

# METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 4

September 1937

Part 9

## I.—PROPERTIES OF METALS

(Continued from p. 317.)

\*The Electrical Conductivity of Aluminium for Use as Free Conductors. Alfred Schulze (*Physikal. Z.*, 1937, 38, (12), 445-446).—Tests have been carried out on 71 test-pieces of aluminium wires to ascertain how far they conform with the proposed electrical and mechanical standards for aluminium to be used in place of copper conductors, *viz.*, a specific electrical resistance,  $\sigma$ , not exceeding 0.02828 ohm mm.<sup>2</sup>/mm. at 20° C., and a tensile strength,  $K$ , not less than 15 kg./mm.<sup>2</sup>. The results are expressed in the form of frequency-distribution curves. The mean values of  $\sigma$  and  $K$  were found to be  $\sigma = 0.02810$  ohm mm.<sup>2</sup>/m. and  $K = 19.0$  kg./mm.<sup>2</sup>. The temperature coeff. of  $\sigma$  at room temperature was 3.9-4.1 parts per thousand. The mean density of the wires was 2.705 gm./cm.<sup>3</sup>, with a max. variation from the mean of about 1.1 part per thousand.—J. S. G. T.

\*Influence of Temperature on Elastic Limit of Single Crystals of Aluminium, Silver, and Zinc. Richard F. Miller and W. E. Milligan (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 229-246; discussion, 246-251; and *Aluminium and Non-Ferrous Rev.*, 1937, 2, (4), 141-145).—See *Met. Abs.*, this vol., p. 73.—S. G.

\*Absorption Coefficients for Al, Cu, and Ag in the X-Ray Region from 13 to 24 Å. R. D. Hill (*Proc. Roy. Soc.*, 1937, [A], 161, (905), 284-297).—Apparatus is described for determining absorption coeffs. of metals in the long wavelength X-ray region. Values obtained for the mass absorption coeffs. for the wave-lengths stated were: 13.3 Å., aluminium 2180, silver 9920; 14.6 Å., aluminium 2290, copper 2470, silver 10,050; 17.6 Å., aluminium 3520, copper 3770; 23.7 Å., aluminium 7330, copper 6870.—W. H.-R.

Beryllium—Its Occurrence and Recovery. E. Reitler (*Metallwirtschaft*, 1937, 16, (18), 419-421).—A review of the history, occurrence, metallurgy, and uses of beryllium.—v. G.

The Production of Very Thin Beryllium Flakes for a Po-Be Neutron Source. T. R. Folsom (*Phys. Rev.*, 1937, [ii], 51, (5), 375).—Brief abstract of a paper read before the American Physical Society. A technique for producing extremely thin flakes of metallic beryllium by a vacuum-evaporation process was described.—S. G.

\*The Shenstone Effect in Bismuth. Alfred H. Weber and Charles B. Bazzoni (*Phys. Rev.*, 1937, [ii], 51, (5), 378).—Brief abstract of a paper read before the American Physical Society. Shenstone's original experiments (*J. Inst. Metals*, 1923, 30, 457), on the variation of the photoelectric sensitivity of bismuth as a function of electric currents passed directly through the metal, were repeated and extended. In this preliminary investigation: (1) the effect reported by Shenstone was verified; (2) the change of the effect with successive runs on the same bismuth specimen was studied (Shenstone used fresh samples for each of his curves); (3) the effect of occluded gases, presumably, on the photoelectric sensitivity was investigated; and (4) curves of the decay of the effect were obtained. Two cast bismuth plates and a bismuth single crystal were used as specimens. The obvious conclusion to be reached from the experiments is that the variations in the photoelectric sensi-

\* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

tivity of bismuth, when electric currents are passed directly through the metal, are due to changes in the quantity of gas occluded by the metal.—S. G.

