N*-zine sulphate, 2*N*-sodium chloride, 0.25*N*-sodium acetate, 1 grm./l. gum arabic, and sulphuric acid to $p_{\rm H}$ 4.0; and (c) *N*-zine cyanide, 0.75*N*sodium cyanide, and 0.5N-ammonium hydroxide. The apparatus used was a modification of that of Haring and Blum (Trans. Amer. Electrochem. Soc., 1923, 44, 313) and in discussing the results their nomenclature has been adopted. The throwing power of bath (a) increases to slightly over 1% with rise in the primary current ratio to 2:1, after which it slowly decreases to -3% with a 9:1 ratio. In (b) a maximum of 4% is obtained with a 3:1 ratio, a minimum of 1% at 4:1, and a second maximum of 3% at 9:1. In the cyanide bath (c) the throwing power increases steadily from 12% to 23% with a rise in the primary current ratio from 2:1 to 9:1. The nature of the cathode affects the throwing power considerably; thus for bath (c) with a primary current ratio of 4:1 the throwing power on Duralumin is 17.6%, on aluminium 23%, on zinc 20%, on copper 16.2%, on brass 9.6%, on sandblasted mild steel - 1700%, and on pickled mild steel 22-5%.-A. R. P. Barrel Plating with Zinc-Cadmium Alloys. Lawrence E. Stout and I.

Barrel Plating with Zinc-Cadmium Alloys. Lawrence E. Stout and I. Kowarsky (*Metal Ind.* (*N.Y.*), 1931, 29, 297-299).—An alloy plate of cadmium with 15-20% zinc lasts 25-30% longer than pure cadmium in the salt spray test, whilst a 70: 30 zinc-cadmium alloy is just as resistant as pure cadmium. For barrel plating a high zinc alloy is deposited from a solution containing 3.7 oz. of cadmium oxide, 9.7 oz. of sodium cyanide, 0.8 oz. of zinc cyanide, and 1.1 oz. of sodium hydroxide per gall.; the deposits obtained at room temperature contain 63% zinc, but at higher temperatures they contain a higher proportion of cadmium. The bath may be operated at current densities of up to 200-300 amp./ft.², but is best worked at 25-80 amp./ft.². To obtain the 15-20% zinc alloy the bath should contain 5.1 oz. of cadmium oxide, 9.7 oz. of sodium cyanide, 0.1 oz. of zinc cyanide, and 1.1 oz. of sodium hydroxide per gall. The anodes used consist of cadmium and zinc plates having a proportionate area of 80: 20 in the first bath and 95-90: 5-10 in the second. When these baths are used for ordinary plating, the cadmium content of the plate is greater than when used for barrel plating.—A. R. P.

Electrolytic Deposits on Aluminium and Its Alloys. M. Ballay (Metallwaren-Ind. u. Galvano-Tech., 1931, 29, 335-336).—To obtain strongly adherent nickel coatings on aluminium and its alloys the articles are first cleaned electrolytically in 10% sodium carbonate, then dipped for 10-30 seconds in a solution containing 6-22 grm./l. of iron as ferric chloride and sufficient hydrochloric to give a 0.1-0.7N-solution, and finally, after washing, plated in any suitable nickel bath, but preferably in a sulphate bath with a high content of sodium or magnesium sulphate.—A. R. P.

Preparing Aluminium Alloy Die-castings for Plating. W. E. Warner (Canad. Mach., 1931, 42, (21), 34).—Successful surface preparation is secured by dipping in an alkaline bath, washing in clean water, and dipping for 10 to 30 seconds in a bath containing 3 parts nitric acid, sp. gr. 1.42, and 1 part hydrofluoric acid; after rinsing in water the etched surface forms a good base for plating. The same plating solutions as for zinc die-castings are frequently used. Nickel-plating gives satisfactory results, and it is customary to plate first with nickel; any desired metal can be deposited in this way.—P. M. C. R.

Electrodeposition of Metals from [Solutions of their Salts] in Anhydrous [Liquid] Ammonia. Harold Simmons Booth and Menahem Merlub-Sobel (J. Physical Chem., 1931, 35, 3303-3321).—Many metals can be deposited cathodically in compact, adherent form, from solutions of their salts in anhydrous liquid ammonia. Of the commoner metals which can be deposited from aqueous solutions of their salts, only bismuth and antimony fail to be deposited cathodically from the ammonia solutions. Of the commoner metals not deposited from aqueous electrolytes, beryllium is the only one found to be deposited electrolytically from solution of its salts in liquid ammonia, apart from the alkali and alkaline-earth metals previously known. An electrolysis cell designed for high-pressure electrodeposition is described. Metals which are not deposited electrolytically at the normal boiling point of the solvent are likewise not deposited from solutions in ammonia under high pressure at room temperature.—J. S. G. T.

The Throwing Power of Electrolytic Baths. A. Wilhelm (*Metallwaren-Ind.* u. Galvano-Tech., 1931, 29, 309-312).—Throwing power is defined and recent methods for its determination are described and discussed.—A. R. P.

Barrel Rolling and Plating. R. J. O'Connor (Monthly Rev. Amer. Electroplaters' Soc., 1931, 18, (10), 5-9; discussion, 10-13).—The cleaning and plating with nickel, brass, copper, and cadmium of small parts in barrels is briefly described.—A. R. P.

Vessels for Electrolyte Tanks and Cleaning Tanks in Electroplating. Herbert Kurrein (Metallwaren-Ind. u. Galvano-Tech., 1931, 29, 213–215).—The merits of the composition known as Haveg are discussed. This material is a mixture of asbestos and an artificial resin obtained by the condensation of phenol and formaldehyde; it forms a suitable material for lining cleaning and electrolytic tanks handling all acid liquors (with the exception of those containing oxidizing acids), as well as feebly alkaline liquors. Haveg is an excellent insulator for heat and electricity; it has d 1.6, a compression strength of 800 kg./cm.[±], and a bending strength of 440 kg./cm.², and is thus resistant to breakage by sudden shocks. With indirect heating Haveg will withstand a temperature of 130° C. without softening.—A. R. P.

The Use of the Compensating Colorimeter in the Electroplating Industry. Theo. J. Zak (Monthly Rev. Amer. Electroplaters' Soc., 1931, 18, (9), 15–24).— The use of the compensating colorimeter for the determination of the nickel content and $p_{\rm H}$ of nickel-plating solutions is described.—A. R. P.

Looking Backward and Forward in the Electroplating Industry. Charles H. Proctor (Monthly Rev. Amer. Electroplaters' Soc., 1931, 18, (7), 5-16).— Historical.—A. R. P.

The Education of the Electroplater. H. W. Faint (Monthly Rev. Amer. Electroplaters' Soc., 1931, 18, (6), 46-49).—An outline of the course given at the lectures of the Chicago Branch.—A. R. P.

ELECTRO-REFINING

Electrolytic Refining of Gold. Y. Kimata (Nihon-Kógyókwaishi (J. Min. Inst. Japan), 1930, 46, 315-331).—[In Japanese.] The history of gold refining in Japan, especially that of the Hitachi Refinery, Nippon Mining Co., operating by the Wohlwill process, is outlined. The influence of the wave-forms on electrolysis, as well as the relation between the conditions of electrolysis and the electrochemical equivalents of the anode and the cathode which are peculiar to gold, are discussed. The range of current density in which an impure gold anode is active is relatively small when d.c. alone is used, but is somewhat enlarged when the full or half waves from a mercury rectifier are applied. A pulsating current comprising a d.c. and an a.c. less than 1.3 times as great has no effect on limiting current density. With a higher ratio of a.c. the anode ceases to be inactive even at a much higher current density. The oscillogram of the pulsating current shows that the minimum value of the voltage is zero when the a.c. is 1.25 times that of the d.c. used. Thus the effect of a.c. does not appear with a negative current, as generally supposed, but only in the voltage of negative value. The electrochemical equivalent varies between those of Au' and Au". according to the conditions, and the value for the anode is always greater than that for the cathode. The ratio of Au' and Au^{...} which takes part in the electrochemical reaction can be calculated from the actual electrochemical equivalent, and is equal to the percentage of the two kinds of gold ions. The relation between the percentage of Au" ion and the conditions of electrolysis may be expressed by the equation $N = m \times D^n$, where N is the percentage of Au^{\dots} ion, D the current density, and m and n are constants depending on the temperature t in °C. For the anode $m = 0.0135t^2 - 2.62t + 136.5$ and n = 0.0088t - 0.12; and for the cathode $m = 0.0036t^2 - 1.4t + 115.5$ and n = 0.0052t - 0.05. The amount of gold in the slime, which varies greatly with the conditions, can also be determined from the above equations. The mechanism of the electrolytic gold-refining process will be discussed later, after potential determinations have been made. -AUTHOR.