\***The Magneto-Resistance Effect in Cadmium at Low Temperatures.** C. J. Milner (*Proc. Roy. Soc.*, 1937, [A], 160, (901), 207–229).—Apparatus is described for investigating the change of electrical resistance of metals in magnetic fields up to 26 kilogauss at low temperatures. The effects were examined in detail for polycrystalline specimens of cadmium of varying purity. Kapitza (*Proc. Roy. Soc.*, 1927, [A], 115, 658) showed that the increase in resistance produced by a magnetic field  $H$  at right angles to the current, was only proportional to  $H^2$  at low field strengths. In higher fields the increase in resistance tended to a linear variation with field strength, and the results could be expressed in the form  $\Delta R/R_0 = b(H - H_k)$ , for  $H \gg H_k$ , where  $R_0$  is the resistance at  $0^\circ \text{C}$ . At temperatures above  $20^\circ \text{K}$ ., this conclusion is confirmed. At  $20.4^\circ \text{K}$ ., the constant  $b$  was the same for specimens of different purity. The critical field  $H_k$  is approximately proportional to the specific resistance, in contrast to Kapitza's conclusion that  $H_k$  was proportional to the residual resistance. The present conclusions are confirmed by experiments at  $77^\circ \text{K}$ . At liquid helium temperatures a new effect was found. In addition to the linear effect at high fields a square law increase is observed, which produces a very large increase in resistance for pure specimens. The results may be expressed in the form  $\Delta R/R_0 = aH^2 + bH$ , where  $b$  is again constant for specimens of different purity, and  $a$  is inversely proportional to the residual resistance of the specimen. The coeff.  $a$  is constant at the very lowest temperatures, but decreases rapidly above  $4^\circ \text{K}$ . to negligible values;  $b$ , however, varies only slightly with temperature. The new effect is present, but previously not recognized, in other workers' data for non-cubic metals, but is probably absent or much smaller in cubic metals; in cadmium the new effect is absent when the magnetic field is parallel to the current.—W. H. R.

**The Embrittlement of Solid Copper Containing Oxygen in Hot Reducing Atmospheres.** T. S. Fuller (*Metal Progress*, 1937, 31, (6), 627, 658).—The embrittlement of tough-pitch copper has been produced artificially by heating in a steel tube containing clean sea sand; both the container and the sand were subsequently shown to be capable of producing the requisite reducing atmosphere.—P. R.

\*[Diffusion of] **Gold and Copper in Rock Salt Crystals and in Synthetic Sylvine.** M. J. Bogomolowa (*Acta Physicochimica U.R.S.S.*, 1936, 5, (2), 161–172).—[In German.] The diffusion of gold and copper ions in rock salt and sylvine at  $700^\circ \text{C}$ . is investigated, and experimental data are given relating to the ionic mobilities of these ions in the crystals, subjected to an electric field, at  $500^\circ$ – $720^\circ \text{C}$ .—J. S. G. T.

**Damage to Cable by Insect.** — Wiemer (*Teleg. Praxis*, 1936, 16, (20), 317).—An illustrated note describing the damage done to a cable by the larva of a willow weevil. The insect had eaten through jute wrapping, lead sheathing, and paper covering.—R. T.

\***Equilibrium Curve and Entropy Difference Between the Supraconductive and the Normal State in Lead, Mercury, Tin, Tantalum, and Niobium.** J. G. Daunt and K. Mendelsohn (*Proc. Roy. Soc.*, 1937, [A], 160, (900), 127–136).—The curves in the  $(H, T)$  diagram showing the equilibrium between the supraconductive and the normal state were determined for very pure lead, mercury, tin, tantalum, and niobium from measurements of the magnetic induction. The entropy differences between the two states were calculated, and the following conclusions are reached: (1) The electronic entropies of non-supraconductive lead and mercury are considerably higher than those given by Sommerfeld's formula (*Ann. Physik*, 1937, 28, 1) on the assumption that the number of free electrons per atom is equal to the valency.



(2) In tantalum and niobium, not only the valency electrons, but also the electrons in the partly unfilled lower shell take part in the supraconductive state. The difference between the specific heats in the two states is calculated, and shown graphically for tantalum and mercury.—W. H.-R.

**\*X-Ray Study of an Anomaly in the Specific Heat of Lithium.** G. Pankow (*Helv. Phys. Acta*, 1936, 9, (2), 87-122; *Sci. Abs.*, 1936, [A], 39, 522).—[In German.] Cf. *Met. Abs.*, 1935, 2, 201. The decrease in the specific heat of lithium, as well as of sodium, potassium, and silicon, from the Dulong-Petit value to almost zero is anomalous in that it is not deducible from the theoretical Debye function. These elements show a cubic crystal structure, and experiment shows that the temperature change of specific heat may be calculated from the Debye function of a monatomic cubic crystal. In the explanation of this phenomenon offered by Simon, it is assumed that only part of the heat supplied to the substance serves to increase the atomic vibrations, the remainder being used up in inter-atomic rearrangements. P. then attempts to verify this assumption by employing an X-ray method to measure the interference patterns as a function of the temperature; a direct estimation may be made from these results of the amplitude of the atomic vibrations. Filtered Cu radiation is used, and the intensity of the lines of the Debye-Scherrer pattern of lithium is measured for temperatures between that of the room and of liquid air. A characteristic temperature of  $352^{\circ} \pm 12^{\circ}$  C. is obtained; this value is lower than that given by Simon ( $510^{\circ}$  C.), but is in agreement with the value of  $363^{\circ}$  C. found by Grüneisen by electrical resistance measurements, and of  $350^{\circ}$  C. by Ruhemann at temperatures near  $25^{\circ}$  K. The characteristic temperature appears to decrease with decreasing temperature; Simon and Swain find a value of  $328^{\circ}$  C. at  $15^{\circ}$  K. If the Debye-Waller theory of the temperature-intensity relation for X-ray interference is assumed for the case of the cubic body-centred lattice, it is shown that nearly all the heat supplied to lithium is used up in increasing the atomic vibrations. Suggestions are made to account for the discrepancies between the experimental and theoretical work. A complete *bibliography* is appended.—S. G.

**\*The Electrode Potentials of Lithium, Rubidium, and Calcium in Liquid Ammonia.** W. Pleskow (*Acta Physicochimica U.R.S.S.*, 1937, 6, (1), 1-10).—[In German.] Values of the electrode potentials of lithium, rubidium, and calcium in liquid ammonia, relative to that of hydrogen in water taken as zero, were found as follows:  $E_{Li} = 2.99$  v.;  $E_{Rb} = 2.68$  v.;  $E_{Ca} = 2.39$  v.—J. S. G. T.

**\*Fine Structure of Soft X-Ray Absorption Edges.** I.—Li, Mg, Ni, Cu Metals. H. W. B. Skinner and J. E. Johnston (*Proc. Roy. Soc.*, 1937, [A], 161, (906), 420-440).—Methods are described for the determination of the X-ray absorption edge fine structure of metals in the wave-length region 100-300 Å. Results are given in detail for Li K, Mg  $L_3$ ,  $L_2$ , and  $L_1$ , Cu  $M_{23}$ , Ni  $M_{23}$ .—W. H.-R.

**\*Some Properties of Magnesium Sheet and Alloys.** Masaharu Goto, Mōsu Nito, and Hiroshi Asada (*Tōkyō Teikoku-Daigaku Kōku-Kenkyūzo Hōkoku (Rep. Aeronaut. Res. Inst., Tōkyō Imp. Univ.)*, 1937, 12, (148), 163-318).—[In Japanese, with 18 pp. German summary.] (1) *Sheet*.—1 mm. sheet was rolled from 28 mm. cast plates. Rolling was carried out at  $360^{\circ}$  C. and in one direction only. The ductility of the hot-rolled sheet was reduced by annealing at higher temperatures. The mechanical properties differed markedly with different directions of test, but the directional effect was almost completely removed by annealing at  $300^{\circ}$ - $400^{\circ}$  C. The electrical properties also showed directional variation. The resistivity was increased or decreased by annealing according to the temperature and time of anneal; annealing at  $350^{\circ}$  C. produced the greatest decrease. (2) *Cast Alloys*.—The effects of mould thickness, mould temperature, casting temperature, and

temperature of superheat were studied and the optimum conditions established for test-pieces  $3 \times 10 \times 10$  cm. The effects, on physical properties and corrosion-resistance, of additions of iron, silicon, manganese, zinc, and cadmium were examined. If a cadmium-rich alloy, in contact with a magnesium alloy, was heated in hydrogen, cadmium vapour from the former alloy was absorbed by the latter with the production of a surface having good resistance to corrosion. The constitutional diagram, coeff. of expansion, and mechanical properties of the magnesium-cadmium-zinc system were studied, the effects of additions of silicon, aluminium, and manganese being examined. The properties of many alloys are detailed. (3) *Corrosion-resistance*.—Cast and machined bars, rolled sheet, and drawn bar, in pure magnesium and various alloys, were tested in brine. The influence of composition and effects of heat-treatment were examined.—H. W. G. H.

\***Electrocapillary Phenomena and the Wetting of Metals. III.—Influence of Surface-Action Substances on Wetting [of Mercury]. Properties of Multi-Molecular Layers.** B. Kabanov and N. Ivanishenko (*Acta Physicochimica U.R.S.S.*, 1937, 6, (5), 701-718).—[In English.] It is found, *inter alia*, that surface-active substances, *e.g.* phenol, heptyl- and amyl-alcohols, always increase the wetting of a clean mercury surface, especially under conditions near the maximum point of the electrocapillary curve. The electrocapillary characteristics of mercury in contact with an electrolyte are discussed.—J. T.