Studies in the Electrolysis of Gold.-I. Y. Kimata (Nihon-Kôgyôkwaishi (J. Min. Inst. Japan), 1931, 47, 677-694) .- [In Japanese.] (a) The Analysis of Acid in the Electrolyte : The acidity of solutions containing hydrochloroauric acid (HAuCl₄) and hydrochloric acid is not always equal to the sum of the two acids present in the solution when determined by the usual method. To ascertain the cause of this discrepancy pure crystals of hydrochloroauric acid were prepared by dissolving gold in hydrochloric acid through which chlorine was passed, and the acidity of several solutions of different concentration made from the crystal was determined by the electrometric titration method. The results showed that hydrolysis of hydrochloroauric acid was the reason why excess alkali was used for the neutralization, and that the presence of certain neutral chlorides, e.g. potassium chloride, prevents the hydrolysis and gives correct results. This salt should therefore be added to solutions containing both hydrochloroauric and hydrochloric acids before titration of the acidity with alkali. (b) The Equilibrium Concentration of the Electrolyte: The compositions and potentials of the gold electrolyte consisting of hydrochloroaurous (HAuCl.), hydrochloroauric (HAuCl.), and hydrochloric acids were determined at the equilibrium state with a view to the elucidation of the mechanism of the electrolysis and to confirm G. Grube's data (Z. Elektrochem., 1929, 35, 703). The results were: (1) With a constant composition the concentration of hydrochloroaurous acid increases with rise in temperature; (2) Increase in the concentration of hydrochloric acid at constant concentration of hydrochloroauric acid, or increase in the concentration of hydrochloroauric acid at constant concentration of hydrochloric acid results in an increase of hydrochloro-

VOL. L.

aurous acid concentration in the solution. Grube's value for the equilibrium constant is much smaller, and his value for the concentration of hydrochloroaurous acid considerably greater than those calculated by K.—AUTHOR.

ELECTROCHEMISTRY-GENERAL

Chemistry of Beryllium. I.—Electrolysis in Non-Aqueous Solutions. II.— Electrolysis of Beryllium Compounds in Organic Nitrogen Derivatives. Harold Simmons Booth and Gilberta G. Torrey (J. Physical Chem., 1931, 35, 2465-2477, 2492-2497).—(I) Literature relating to beryllium is briefly reviewed and misstatements occurring therein are corrected. Solutions of beryllium salts in non-aqueous non-nitrogenous solvents have been subjected to electrolysis. The majority of the solutions are very poor conductors of the electric current, and none is suitable for the production of metallic beryllium. (II)—Solutions of beryllium salts in organic derivatives of ammonia have been subjected to electrolysis. Some of the solutions are absolutely non-conducting, whilst others—more especially solutions in piperidine and pyrrole—conduct a small current, and yield a small amount of metallic beryllium. In general, the solutions are colloidal and gelatinous, and the practical separation of metallic beryllium therefrom is problematical.—J. S. G. T.

A Study of the Zinc Electrode. Frederick H. Getman (J. Physical Chem., 1931, 35, 2749–2759).—The c.m.f. of the cell $Zn_z Zn Cl_2(M)_z Hg_2 Cl_2$. Hg has been measured at 25° C. with concentrations of zinc chloride ranging from 0.002 to 1.0M and using pure zinc electrodes in the form of single crystals and polycrystalline aggregates. The single-crystal electrodes were found to resemble single crystals of copper and cadmium in exhibiting a tendency to develop a difference of potential towards the electrolyte which was slightly greater than that developed by the polycrystalline electrodes. The average normal electrode potential of zinc, determined by 3 different methods, was found to be 0.7613 v.—J. S. G. T.

X.-INDUSTRIAL USES AND APPLICATIONS

Babbitt Bearings Spun and Diamond-Cut. Robert E. Bultman (Metal Progress, 1931, 20, (5), 55-56).—Some motor manufacturers prefer Babbitt bearings for heavy duty. A fine surface requiring little further working is obtained by centrifugally easting the bearing round the rotating connecting-rod, with thin shims to prevent the Babbitt from forming a continuous ring. Cleaning and easting precautions are described. Finish is applied with a diamond tool, which does not tear out the hard tin-antimony crystals, as do ordinary tools. B. emphasizes the importance of pure ingredients and strict adherence to specification. The recommended composition is: tin, 87.25% min.; copper, 5.5-6.0%; antimony, 6.50-7.0%; lead 0.35% max.; arsenic, 0.10% max.: bismuth, 0.08% max.: aluminium and zine, none.

-P. M. C. R.

Anodically Oxidized Aluminium as a New Constructional Material for Electrotechnics and Automobile Construction. Karl Altmannsberger (Metalltearen-Ind. u. Galvano-Tech., 1931, 29, 217-218).—In the Eloxal process aluminium and its alloys are anodically oxidized in a cold solution of arsenious acid using an aluminium sheet cathode. The resulting oxide films can be built up to a thickness of 0.5 mm., and are strongly adherent and resistant to ecrosive action. A film 0.5 mm. thick will withstand a pressure of 10,000 v., and aluminium sheet with such a film may be used for the manufacture of condensers provided that the metal contains less than 0.2% of impurities. The anodic films can be suitably coloured by adsorption of aniline dyes and rendered impervious to moisture by impregnation with lanoline; Lautal so treated has been largely used in automobile construction. —A. R. P.

Metals Used in Airplane Construction. Thomas Lyons (Monthly Rev. Amer. Electroplaters' Soc., 1931, 18, (9), 26-39).—The use of aluminium and its alloys in aircraft construction is described.—A. R. P.

Light-Weight [Automobile] Body Construction. Anon. (Automobile Eng., 1931, 21, 425).—A description of a sports four-scatter automobile body constructed of Birmabright, where the main members consist of extruded angle sections, joined by means of large corner brackets, and where Birmabright rivets are used to secure the brackets to the main frame. The structure weighs 57 lb., and the completed body with actual trimming material (plywood panels) weighs 96 lb., a saving of approximately $1\frac{1}{2}$ ewt. over a similar body constructed of ash.—J. W. D.

Copper-Silicon Alloys, New Working Materials for the Construction of Apparatus and Machines. Erich Becker (*Apparatebau*, 1931, 43, 241-242).— The value of silicon as an alloying element in copper alloys is discussed and the mechanical properties are given of some copper alloys containing silicon (e.g., Everdur, Isima bronzes, Corson alloys, Tombasil).—M. H.

British Standard Specification for Phosphor Bronze Castings for Gear Blanks. —— (Brit. Eng. Stand. Assoc., No. 421, 1931, 1-8).—The specification covers castings (a) centrifugally cast, (b) cast in chill moulds, or (c) cast in sand moulds, the method to be used being the subject of agreement. The material is required to show on analysis: tin 11-13%, phosphorus not less than 0.15%, lead not more than 0.5%, nickel not more than 0.5%, zine not more than 0.3%, copper the remainder, and a maximum total of other elements 0.15%. The copper used must be of at least "Best Select" (B.S.S. No. 203) quality. Test samples taken on the actual casting are cut from the portion representing the teeth of the finished wheel. For castings of more than 100 lb. in weight, the test sample may be either separately cast from the same pot of metal (a) in a chill mould to represent centrifugal castings and chill castings, and (b) in sand to represent sand castings, or cut from the casting. The test samples hall not be annealed or otherwise treated before testing unless the castings have been similarly and simultaneously so treated. The specified minimum physical properties are as follows :—

Type of Casting.	Type of Sample,	Minimun Stree	n Tensile ngth.	Elonga- tion. %-	Minimum Brinell Hardness No.	
		1008/10	Ng./mm			
Contrifunal	Cut from casting.	17	26.8	3	90	
Centringar .)	Separately chill-cast.	17	26.8	3	90	
Chilled eastings	Cut from casting.	15	23-6-	2	82	
Chined castings (Separately chill-cast.	17	26.8	3	90	
	Cut from casting.	12	18.9	3	69	
Sand-castings .	Cast attached or sep- arately in sand.	14	22.0	7	69	

Should the dimensions of the casting be such as to preclude the use of the British Standard tensile test-pieces C, D or E (given in an Appendix), a sample shall be cast of gauge length $4\sqrt{a}$ with a minimum of 1 in. The fractures shall show clean sound metal. The Brinell hardness test is made with $\frac{P}{D^2} = 5$ (B.S.S. No. 240). Other clauses deal with dimensions, rejection and testing facilities.—R. G.