\***On the Hysteresis of Magnetostriction of Iron, Nickel, Cobalt, and Single Crystals of Iron.** Yosio Masiyama (*Sci. Rep. Tôhoku Imp. Univ.*, 1937, [i], 26, (1), 1-39).—[In English.] The hysteresis of the magnetostriction caused by cyclic change of magnetic field in the cases of iron, nickel, cobalt, and single crystals of iron were determined by varying the field gradually or suddenly. An anomalous phenomenon, due to sudden change of field, was observed, *i.e.* by suddenly annihilating the field, the residual elongation is considerably greater than when the field is slowly reduced to zero. In the case of single crystals a small hysteresis is observed, and the anomaly due to sudden change of field is also found. This anomaly can be explained by the idea of inertia of angular motion of the elementary magnets or complexes; *i.e.* by sudden annihilation of the field the elementary complexes do not only turn over to their initial directions, but some of them further turn over to the next stable directions by inertia, and thus the anomalous residual elongation results. Starting from this anomalous state, if the field is applied, in the same or opposite direction, the elongation in the weak fields takes place in a direction such that the elongation is at first diminished and then increased. This has also been explained by use of the same idea.—S. G.

\***On Gerlach's Thermomagnetic Electromotive Force in Nickel, Iron, and Nickel-Iron Alloys.** Norie Yamanaka (*Sci. Rep. Tôhoku Imp. Univ.*, 1937, [i], 26, (1), 40-47).—[In English.] Gerlach's thermomagnetic e.m.f. was observed in nickel-iron alloys, and its dependence on applied magnetic field, temperature gradient, composition, and also thermal treatment of the test wires was fully studied.—S. G.

\***On the Effects of Stress on Gerlach's Electromotive Force in Nickel, Iron, and Nickel-Iron Alloys.** Norie Yamanaka (*Sci. Rep. Tôhoku Imp. Univ.*, 1937, [i], 26, (1), 48-54).—[In English.] The effect of tension and torsion on Gerlach's thermomagnetic e.m.f. was studied with nickel, iron, and nickel-iron alloys. The chief results obtained are: (1) In nickel, and nickel-iron alloy (87.5% nickel), the saturation value of the e.m.f. and the intensity of magnetic field at which the e.m.f. is saturated, increase with increase of tension; (2) In nickel-iron alloys containing < 87.5% nickel, the greater the tension applied the smaller is the e.m.f. generated; (3) In iron, the application of tension results on the one hand in diminution of the positive maximum value of the e.m.f., and on the other hand in displacement of the



field intensity at which the c.m.f. changes its sign toward the weaker field; (4) Torsion results in decrease of the c.m.f. in iron and nickel.—S. G.

\*On the Effect of Temperature on the Discontinuous Process of Magnetization in Nickel and Nickel-Iron Alloy (40% Ni). Mitiyasu Takagi (*Sci. Rep. Tôhoku Imp. Univ.*, 1937, [i], 26, (1), 55-64).—[In English.] T. observed the effect of temperature on the discontinuous magnetization in nickel and a nickel-iron alloy containing 40% nickel. The chief results obtained were: (1) The discontinuous process of magnetization diminishes on the whole almost linearly with increase in temperature; (2) The prominent discontinuous jumps in strained materials are displaced generally towards weaker fields, but sometimes towards stronger fields.—S. G.

\*Thermal Diffusivity of Nickel. Chauncey Starr (*Phys. Rev.*, 1937, [ii], 51, (5), 376).—Brief abstract of a paper read before the American Physical Society. The dynamic method devised by King for determining thermal diffusivities has been improved. A sinusoidal temperature is impressed on one end of a wire specimen, and the thermal diffusivity is determined from the characteristics of the temperature wave travelling along the specimen. In King's method the velocity of the wave is measured; in the present method the amplitude decrement is determined. The unknown surface heat loss from the specimen can be eliminated from the calculations by measurement with heat waves of two different periods. Greater precision is possible with this method than with previous methods. The thermal diffusivity of nickel, measured at 25° C., was 0.15885 cm.<sup>2</sup>/second, with a probable error of 0.06%. The specimen had been annealed in hydrogen at 870° C., and had a total nickel content > 99.98%, a density of 8.79 gm./cm.<sup>3</sup>, and an electrical resistivity of 7.21 microhm-cm. at 22° C. The thermal conductivity of nickel corresponding to this determination is 0.618 watt/cm.<sup>2</sup>/° C.—S. G.