The Different Bronzes Used by Railway Companies. R. Loiseau (Aciers speciaux, 1931, 6, 203-208).—A classification of bronzes containing 60-90% copper, and of antifriction alloys, their compositions and impurity tolerances, and their applications as laid down by railway companies in France, is given and the applications of other copper alloys such as brasses, nickel-brass and "aluminium-bronze" in this connection are noted.—J. H. W.

Aluminium-Brass Condenser Tubes. Anon. (Met. Ind. (Lond.), 1931, 39, 392).—Short notice of a brochure issued by the Broughton Copper Co., Ltd., Manchester, giving technical information of aluminium-brass tubes made of an alloy containing copper 76, zine 22, and aluminium 2%. This alloy consists of a single phase, the α -phase of the ternary system, and is said to have remarkable protective film-forming properties.—J. H. W.

Lead-Covered Cable. Anon. (Wire and Wire Products, 1931, 6, 402–404). —From "Facts about Lead," compiled by the Lead Association, describing the use of lead and a lead-calcium alloy containing 0.03–0.04% calcium and of other lead alloys for covering electric cables.—J. H. W.

Lead-Base Metal versus High-Silicon Iron. Anon. (Found. Trade J., 1931, 45, 223).—An account is given of the difficulties encountered in producing lead-base containers for use in acid manufacturing plants, and of how these difficulties are overcome. The advantages of these alloys over highsilicon iron are set out.—J. H. W.

Molybdenum Increasingly Useful. A. E. B. (Sci. American, 1931, 145, 55-56).—A substantial outlet for molybdenum has recently been developed in the new nickel-molybdenum-iron alloys containing as much as 20% molybdenum. These alloys resist the attack of hydrochloric acid. A large amount of molybdenum is also used in the manufacture of thermionic valves. —W. P. R.

Monel Metal Radiator. Anon. (Chem. and Met. Eng., 1931, 38, 417).— A radical departure in the fabrication of heating surfaces for industrial purposes is announced by the Maschinenfabrik Wiesbaden G.m.b.H., Wiesbaden, Germany. This consists in the production of pressed Monel sheet-metal sections, welded together to form radiator sections similar in appearance to the ordinary cast-iron radiators used for building heating. The sections are made in thicknesses from 0.91 to 1.50 mm.—F. J.

The Non-Wearing [Tungsten Carbide] Sand Blast Jet. V. Lohse (Z.V.d.I., 1931, 75, 1107-1109).—A jet made of a cast tungsten carbide alloy has an average life of 800-900 working hours whereas an ordinary steel jet lasts only 3-4 hrs.—v. G.

New Alloys Extend Field of Zinc's Usefulness. A. E. B. (Sci. American, 1931, 145, 68).—The die-casting zinc alloy containing aluminium 4, copper 3, magnesium 0.1%, and the remainder high-purity zinc is satisfactorily used for fuel pumps, carburctors, steering wheel parts, &c.—W. P. R.

Shipbuilding Industry Closely Linked to the Foundry. A. H. Jansson (Foundry, 1931, 59, (8), 90-91, 110).—Castings of bronze, brass, aluminium, and other metals are used in large quantities on any type of ship, and because of severe conditions of service, the relative proportion of castings is greater than in any land structure. Manganese-bronze propellers, often planed to a true helical surface and polished bright, are used in the better-class and larger ships. Tail shafts are protected by cast bronze sleeves. Steel, brass, and other metal castings are used for dead lights, portlights, and window-framing. Hardware is sometimes made in nickel silver and other alloys, and rail fittings sometimes in bronze or brass. There is much cast non-ferrous metal in the ship's machinery, pumps, &c.—F. J.

XI_HEAT-TREATMENT

Commercial Heat-Treating Plant Has 16 Furnaces. Harry Turner (*Iron* Age, 1931, 128, 1238–1240).—Quick ageing of zinc die-castings is effected by heating them at 300° F. (150° C.) for 24 hrs., thus eliminating the growth which at room temperature would proceed for long periods. This is done in a furnace fitted with a specially designed burner with automatic control.

-J. H. W.

Annealing with Gas in a Brass Finishing Plant. S. P. Rodgers (Amer. Gas J., 1930, 133, (2), 37-38).—The use of gas for annealing rolled brass with an over-all thermal efficiency of about 24% is described.—J. S. G. T.

Fundamentals of Copper Wire Annealing. O. S. Haskell (Wire and Wire Products, 1931, 6, 220-222).—To obtain uniform annealing, economy of labour and minimum procedure, 2 types of furnace for annealing copper wire have been developed: the hood type and the water-seal elevator type. Since continuous furnaces require continuous and at least semi-skilled attention, the batch system is used. A brief description of the operation and the production data of these 2 types of furnace is given.—J. H. W.

Heat-Treatment of Metals with Special Reference to Steel. J. A. G. Stuart (*Mech. World*, 1931, 90, 154–156, 169–170).—A theoretical study, in which only slight reference is made as regards non-ferrous metals, to the influence of annealing on the crystalline structure.—F. J.

XII.—JOINING

Aluminium Rivets for Aircraft. Anon. (Amer. Machinist (Eur. Edn.), 1931, 75, 413).—Short note on the use of annealed Duralumin rivets for aircraft construction work.—J. H. W.

Distillation Phenomena in Brazing with Copper-Zinc Alloys. W. Claus (Z. Metalllunde, 1931, 23, 243-244).—In cases where change of composition of the solder during soldering takes place by evaporation of a volatile component, a mathematical treatment of the kinetics of the soldering process by means of diffusion constants is impossible. This applies to the brazing of iron tubes with copper-zinc alloys under very unfavourable thermal conditions when considerable losses of zinc have been found to occur.—M. H.

Low Melting Point Brazing Alloy. Anon. (Wire and Wire Products, 1931, 6, 343-345).—An account of the properties of "Sil-Fos," a brazing alloy containing a small percentage of silver is given. (See this J., 1931, 47, 596.) —J. H. W.

Lead Soldering in the Chemical Industry in Upper Silesia. Anon. (Soudeur-Coupeur, 1931, 10, (3), 5-6).—Abstracted from Spawanie i Cieci Metali. A description and examples are given of lead-soldering in chemical plant construction in Upper Silesia, Poland.—J. H. W.

Autogenous Welding of Aluminium. R. Granjon (*Rev. Aluminium*, 1931, 8, 1469-1474).—A description of the methods adopted in the autogenous welding of aluminium and examples of the type of work for which this process is especially applicable are given.—J. H. W.

Warning in Welding Light Metals. Anon. (Metallwaren-Ind. u. Galvano-Tech., 1931, 29, 336).—When Elektron is welded under the conditions normally used for aluminium there is great danger of the metal taking fire. Such fires must be quenched with dry sand, and not with water. If a light metal of unknown composition is to be welded it should be tested before welding by throwing a few filings into a 6:3:1 mixture of concentrated sulphuric, hydrochloric, and nitric acids; Elektron remains unattacked, whereas aluminium alloys dissolve readily.—A. R. P. **Care in Welding Light Metals.** Anon. (Z. ges. Giesserei-Praxis: Das Metall, 1931, 52, 108).—Short note enumerating the precautions to be taken in welding aluminium and magnesium alloys, especially with regard to the danger of burning them.—J. H. W.

Welding Chrome-Nickel Alloys. J. G. Norris (*Welding Eng.*, 1931, 16, 46-47).—A description of the various methods available for welding chromiumnickel alloys is given.—J. H. W.

Copper Welding Solves Refinery Problem. Anon. (Oxy-Acetylene Tips, 1931, 10, 141-142).—Details of copper welding parts of stills made of sheet copper and capable of resisting the action of zinc chloride.—J. H. W.

Lead Welding. Anon. (Oxy-Acetylene Tips, 1931, 10, 168-169).—A description is given of the method adopted for welding lead by the oxy-acetylene process.—J. H. W.

On the Welding of Monel Metal in the Construction of Chemical Apparatus. Rud. Müller (*Chem. Fabr.*, 1931, 4, 310-312).—Welding of Monel metal presents no difficulties provided that oxygen be excluded from the welds, as it forms cuprous oxide, which renders the welds brittle and more sensitive to corrosion. In oxy-acetylene welding a slight excess of acetylene should be used, but care must be taken not to carburize the metal; a flux is usually unnecessary but, if required, a 1:1 mixture of boric acid and borax gives the best results, or the welding gases may be passed through an alcoholic solution of boric acid. In are welding Monel metal the work should be made the negative pole and the welding rod should be of the same composition as the work, and should be coated with a thin layer of powdered flux containing a magnesium-manganese-silicon or titanium-calcium alloy as deoxidizer. Good results are also obtained by the use of atomic hydrogen, *i.e.* hydrogen blown through a tungsten arc, but care must be taken not to overheat the metal, or a very coarsely crystalline structure will be obtained.—A. R. P.

Thermocouple Elements Improved. Anon. (Oxy-Acetylene Tips, 1931, 10, 172).—Joins in both base metal and the platinum group metals for use as thermocouple wires are more satisfactorily effected by the oxy-acetylene process.—J. H. W.

The Welding of Alloys. Anon. (Oxy-Acetylene Tips, 1931, 10, 71-76).— Brief accounts are given of the procedure to be adopted in oxy-acetylene welding ferrous alloys, and aluminium, nickel, copper, and their alloys.

-J. H. W.

Impressions in the Field of Welding Technology from the United States of America. H. Lottmann (Z.V.d.I., 1931, 75, 1265-1269).—In America spotwelding, gas-welding, and arc-welding are frequently employed for aluminium with satisfactory results.—v. G.

Stamping Technique and Resistance Welding. Felix Goldmann (Maschinenbau, 1931, 10, 489-492).—The method and apparatus for electrical resistance welding with special reference to iron, aluminium, copper, and brass, are described.—v. G.

The Use of Copper Forms in Shape Welding. Miles C. Smith (Welding Eng., 1931, 16, (5), 45-47).—'The use of a copper form in welding confines the weld deposit to the desired area and thus eliminates much if not all grinding, but its use is confined almost entirely to are welding. Examples are given of the use of a copper form for the building up of oil-field drilling bits and gear wheels.—J. H. W.

Modern Welding and Cutting Requirements. H. Reininger (Maschinenbau, 1931, 10, 581-587).—A new welding process is described, called the "Arcogen" process, in which the weld is made simultaneously with an acetylene flame and an electric arc. In this way completely non-porous welds may be made in copper. Numerous new pieces of apparatus for gas-welding and cutting and for arc-welding are described.—v. G.

Working

The Arcatom and Arcogen Welding Processes. Anon. (Allgem. Oesterr. Chem. u. Tech. Zeit., 1931, 23, 47-51).—The Arcatom process involves the use of an a.e. are between tungsten electrodes through which hydrogen is passed to prevent oxidation of the electrodes and metals, *i.e.* welding is effected by the atomic hydrogen flame. The Arcogen process uses a combination of the are between earbon electrodes and the oxy-acetylene flame. Examples of the use of both processes are described.—A. R. P.

Something About Electrodes. — Beissner and — Kilger (Siemens Rev., 1931, 7, 187–190).—Bare wire and flux-coated electrodes are compared. —R. Gr.

Oxweld No. 21 High Strength Welding Rod. Anon. (Amer. Gas J., 1929, 130, (3), 65).—A welding rod, suitable for welding brass, bronze, and malleable and grey iron castings is referred to.—J. S. G. T.

Atomic Hydrogen Welder. — (Elect. Times, 1931, 79, 1037).—Photograph of the latest type of iron-clad welding unit manufactured by the Metropolitan-Vickers Electrical Co., Ltd.—S. V. W.

Modern Welding Installations in Great Britain. F. A. Cramer (Siemens Rev., 1931, 7, 190-193).—Some electric arc welding installations are described. —R. Gr.

Survey of the Various Kinds of Arc-Welding Machines for Hand and Automatic Operation. G. Falck (Siemens Rev., 1931, 7, 180-184).—The d.c. welding converter is compared with the welding transformer. Automatic welding machines are described.—R. Gr.

XIII.--WORKING

Aluminium Sheet Production. IX .- The Hot Break-Down Operation. Robert J. Anderson (Metallurgia, 1931, 4, 117-118, 149-151, 173-174, 176). -In the rolling of aluminium ingots to slabs, practice at the hot-mill, including rolling temperatures, drafts and passes, lubrication of ingots and cooling of rolls, slab thicknesses, and man-power requirements, are discussed. The range of temperature employed in practice for aluminium and alloy sheet ingots varies from 450° to 525° C., pure aluminium (99%) being rolled most satisfactorily at about 455° C., whilst alloys of the heat-treatable type like Duralumin are rolled at lower temperatures. Ingot temperatures have also to be regulated by the number of passes and the magnitude of the drafts. Empirical scales giving dial readings for successive passes for hot-rolling ingots measuring 31 in. $\times 14$ in. $\times 24$ in. to various widths are given, as well as tables showing thicknesses to which ingots are broken down hot for various sizes and gauges of aluminium sheets, and thickness of aluminium slabs after each of the successive passes on hot-rolling. Lubrication and cooling in tonnage production should be combined and continuous, an effective method being the spraying of rolling surfaces with a water emulsion of a soluble oil, the water acting as a coolant and the oil as a lubricant. Oils such as kerosene, light transformer, and machine oils are used as lubricants, but are unsuitable for cooling .- J. W. D.

The Production of Copper Tubes. A. Schummel (Met. Ind. (Lond.), 1931, 39, 98 and 101).—Abstract from Tech. Blätter. The usual method of manufacturing seamless copper tubes here described is the Mannesmann process, but smaller diameter tubes are generally pressed. In both cases, subsequent cold-drawing to the required dimensions is necessary. Copper tubing is preferred to iron tubing in a large number of cases, owing to its greater resistance to corrosion, which makes the final cost of the two classes of tubing comparable. Joints in copper tubing are effected by compression pieces, thus obviating increased thickness of walls necessary for thread-cutting. They are also made by welding and hard soldering.—J. H. W.

Researches on the Power Consumption in the Extrusion and Punching of Metals. Erich Siebel and Erich Fangmeier (Mitt. K.-W. Inst. Eisenforschung. 1931, 13, 29-41) .- The theoretical power requirements in extrusion presses and punching machines may be calculated from the work done in shaping which is the product of the shaped volume, the deformation strength (which is constant in hot deformations), and the absolute maximum deformation. As the course of the deformation of individual volume parts is very difficult to follow, a simple parallelepiped movement from the original to the final shape has been assumed to occur. Friction of the tools and deviations from the simplest type of flow are taken into account by replacing the deformation strength with a correspondingly greater material constant. The principal deformation in extrusion is the effective stretching; in punching, however, it is the effective reduction in thickness of the ring-shaped body elements which is at a minimum in the external lavers, but is infinitely great in the core zone. Its mean value can be determined by integration. Extrusion and punching tests on carefully homogenized soft lead have confirmed the theoretical conclusions. In the indirect extrusion process the friction on the walls of the press cylinder is reduced, but a higher rate of extrusion and a correspondingly greater power consumption must be employed to obtain smooth extruded rods. The punching process of Ehrhardt in which the material is forced out radially requires only a small power at the beginning, but a much higher power at the end of the operation, so that this process is only partly superior to the ordinary punching process. The most favourable shapes for the extrusion die and the punching piston have been determined .- J. W.

Shaping of Metals without Cutting. G. Sachs [with W. Eisbein, W. Kuntze, and W. Linicus] (*Mitt. Material., Sonderheft* 16, 1931).—See the following five abstracts.—J. W.