\*On the Diffusion of Nickel Ions in Rock Salt. I. A. Parfianowitch and S. A. Schipizyn (*Acta Physicochimica U.R.S.S.*, 1937, 6, (2), 263-274).—[In German.] Nickel is shown to migrate in rock salt in the same manner as that characterizing electrolysis. The dependence of the mobility,  $u$ , of nickel ions in rock salt upon temperature is investigated at 640°-777° C. The variation is expressed by the relation  $u = Ae^{-B/T}$  when  $B = 12,680$ , and  $A = 2.72$ .—J. S. G. T.

\*Kinetics of the Activated Adsorption of Hydrogen by Polished Nickel. O. Lypunsky (*Acta Physicochimica U.R.S.S.*, 1936, 5, (6), 807-812).—[In German.] The activated adsorption of hydrogen by polished nickel is investigated at -145° and -118° C., and the results are discussed in terms of Langmuir's theory. The heat of activation is found to be 2050 cal.—J. T.

\*The Equilibrium of the Reaction of Oxidation of Nickel with Carbon Dioxide. A. Kapustinsky and Anna Silberman (*Acta Physicochimica U.R.S.S.*, 1936, 5, (5), 605-616).—[In English.] The equilibrium constants of the reaction  $Ni + CO_2 \rightleftharpoons NiO + CO$  are determined at 612°-943° C.—J. S. G. T.

On the Rôle of Oxygen in the Process of Hydrogenation of Ethylene on Palladium. D. Dobytehin and A. Gelbart (*Acta Physicochimica U.R.S.S.*, 1937, 6, (1), 95-104).—[In English.] The addition of 0.01-1.0% of oxygen to a hydrogen-ethylene mixture does not affect the rate of hydrogenation of ethylene on palladium at a pressure of several cms. of mercury and at room temperature. Carbon monoxide activates palladium catalysts used for hydrogenation of ethylene. This is attributed to a crumbling of the surface of the palladium due to processes of oxidation and reduction.—J. S. G. T.

Titanium; Its Minerals and Production. Maurice Dérivé (*Mécanique*, 1937, 21, (273), 189-192).—A review, with bibliography, of the history, occurrence, principal minerals, extraction, physical properties, and uses of titanium.—P. R.

\*The Exact Measurement of the Specific Heats of Solid Substances at High Temperatures. XI.—Specific Heats, Electrical Resistance and Thermo-Electrical Behaviour of Titanium in Their Dependence on the Temperature. F. M. Jaeger, E. Rosenbohm, and R. Fonteyne (*Rec. trav. chim.*, 1936, 55, (7/8), 615-654).—[In English.] Calorimetric, electrical, thermo-electrical, and X-ray spectrographic characteristics of titanium are measured from atmospheric temperatures to 1300° C. The metal is found to occur in two modifications, viz. an  $\alpha$ -modification of hexagonal symmetry, stable below about 905° C., and a body-centred cubic  $\beta$ -form, stable above 880°-905° C. The transition from one to the other is slow, but not so slow as that of  $\alpha \rightarrow \beta$  zirconium. A series of minor "transition points" occur at 200°-250°, 297°, 400°, 508°, and 630° C.; hysteresis effects, partially attributable to traces of oxygen, or perhaps nitrogen, occur at these temperatures on cooling the metal.—J. T.

\*A Study on the Hardness of Pressed Lumps of Metal Powders. Rimpei Kikuchi (*Kinzoku no Kenkyu (J. Study Metals)*, 1937, 14, (2), 64-74 (in Japanese); and *Sci. Rep. Tōhoku Imp. Univ.*, 1937, [i], 26, (1), 125-141 (in English)).—Experiments were carried out on the hardness of pressed lumps of some powdered metals and alloys, such as copper, zinc, silver, Duralumin, copper-zinc, and copper-silver alloys, especially in reference to the effect of size of powder, pressure, and annealing temperature. In general, the hardness of pressed lumps of metal powder: (1) increases at first rapidly, and then slowly, with increase of applied pressure, tending to a certain definite value characteristic of the metal; (2) decreases, in general, with increase of annealing temperature, but in some cases it increases on annealing above a certain temperature; (3) increases with the fineness of the powder. The hardness of a pressed lump of two different materials shows the mean value of each component material, provided that the lump is not annealed; when the lump is annealed the hardness changes abnormally because of diffusion or oxidation of particles.—S. G.

\*Physical Properties of Surfaces. IV.—Polishing, Surface Flow, and the Formation of the Beilby Layer. F. P. Bowden and T. P. Hughes (*Proc. Roy. Soc.*, 1937, [A], 160, (903), 575-587).—The effect of rubbing or polishing metals and alloys with different materials was studied. In general, the relative hardness of the polisher and the solid is unimportant, and the relative melting point is the most important factor. Surface flow and polishing occur readily when the polisher has a higher melting point than the solid, but not when the polisher has a lower melting point. Thus tin (melting point 232°) shows no surface flow when rubbed on camphor (melting point 178°), but shows surface flow with oxamide (melting point 417°). There are, however, exceptions to this rule, e.g. molybdenum (melting point 2470°) is polished by cuprous oxide (melting point 1235° C.)—and these are ascribed to the weakness of the metal crystals at the high temperatures which exist between the surfaces on rubbing. The heat liberated by friction is quite sufficient to melt a surface layer, and evidence for high surface temperatures is discussed. Experiments on glasses and minerals are also described.—W. H.-R.

\*Notes on the Wetting of Filaments by Molten Metals. M. Alden Countryman (*J. Applied Physics*, 1937, 8, (6), 432-433).—Interesting information is given on the wetting of hot filaments of nickel, platinum, molybdenum, tantalum, and tungsten, by molten metals, e.g. aluminium, silver, gold, copper, nickel, chromium, and platinum. In general, if the molten metal adhered to the filament it would evaporate successfully unless its vapour pressure was too low at the highest safe temperature for the filament, or unless it united with the filament to form a low melting point alloy.—I. J.

\*Diffusion Phenomena and Temperature Fields in Solidifying Melts. Josef Müller-Strobel (*Z. Krist.*, 1937, 96, (6), 466-480).—Theoretical. The process of solidification of molten alloys is investigated theoretically, with special



reference to diffusion phenomena, concentration differences, and the temperature fields of the solidifying melt. Equations representing the process are developed, and are discussed in relation to the equilibrium diagram. If the times of freezing are known, the theory enables the temperature field to be reconstructed approximately.—W. H.-R.

**Recent Advances in Science. Physical Chemistry. Diffusion of Gases Through Metals.** H. W. Melville (*Sci. Progress*, 1937, 32, (125), 99-103).

—S. G.

**\*A Theoretical Formula for the Solubility of Hydrogen in Metals.** R. H. Fowler and C. J. Smithells (*Proc. Roy. Soc.*, 1937, [A], 180, (900), 37-47).—The equilibrium between gaseous hydrogen and a metal containing dissolved hydrogen is investigated theoretically by the methods of statistical mechanics. Outside the metal, the hydrogen consists chiefly of molecules with a very few free atoms; inside the metal the hydrogen is assumed to exist either as atoms, or as protons plus free electrons, which are added to the metallic electrons, and distributed with these in the bands of metallic electron levels according to the Fermi-Dirac statistics. The theory leads to an equation of

the type  $\log s \leq A - \frac{B}{kT}$ , where  $s$  is the solubility of hydrogen at a given

pressure, and this is in agreement with the facts for the absorption of hydrogen by iron, cobalt, nickel, and copper. A preliminary theory is developed for the case where the metal forms a definite hydride, as with titanium, vanadium, zirconium, and thorium.—W. H.-R.

**\*The Recombination of Atomic Hydrogen in an Adsorbed Layer.** O. I. Leypunsky (*Acta Physicochimica U.R.S.S.*, 1936, 5, (2), 271-298).—[In German.] The adsorption and recombination of atomic hydrogen at a surface of nickel, iron, copper, or aluminium at  $-180^{\circ}$  to  $0^{\circ}$  C. are investigated. The mechanism of the recombination is discussed.—J. S. G. T.

**\*The Exact Measurement of Specific Heats at High Temperatures. VIII.—On the Additive Rule of the Specific Heats of Metals in Binary Combinations.** F. M. Jaeger and T. J. Poppema (*Rec. trav. chim.*, 1936, 55, (6), 492-517).—[In French.] Values of the mean and true specific heats and of the atomic or molecular heats of some metals and alloys are given, viz. zinc,  $100^{\circ}$ - $360^{\circ}$  C.; magnesium,  $100^{\circ}$ - $550^{\circ}$  C.;  $MgZn_3$ ,  $100^{\circ}$ - $500^{\circ}$  C.; platinum (empirical formulæ for atomic heats only),  $0^{\circ}$ - $1600^{\circ}$  C.; palladium,  $0^{\circ}$ - $1500^{\circ}$  C.; antimony,  $100^{\circ}$ - $600^{\circ}$  C.;  $PtSb_2$ ,  $196^{\circ}$ - $620^{\circ}$  C.;  $PdSb$ ,  $190^{\circ}$ - $600^{\circ}$  C.;  $PdSb_2$ ,  $200^{\circ}$ - $600^{\circ}$  C.;  $\alpha$  and  $\beta$   $Pd_3Sb$ ,  $200^{\circ}$ - $1000^{\circ}$  C.; copper (empirical formula for atomic heats only),  $300^{\circ}$ - $900^{\circ}$  C.;  $PdCu$ ,  $200^{\circ}$ - $900^{\circ}$  C.;  $PdCu_3$ ,  $200^{\circ}$ - $900^{\circ}$  C. The additive rule of atomic heats proposed by Neumann, Kopp, Joule, and Regnault, is found, in general, not to hold for the alloys; deviations from the rule increase rapidly with increasing temperature. The calorimetric method employed was sufficiently exact to reveal thermal transitions.—J. T.