Introduction to the Technology of Shaping [of Metals] without Cutting. G. Sachs (*Mitt. Material., Sonderheft* 16, 1931, 5–10).—The problems associated with and a general scheme of research for a modern technology of plastic shaping of materials are discussed. Its basis is the now rapidly extending physical knowledge of constructional materials. The most important points of view for the evaluation of the tools, of the metal under various shaping conditions, and of the limits to which it can be worked are described, directions are given for carrying out researches and the problems associated with the development of a theory of the mechanism of plastic shaping in general are outlined.—J. W.

Researches on Deep Drawing. G. Sachs [with W. Riem] (Mitt. Material., Souderheft 16, 1931, 11-38) .- The phenomena which occur in the first draw in the deep drawing of circular metal sheets have been investigated experimentally and theoretically. The apparatus used included a screw spring device for measuring the force required to hold the sheet in position, whilst the drawing force was measured by the relative movement of the plunger. The part played by the most important factors in determining the course of the drawing operation was first determined by experiments on annealed sheets, 0.5 and 1.5 mm. thick, of aluminium, copper, 85, 72, 63% brass, and a 6% tin-bronze. "Pure deep drawing" takes place only when the plunger exerts pressure solely on the bottom of the hollow body. The drawing aperture must in this case be wide enough to allow the thickening lateral zones of the metal to flow freely. In other cases deep drawing becomes similar to ordinary tube drawing, and the drawing curves change in a characteristic manner. The aperture necessary for pure deep drawing is 1.4 times the thickness of the original sheet of metal, and this value was maintained in further work. The results obtained are of value, however, in ordinary practice which usually employs narrower apertures. With decreasing aperture size, lengthening of the drawing path and consequent increase in power consumption occurs only at the end of the drawing operation. The most favourable pressure for holding the outside rim of the sheet to prevent folding is the same for each sheet thickness tested, but generally increases with increase in the resistance to flow of the material. The maximum drawing power increases linearly with the holding power when this exceeds the minimum value corresponding with the increasing friction between the metal and the tools. The drawing power increased linearly also with increase in the diameter of the test sheet. The capacity for deep drawing depends only slightly on the thickness of the sheet, but is more dependent on the holding power and on the shape of the plunger (curvature at the end), although it appears to bear no definite relation to the flow curve. When the specimen is too large, the tube produced by deep drawing splits near the bottom under a load corresponding with slightly more than the tensile strength. The ratio of the surface of the hollow body to that of the sheet before drawing increases with the size of the latter to an extent which is greater the greater the elongation of the metal in the tensile test. In the theoretical treatment of the laws governing the deep drawing process the stress relations have been determined from the geometry of the shaping under the holding collar based on the hypothesis of the change of shape. From the relations between edge displacement and the movement of the plunger, and between the flow curve for the metal and an approximate friction value, the theoretical drawing curves have been derived; the deviations of these from the experimental results correspond with the omission of the component of bending force from the calculations. As a preliminary only the method of calculating the deep drawing capacity of a metal is indicated .-- J. W.

Researches on the Properties of Drawn Wires and the Power Consumption in Wire Drawing. W. Linicus and G. Sachs (Mitt. Material., Sonderheft 16, 1931, 38-67) .- Soft brass wire (63% copper), 3 mm. in diam., was drawn in one stage at room temperature through dies lubricated with rape oil, and the effects of reduction in cross-sectional area, the angle of the die, and the material of the die on the power requirements and on the properties of the wire were determined. In a special series of tests with rotating dies the approximate coeff. of friction for the drawing of brass wires was found to be 0.06 for Elmarid dies and 0.1 for steel dies, irrespective of the angle of the die, provided that the reduction in area of the wire was not too small, so that the deformation component of the drawing power could be mathematically correlated with the properties of drawn wires. Drawn wires show in the tensile test, especially with small stages and steep die angles, a considerable additional increase in strength and a correspondingly smaller clongation at fracture, i.e., they behave like tensile test-pieces which have previously been subjected to a corresponding preliminary stretching. The tensile curve can be directly derived by extrapolation of the yield point of wires which have been drawn to various stages to a drawing angle of 0°. The actual flow curves for different drawing angles can be reduced to the tensile curve by determining the yield point after various reductions in area by drawing if the actual reduction in area is replaced by a correspondingly greater "effective" reduction in area; the frictionless drawing strain can then be calculated with a close approximation to the experimental results. Extensive researches have allowed conclusions to be reached as to the nature and origin of the additional hardening effect. The outer skin of wires drawn through steep-angled dies with small reductions in area is up to 50% harder than the core, as additional deformations occur in these outer layers due to irregular flow in the die. These deformations have been followed by observations of the displacement of the end faces and of the stretching stresses. On removing half the wire by planing, maximum values of the longitudinal stresses are found, when the reduction in area is 20%, at the places where the maximum additional hardening and the maximum differences in tensile strength between the core and the outer layers occur. The mercurous nitrate test develops longitudinal fissures in severely drawn wires, indicating the presence of predominating transverse stresses. In an appendix it is shown that the laws governing the behaviour of brass wires in the first passage through the die are also applicable to soft steel wires and are therefore generally applicable. Tests on hard-drawn brass wires show that in further drawing to the same final diameter the effects of drawing angle and degree of reduction on the final strength of the wire are small; it appears that in this case the irregularity of the flow of the metal is great and depends only slightly on the drawing angle.—J. W.

Power Consumption and the Mechanism of Flow in Extrusion Presses. W. Eisbein and G. Sachs (Mitt. Material., Sonderheft 16, 1931, 67-96) .-(1) The power consumption in extruding tin and lead at room temperature in laboratory presses is independent of the original length of the ingot, falls as the length decreases during extrusion owing to slowly decreasing friction, rises considerably with increasing roughness of the matrix, and rises to a smaller extent with increasing rate of extrusion and with increase in the circumference, the cross-sectional area remaining constant. The minimum extrusion pressure bears a logarithmic relation to the reduction in area. The combined effects of matrix friction and irregularity of flow of the metal result in a minimum extrusion pressure being necessary with a matrix angle of 30°-50°. In "indirect" extrusion the work of friction between the ingot and the wall of the cylinder is obviated, so that the power required is somewhat less. The mechanism of flow has been followed in a series of tests in which a gauge smearcd with red lead is inserted longitudinally through the centre of the specimen. (2) Hot extrusion tests with hard brass (58% copper) and with copper in a large extrusion works have shown the general applicability of the laboratory results to large-scale conditions, and have confirmed the information gained in the small tests. The funnel-shaped depression formed at the end of the rod when the extrusion is complete can be prevented from forming by making a corresponding depression in the pressure plate of the piston. In spite of the considerable increase in power consumption a high rate of movement is necessary in hot extrusion if a uniform rod is to be obtained. The processes of flow are strongly dependent on the friction relationships, and hence on the nature of the material, but not appreciably on the dimensions of the press or on the temperature of extrusion. (3) For the theory of the power consumption in the extrusion of rods the principles are developed with reference to the friction by comparing the stress distribution in conical extrusion dies with that in conical drawing dies. The resistance of the material to flow is obtained by compression tests at the extrusion temperature; it can be assumed to be dependent only on the rate of flow; and its mean value in extrusion can be determined by measuring the network lines. The friction in the deformation process cannot be calculated with certainty; nevertheless an insight has been obtained into the effect of the determinative factors .-- J. W.

Mechanism of Impression in Metals [by Tools]. W. Kuntze and G. Sachs (*Mitt. Material., Sonderheft* 16, 1931, 96–127).—In order to determine the actual resistance of a metal to plastic deformation by pressure of various shaped tools into the surface, experiments have been made on Duralumin, electrolytic copper, α -brass (72% copper), soft iron, and Banka tin, using lubricated cylinders, spheres, and cones of various angles, as well as a few composite tools. The effect of external friction on the mechanism of the penetration has been determined in a special series of tests in which the load was applied in steps with intermediate removals of the tool from the impression. With conical tools the resistance to penetration becomes smaller with successive

applications of the load, so that Kick's similarity law applies only when the load at each stage is so selected that the increase in load is a constant proportion of the total increased load. The highest hardness number is obtained in the first impression (proportional number 1), i.e., when the whole of the friction takes part. The true resistance of a material to penetration by conical tools appears with a proportional number of 0.1 (H_{K} or). With cylindrical impressions the external friction of course falls away and the resistance to penetration with increasing proportionate depths of penetration t/d gives a hardening curve expressed by the relation $H_z = c \cdot (t/d)^n$. The influence of the cone angle, α , on the frictionless cone hardness is given by the relation $H_{K\alpha,1} = 1 \cdot \pi/(\pi + \cot \alpha)$, so that for an angle of $2\alpha = 180^{\circ}$ the hardness is 1. The difference in the form of the cone and cylinder impressions gives the relation $H_{K_{0}\cdot 1} = 10^{-0.177n} \cdot H_Z \cdot \pi/(\pi + \cot \alpha)$. The friction component for obtuse cone angles is given approximately by the expression $H_{K\alpha_1} = H_{K\alpha_1}(1 + \mu \cot \alpha)$; μ can be approximately determined from tests with a cone having an angle of 90° to be $\mu = (H_{Ka1} - H_{Ka1})/H_{Ka1}$ Hence the ordinary cone hardness is given by the expression $H_{Kel} =$ $c(\cot \alpha/2)^n$. $10^{0.177n}$. $\pi(1 + \mu \cot \alpha)/(\pi + \cot \alpha)$. The ball hardness can be analyzed in a similar way; the hardness numbers lie, when expressed as depth of penetration/diameter of impression, between the cone and cylinder hardness numbers. The hardening mechanism in the impression range can be approximately calculated by assuming that the state of stress is similar to theoretical elastic state of stress and by correlating the maximum displacement stress calculated from this assumption with the corresponding deformation taken from Ludwik's compression curve. The resistance to penetration by impression of cylindrical tools calculated in this way agrees, however, with experimental results only at the yield point, and is, with increasing depth of penetration, only 0.6 (iron) to 0.8 (copper) times the measured value. With the penetration of the hardened zones the volume of metal taking part in the flow gradually becomes larger than the theoretical volume of flow (proved by recrystallization tests). The mechanism of flow and the extension of the displaced surfaces, however, affect the resistance to penetration only very slightly.-J. W.

XIX.-BIBLIOGRAPHY

- Agejenkow, W. G. Methods for the Technical Analysis of Ores and Metallurgical Products in Copper, Lead, and Zinc Manufacture. [In Russian.] Pp. iii + 274. 1931. Tomsk: Isdatkom Wtusow. (Rbl. 3.50.)
- *Bacon, Frederic. An Inquiry into the Causes of the Breakage of Rolls. Paper read before a meeting of the Staffordshire Iron and Steel Institute, at Dudley, January 20, 1931. [With discussion.] Demy 8vo. Pp. 31, with 12 illustrations. 1931. Birmingham: Staffordshire Iron and Steel Institute, 29 Galton Rd., Warley.
- *Berl, Ernst, und Lunge, Georg. Chemisch-technische Untersuchungsmethoden Zweite Band, Erster Teil. Achte, vollständig umgcarbeitete und vermehrte Auflage. Herausgegeben von Ernst Berl. 8vo. Pp. xl + 878, with 215 illustrations in the text. 1931. Berlin : Julius Springer. (R.M. 69.)
- *British Electrical Development Association, Inc. Electric Heat for Industry. (E.D.A. 906.) 4to. Pp. 32, illustrated. London: The British Electrical Development Association, Inc., 15 Savoy Street, W.C.2. (Gratis.)
- Cazaud, R. Agenda Dunod. Métallurgie, 1932. 48c. édition. Pp. xx + 516. 1931. Paris : Dunod. (Br., 20 francs.)

Bibliography

- *Ellinger, George A. Thermomagnetic Investigation of Tempering of Quenched 0.75 per Cent. Carbon Steel. (U.S. Department of Commerce, Bureau of Standards, Research Paper No. 350. Reprint from Bureau of Standards Journal of Research, Vol. 7, September, 1931.) Med. 8vo. Pp. 441-451, with 6 illustrations. 1931. Washington, D.C.: Government Printing Office. (10 cents.)
- Fournel, P. et Quevron, L. Cours de chimie industrielle. Troisième partie : La chimie des métaux. Pp. 171, 1931. Paris : Delagrave. (28 francs.)
 Glasstone, Samuel. Recent Advances in Physical Chemistry. Ex. Cr. Svo.
- Glasstone, Samuel. Recent Advances in Physical Chemistry. Ex. Cr. Svo. Pp. vii + 470. 1931. London: J. and A. Churchill. (15s.)
- *Gmelin. Handbuch der anorganischen Chemie. System-Nummer 29: Strontium. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. Achte völlig neubearbeitete Auflage. Sup. Roy. 8vo. Pp. xviii + xii + 239, with 24 illustrations in the text. 1931. Berlin: Verlag Chemie G.m.b.H. (R.M. 41; subscription price, R.M. 36.)
- *Gmelin. Handbuch der anorganischen Chemie. System-Nummer 58: Kobalt. Teil A: Lieferung 1. Pp. v + 220, with 19 illustrations. Teil B: Die Ammine des Kobalts. Pp. xxv + 376. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. Achte völlig neubearbeitete Auflage. Sup. Roy. 8vo. 1931. Berlin: Verlag Chemie G.m.b.H. (Teil A, Lief. 1, R.M. 34; subscription price, R.M. 30; Teil B, R.M. 58; subscription price, R.M. 45.)
- *Hamill, T. E. Aqueous Solutions of Ethylene Glycol, Glycerin, and Sodium Silicate as Quenching Media for Steels. (U.S. Department of Commerce, Bureau of Standards, Research Paper No. 357. Reprint from Bureau of Standards Journal of Research, Vol. 7, September, 1931.) Med. 8vo. Pp. 555-571, with 14 illustrations. 1930. Washington, D.C.: Government Printing Office. (15 cents.)
- Hartmann, Friedrich. Das Verzinnen, Verzinken, Vernickeln, Verstählen, Verbleien und das Überziehen von Metallen mit anderen Metallen überhaupt. Eine Darst. prakt. Methoden zur Anfertigung aller Metallüberzüge aus Zinn, Zink, Blei. 9., neubearb. u. verm. Auflage von Wolfgang Friedrich Hartmann. (Chemisch-technische Bibliothek. Band 76.) 8vo. Pp. viii + 312. 1931. Wien und Leipzig: Hartleben. (Geh., M. 7; geb., M. 8.)
- Heim, Ludwig, und Skell, Fritz. Anleitung zur Mikrophotographie auch mit einfachen Einrichtungen, mit zweckmässigster Beleuchtung und mit ein neuen, wenig kostspielen Apparat für d. tägl. Gebr. auf d. Mikroskopiertsch. 8vo. Pp. viii + 92. 1931. Jena: Fischer. (M. 4.50; Lw., M. 5.50.)
- Höhn, Ernst. Über den Spannungszustand und die Festigkeit von Kehlnähten.
 Über die Wirkung von Blasen und Kerben von autogen und elektrisch geschweissten Nähten. 8vo. Pp. 33 + 15. 1931. Braunschweig: Vieweg und Sohn. (M. 2.)
- International Labour Office. Protection of Workers Operating Metal-Working Presses. (Studies and Reports, Series F, Second edition (Safety) No. 4.) Med. 8vo. Pp. viii + 123, with 121 illustrations. 1930. Geneva: International Labour Office; Boston, Mass.: World Peace Foundation, 40 Mount Vernon St. (\$1.25.); London: P. S. King and Son, Ltd., 14 Great Smith St., S.W.1 (5s.).
- *Kroenig, W. O. The Influence of Iron on the Properties of Duralumin. [In Russian, with German summary.] (U.S.S.R. Scientific Research Institutes of the Supreme Council of National Economy, No. 468; Transactions of the Central Aero-Hydrodynamical Institute, No. 96.) Roy. 8vo. Pp. 15, with 16 illustrations. 1931. Moscow and Leningrad: State Scientific-Technical Bookshop. (30 k.)

Laubenheimer, K. Lehrbuch der Mikrophotographie und Mikroprojektion. Zweite vollständig umgearbeitete und vermehrte Auflage. Roy. 8vo, Pp. 272. 1931. Berlin und Wien: Urban und Schwarzenberg. (R.M. 18.)