**\*The Formation of Unimolecular Films on Thin Foils of Metals and Cellulose.** H. Mark and H. Motz (*Chem. Eng. Congr. World Power Conf.*, 1936, *Advance proof* M1, 13 pp.; *C. Abs.*, 1937, 31, 3759).—The migration of single molecules to the surfaces of metal and cellulose was studied by means of the diffraction pattern of cathode rays. Increase in diffusion with temperature indicates an energy of activation of 5 to 10 kg.-cal./mol. The diffusion velocity decreases from saturated compounds to esters, ethers, and ketones, to acids, alcohols, and amines. The velocity of crystallization increases with chain length. Mixtures containing different chain lengths have good crystallizing power. Diffusion on metal surfaces is slower and less regular, owing to active spots.—S. G.

**\*Contact Potentials for Metals Immersed in a Dielectric and Conduction of Electricity by Liquid Dielectrics.** Harold J. Plumley (*Phys. Rev.*, 1937, [ii], 52, (2), 140).—A note. The contact potential difference between gold and

brass immersed in several highly purified mineral oils was determined and was always nearly equal to the value measured in a vacuum. The theory of Baker and Boltz (*Phys. Rev.*, 1937, [ii], 51, 275, 989) is criticized.—W. H.-R.

**\*The Change of Saturation Magnetization Produced by Pressure Applied in all Directions.** H. Ebert and A. Kussmann (*Physikal. Z.*, 1937, 38, (12), 437-445).—The effect of hydrostatic pressure on the saturation magnetization of iron and nickel, and of alloys of iron with nickel, cobalt, chromium, and platinum, of alloys of nickel with aluminium, chromium, cobalt, copper, and manganese, of platinum alloyed with manganese, and of ternary alloys composed of iron alloyed with cobalt and chromium is investigated experimentally. In the case of the metals and most of the alloys, including those with a comparatively low Curie point, the measured effect of pressure is small, being of the order 0.1-0.01% per 1000 kg./cm.<sup>2</sup>. In the case of the nickel-iron alloy containing 30% of nickel, the platinum-iron alloy containing 60% of platinum, and the ternary iron-cobalt-chromium alloys, the saturation intensity was found to decrease considerably with increase of pressure, the pressure-coeff. at room temperature being of the order 6.5 per 1000 kg./cm.<sup>2</sup>. Various explanations of the phenomenon are discussed.—J. S. G. T.

**\*Magnetic Energy and the Thermodynamics of Magnetization.** Edmund C. Stoner (*Phil. Mag.*, 1937, [vii], 23, (157), 833-857).—Theoretical.—W. H.-R.

**\*The Theory of Ferromagnetism: Lowest Energy Levels.** J. C. Slater (*Phys. Rev.*, 1937, [ii], 52, (3), 198-214).—The theory of ferromagnetism is formulated by the method of energy bands and the method of spin waves, and the connection between them is indicated. Neither represents the true situation, which must be found by perturbation theory. The final result is that below the continuum of levels indicated by the energy band theory, there is a set of discrete levels. The lowest of these is a spin wave, and is the state ordinarily occupied. For investigating the temperature variation of magnetization, the spin wave theory should be used. On the other hand, the energy band theory leads to approximately correct conclusions as to which elements should be ferromagnetic.—W. H.-R.