- *Mantell, C. L. Industrial Electrochemistry. (Chemical Engineering Series.) Med. 8vo. Pp. viii + 528, with 178 illustrations. 1931. New York : McGraw-Hill Book Co., Inc.; London : McGraw-Hill Publishing Co., Ltd. (30s. net.)
- Mass, O., and Steacie, É. W. R. An Introduction to the Principles of Physical Chemistry. 8vo. Pp. 269. 1931. London: Chapman and Hall, Ltd. (13s. 6d. net.)
- *Masson, Irvine. Problems in the National Teaching of Science. The Alexander Pedler Lecture, 1931. Delivered under the auspices of the Durham Philosophical Society. Demy 8vo. Pp. 40. 1931. London: British Science Guild, 6 John St., Adelphi, W.C.2. (1s.)
- Menschutkin, Boris Nikolaiewitsch. Text-Book of General (Inorganic) Chemistry. [In Russian.] Pp. 352. 1931. Moscow and Leningrad : State Scientific-Technical Bookshop. (Rbl. 3.65.)
- Moore, F. J. A History of Chemistry. New, second, edition, revised by William
 T. Hall. Pp. 324. 1931. New York: McGraw-Hill Book Co., Inc. (\$3.00); London: McGraw-Hill Publishing Co., Ltd.
- Mostowitsch, W. J. Metallurgy of Copper. [In Russian.] Second edition. Pp. 373. 1931. Tomsk: Isdatkom Wtusow. (Rbl. 6.)
- *Newfoundland and Crown Colonies and Protectorates. The Manufacturing Industries of the British Empire Overseas. Part V.—Newfoundland and Crown Colonies and Protectorates (Section I). Fcap. Pp. 64, with 9 folding diagrams. 1931. London: Erlangers, Ltd., 4 Moorgate, E.C.2. (2s. 6d.)

[Deals with: Newfoundland, West Indies, Ceylon, Malaya, Hong Kong, Sarawak, Brunei, and Borneo.]

- Pavlov, M. A. Metallurgical Furnaces. [In Russian.] Third edition. Pp. 103. 1931. Leningrad : Kubutsch-Verlag. (Rbl. 2.50.)
- Rickard, T. A. Technical Writing. Third edition. Ex. Cr. 8vo. Pp. xi + 337. 1931. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. (10s. 6d. net.)
- *Rolfe, R. T. Edited by. Foundrywork and Metallurgy. A Practical and Authoritative Guide for Moulders, Patternmakers, and Apprentices. To be completed in about 30 weekly parts. Cr. Svo. Part 9, Pp. 513– 576. Part 10, Pp. 577–640. Part 11, Pp. 641–704. Part 12, Pp. 705– 768 (end of Volume III). 1931. London, Bath, Melbourne, Toronto and New York: Sir Isaac Pitman and Sons, Ltd. (1s. per part.)

[Contents of Parts 9-12: Section VII—" Refractories" (continued), by Alfred B. Scarle (pp. 513-550); Section VIII.—" Dressing, Trimming, and Sand-Blasting," by J. McLachlan and Chas. A. Otto (pp. 551-660); Section IX.—" Pyrometry," by R. T. Rolfo (pp. 001-694); Section X.—" Foundry Plant," by James Cunningham (pp. 695-760); Section XI.—" Metal Melting," by R. T. Rolfe (pp. 761-).]

- *Rosenberg, Samuel L. The Resistance to Wear of Carbon Steels. (U.S. Department of Commerce, Bureau of Standards, Research Paper No. 348. Reprint from Bureau of Standards Journal of Research, Vol. 7, September, 1931.) Med. 8vo. Pp. 419-428, with 12 figures. 1931. Washington, D.C.: Government Printing Office. (10 cents.)
- *Royal Mint. Sixty-First Annual Report of the Deputy Master and Comptroller of the Royal Mint, 1930, with a General Index to the Annual Reports from 1910 to 1929 inclusive. Roy. 8vo. Pp. iv + 165 + lvii, illustrated. 1931. London: H.M. Stationery Office. (4s. 6d. net.)

Bibliography

- Schilow, N. A. Mass Analysis. [In Russian.] Fifth edition. Pp. 182. 1931. Moscow and Leningrad : State Scientific-Technical Bookshop. (Rbl. 1.60.)
- *Schmöle, R.u.G., Metallwerke A.G. Herausgegeben von. Taschenbuch für Metalltechnik. 4., neubearbeitete Auflage. Post 8vo. Pp. 163, illustrated. 1931. Menden, Kr. Iserlohn: R.u.G. Schmöle Metallwerke A.G.
- *Scientific and Learned Societies. The Official Year-Book of the Scientific and Learned Societies of Great Britain and Ireland : a Record of Work done in Science, Literature, and Art during the Session 1930–1931 by Numerous Societies and Government Institutions. Compiled from official sources. Forty-eighth annual issue. Med. Svo. Pp. vii + 171. 1931. London: Charles Griffin and Co., Ltd. (10s.)

[The latest edition of the Year-Book does not contain, as heretofore, the "List of Papers Read" before the various societies listed. It really ceases, therefore, to be a "record of work done" and is now a directory of the scientific and learned societies of which it gives such information as address, names of president and secretary, particulars regarding membership, meetings, and publications. By omitting the "List of Papers Read" it has been possible to reduce the price of the book.]

*Siebert, G., G.m.b.H. Festschrift zum Fünfzigjährigen bestehen der Platinschmelze G. Siebert G.m.b.H., Hanau. Herausgegeben von H. Houben. Med. 8vo. Pp. xxiv + 338, with numerous illustrations. 1931. Hanau: G. M. Alberti's Hofbuchhandlung.

[Contains the following papers (abstracts of all those of metallurgical interest will shortly appear in the Journal): K. Arndt: "Platin in der Elektrochemie": E. Birk und H. Kamm: "Über den thermischen Abbau der Luteorhodiumhalogenide"; K. Falck: "Platin und seine Legierungen in der Zahnheilkunde "; W. Gerlach und K. Ruthardt : "Spektralanalytische Untersuchungen an Platinmetallen und- Legierungen "; W. Goedecke : "Über Thermoelemente und die Reproduzierbarkeit ihrer Daten-Kriterien für ihre Brauchbarkeit zur Temperaturmessung"; W. Goedecke : "Studien über die Vergütung der Legierungen des Systems Gold-Platin durch geringe Zusätze dritter Komponenten"; G. Grube, F. Oettel, und H. Reinhardt : "Die elektrolytische Übertragung des Platins in salzsaurer Lösung ". H. Holzmann : "Experimentelle Studien über den Zusammenhang zwischen Walztextur, Tiefziehfähigkeit und Härte bei den Metallen Silber, Kupfer, Aluminium und seiner Silber-Kupfer-Leglerungen "; H. Holzmann : " Unter-suchungen über den Verlauf der Atomwärmen von Ruthenium, Rhodium und Palladium sowie der Ausdehnungskoeffizienten von Rhodium und Palladium bei höheren Temperaturen "; G. F. Huettig und F. Weissberger : "Über den Katalytischen Wirkungsgrad der Metalle der Platingruppe gegenüber dem Methanolzerfall "; A. Koenig: "Über das Verhalten der Wasserstoff-Palladium-Diffusions-Elektrode bei Stromlieferung"; E. J. Kohlmeyer und I. Westermann : "Über die Einwirkung von Oxyden auf Platin bei hohen W. Oswald und E. Brauer : " Platin als weltgeschichtlicher Faktor "; H. Schneiderhochn und H. Moritz : "Spektrographische Untersuchungen über die Verteilung der Platinmetalle in den Mineralien der südafrikanischen Platinlagerstätten "; W. Stenzel und J. Weerts : " Die Gitterkonstanten der Silber-Palladium- und Gold-Palladium-Legierungen "; W. Stenzel und J. Weerts: "Röntgenuntersuchungen im System Gold-Platin"; G. Tammann und H. J. Rocha: "Über die Legierungen des Palladiums mit Platin und mit Rhodium "; L. Wochler und K. F. A. Ewald : " Uber des Rhodlumdioxyd."]

- Smirnow, I. D. Analytical Chemistry. Qualitative Analysis. [In Russian.] Seventh edition. Pp. 102. 1931. Moscow and Leningrad: State Scientific-Technical Bookshop. (75 k.)
- Stolzenberg, Otto. Technology of Metals. Part I. 1931. Moscow and Leningrad: State Scientific-Technical Bookshop. [In Russian.]
- *Swanger, Wm. H., and Caldwell, Frank R. Special Refractories for Use at High Temperatures. (U.S. Department of Commerce, Bureau of Standards, Research Paper No. 327. Reprint from Bureau of Standards Journal of Research, Vol. 6, June, 1931.) Med. 8vo. Pp. 1131-1143, with 4 illustrations. 1931. Washington, D.C.: Government Printing Office. (10 cents.)

Book Reviews

- Tafel, Wilhelm. Laminage et tracé des Cannelures des Cylindres de Laminoirs. Traduit par Marcel Grison d'après la troisiéme édition allemande, augmentée, revue et corrigée par l'auteur. Roy. 8vo. Pp. xii + 352 + 14 plates. 1931. Paris : Dunod. (88 frances.)
- *Tichonov, E. S. Investigation of Mineral Paints and Varnishes Used for Metals in Aircraft Building. [In Russian, with English summary.] (U.S.S.R. Scientific Research Institutes of the Supreme Council of National Economy, No. 457; Transactions of the Central Aero-Hydrodynamical Institute, No. 88.) Roy. 8vo. Pp. 59, with 78 illustrations. 1931. Moscow and Leningrad: State Scientific Technical Bookshop. (Rbl. 1.50.)
- Twyman, F., Compiled by. The Practice of Spectrum Analysis with Hilger Instruments: including a Note on the various types of Emission Spectra. Fifth edition. Contributors: E. N. da C. Andrade, Samuel Judd Lewis, D. M. Smith, S. Barratt, A. A. Fitch, J. W. Ryde, C. Stansfield Hitchen. Roy. Svo. Pp. 53. 1931. London: Adam Hilger, Ltd. (3s. 6d. net.)
- Twyman, F., and Smith, D. M. Wave-Length Tables for Spectrum Analysis. Second edition. Pp. 192. 1931. London: Adam Hilger, Ltd. (14s. 9d. net.)
- *U.S. Department of Commerce. Bureau of Standards. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1931. (Miscellaneous Publication, No. 131.) Med. 8vo. Pp. 50. 1931. Washington, D.C.: Government Printing Office. (15 cents.)
- Urasow, G. G., and Tschernomorski, M. L. Metallurgy of Nickel. [In Russian.] Pp. 228. 1931. Moscow and Leningrad : State Scientific-Technical Bookshop. (Rbl. 3.50.)
- *Watts, A. S., and King, R. M. Relative Heat Transfer through Refractories. (Ohio State University Studies, Engineering Series, Bulletin No. 64.) Med. 8vo. Pp. iv + 32, with 2 figures in the text. 1931. Columbus, O.: Engineering Experiment Station, Ohio State University. (50 cents.)
- Watts, (the late) W. Marshall. Index of Spectra. Appendix A.A.: Krypton, Lanthanum, Lead, Lithium, Magnesium, and Compounds. Demy 8vo. Pp. 49. 1931. Westcliff-on-Sea: T. M. F. Tamblyn-Watts. (7s. 6d.)

XX.-BOOK REVIEWS

Secondary Aluminium (Metallurgy, Technology, Raw Materials, Production, Economics, and Utilization). By Robert J. Anderson. Med. 8vo. Pp. xv + 563, with 197 illustrations. 1931. Cleveland, O.: The Sherwood Press, Inc., Box 2617, Lakewood Branch. (\$10.00 post paid.)

Dr. Anderson's work on secondary aluminium is probably the most comprehensive and detailed publication which has yet appeared dealing with this important subject. The recovery, refining, and use of secondary aluminium have been, in most countries, looked upon somewhat askance by many metallurgists and manufacturers. As a result, this branch of the metal industries has not attracted sufficient attention from competent technicians, and the organization of the industry and the standardization of its products have thus not made that progress that is warranted by the important economic aspects involved.

The author, in his first chapter, cites striking statistics illustrating the magnitude of the secondary aluminium industry in the U.S.A. which may be assumed to exist in similar ratio to the primary metal industry in Great Britain. From the information given it is abundantly clear that the use of recovered secondary aluminium on a large scale is firmly established by

the operation of obvious economic laws, and Dr. Anderson renders a great service to engineering in general in pointing the way to the correct treatment of various forms of scrap, and the careful grading and alloying of the resultant ingot, all of which, if intelligently carried into practice, should help to remove the suspicion of secondary aluminium products, which still largely exists, and which has been caused by much unsatisfactory material being made and sold without adequate technical knowledge and control.

The author classifies the various forms of scrap usually met with in commerce, and also indicates the nature and extent of contamination usually occurring. Useful suggestions are made whereby contamination may be reduced, to the advantage of both producer and purchaser, by close co-operation between the two. Methods of sorting and grading scrap are fully described and discussed, and equipment useful in this connection is illustrated and described.

The commercial aspect of buying and selling aluminium scrap is considered at length, and standard forms of classification of scrap aluminium as issued by American and German trade associations are reprinted. Reference is made to abuses in the scrap-metal trade, which have undoubtedly done much to bring it into disrepute.

Sampling and assaying is an important phase of the secondary aluminium industry, and Dr. Anderson describes in detail the various sampling systems in vogue and also the apparatus and methods best adapted for assaying.

Chapters VII and VIII, dealing with the oxidation of aluminium scrap and the function and properties of various flux compositions for the prevention or reduction of oxide formation in the melting process, are probably the most interesting and important chapters in the book. A careful study of these chapters will well repay all aluminium founders, whether they use secondary metal or not, as the author, whilst clearly warning the reader against useless or harmful nostrums, gives, in considerable detail, data relating to those flux compounds possessing properties likely to assist in improving aluminium melts. In addition to discussing the physical and chemical effects of different flux compositions on various forms of scrap remelts, some very valuable and interesting data are given of the effect on percentage good metal recovery obtained with certain specified flux compositions used in varying ratios to the scrap metal charge. The preliminary treatment of different forms of scrap is considered in detail and suitable plant for carrying out the necessary operations efficiently is illustrated and described.

In Chapter X a great deal of information is given with regard to the types of furnaces which may be used for remelting scrap, together with sound comments as to the advantages and disadvantages of each type from the technical and commercial points of view. The actual methods—such as hand puddling, liquid flux process, &c.—used in manipulating the metal during the melting process are fully discussed, the most advantageous method to be employed for each of the many forms of scrap encountered being also suggested. Chapter XIII embraces the relatively new but important subject of refining the recovered aluminium, as distinct from any cleansing or partial refining effects obtained by the use of active fluxes. The various methods hitherto employed for the expulsion of dissolved gases, elimination of oxides and non-metallic impurities, and the reduction of grain-size, are dealt with in detail and at some length. This chapter may well be studied by the reader in conjunction with Chapters VII and VIII, as together they form a very valuable résumé of modern practice in methods of cleansing and refining remelted secondary aluminium. Unless such processes are successfully carried out, so as to produce resultant ingot of good casting and physical properties, it is obvious that secondary lngot can be used only for relatively unimportant products.

The important matter of costs is considered in Chapter XVII, and excellent suggestions are made as to the methods of ascertaining costs in each operation incidental to the recovery of secondary aluminium, together with the varied uses to which these ascertained costs may be put in determining the best fields in which to buy and sell, reduction of waste, efficiency of controlling staff, &c.

Quality and use of secondary metal receive detailed treatment in Chapter XVIII. The metallic compound formations likely to be met with, and their effects on casting properties, &c., are reviewed, and typical analyses given of secondary ingot recovered from various sources.

The final chapters deal with the technical control necessary for the production of uniform and satisfactory secondary metal and with the economic aspects of the industry.

It is to be thought that few secondary aluminium producers in this country regard or control the technical side of their business with that care which its importance demands. If Dr. Anderson's work inspires the industry as a whole to aim at higher standards than those bitherto apparent, he will have rendered a genuine service to all who use or produce aluminium goods involving the use of secondary metal.

Illustrations are profuse, if often somewhat redundant, whilst the indexing is a model of what should appear in any technical work, but frequently does not 1-E. PLAYER.