**\*Magnetic Interaction and Resultant Anisotropy in Unstrained Ferromagnetic Crystals.** L. W. McKeehan (*Phys. Rev.*, 1937, [ii], 52, (1), 18-30).—Theoretical. The mutual potential energy of two equal and parallel magnets is derived for several specially symmetrical distributions of magnetic moment in each. If  $R$  is the distance between two magnet centres, the first three terms in order of importance depend on  $R^{-3}$ ,  $R^{-5}$ , and  $R^{-7}$ ; these are called dipole, quadrupole, and sextupole terms respectively. The magnets previously considered as representing the atoms in a ferromagnetic crystal are special cases of those considered here, sextupole terms being considered for the first time. Magnetic anisotropy involves differences in potential energy for differences in direction of magnetization in a crystal, and requires sums of zonal harmonics over the points occupied by the atoms; sums of second- and fourth-order harmonics were previously known, and those for sixth-order harmonics are given. Calculated values for magnetic anisotropy are given for iron, nickel, and cobalt, and for iron-cobalt, iron-nickel, nickel-cobalt, and nickel-iron-cobalt alloys. The FeCo, Ni<sub>3</sub>Fe, and Ni<sub>3</sub>Co superlattice structures are also considered. The agreement with the experimental values is discussed.—W. H.-R.

**\*The Nature of the Superconducting State.—II.** J. C. Slater (*Phys. Rev.*, 1937, [ii], 52, (3), 214-222).—The suggestion of electrons in special stationary states of the system as a whole, lying a little below the lowest state of the Bloch theory of energy bands (cf. Slater, *Met. Abs.*, this vol., p. 134) is developed in further detail. The wave functions correspond to electrons which can wander for some distance through the metal, but are held to a finite region by forces of interaction with positive ions. Such wave functions will carry



no current in the ordinary way, since they correspond to a correlation of an electron and a positive ion, and the opposite charges move together. Since they are similar to large atoms, they have a large diamagnetism, and so may lead to London's theory (*Une Conception Nouvelle de la Supraconductibilité. Actualités Scientifiques et Industrielles*. Paris. 1937) of supraconductivity. The two conventional types of theory for bound electrons and free electrons respectively are treated so differently that one cannot always interpolate between them. To produce supraconductivity the orbits required are of the order 137 atomic diameters, which is not unreasonable on S.'s model, and leads to a magnetic field of the right order to destroy supraconductivity.

—W. H.-R.

**Critique of the Quantum Theory of Metallic Conduction.** Ernst Weber (*Phys. Rev.*, 1937, [ii], 51, (5), 378).—Brief abstract of a paper read before the American Physical Society. Although quantum theory has shown many successes in its applications to metal physics, there are some fundamental inconsistencies, e.g. the concept of the "free path" of the quantized and spinning electron, its treatment by periodic functions without boundary conditions applicable to the metal, nevertheless the assumed potential barrier at the surface; the "gas" character of the electrons and the tremendous internal pressure, yet no admitted compressibility; and the fact that there is no room for supraconductivity. The inference is reached that other than ideal "gas concepts" should be applied to the electron swarm, and a theory of electric conduction is proposed which, while essentially a continuum theory, leaves room for quantum theoretical treatment of the new parameters for microscopic phenomena. Conductivity variations with thickness of films, resistance variations in the magnetic field, and the galvanomagnetic phenomena can be described in simple terms.—S. G.

**Note on the Quantum Absorption Probability in the Case of the Photoelectric Effect.** A. T. Waterman (*Phys. Rev.*, 1937, [ii], 51, (5), 378).—Brief abstract of a paper read before the American Physical Society.—S. G.

†**The Theory of Photoelectric Absorption for X-Rays and  $\gamma$ -Rays.** Harvey Hall (*Rev. Modern Physics*, 1936, 8, (4), 358-397).—A theoretical review which contains some tables and graphs showing the absorption coeffs. of metals for X-rays and  $\gamma$ -rays.—W. H.-R.

**On the Values of Fundamental Atomic Constants.** Sten von Friesen (*Proc. Roy. Soc.*, 1937, [A], 160, (902), 424-440).—The most probable values of the fundamental atomic constants are discussed in detail, and the following values given: velocity of light  $(2.9978 \pm 0.0002) \times 10^{10}$  cm./sec.; specific charge of the electron e./m. =  $(1.7585 \pm 0.002) \times 10^7$  e.m.u./g.; electronic charge  $(4.800 \pm 0.005) \times 10^{-10}$  e.s.u.; Planck's constant  $(6.610 \pm 0.015) \times 10^{-27}$  erg sec.; Avogadro's number  $(6.028 \pm 0.008 \times 10^{23})$ ; mass of hydrogen atom  $(1.673 \pm 0.003) \times 10^{-24}$  g. The  $\pm$  terms are estimates of reasonable limits of error (not probable errors).—W. H.-R.

**On the Values of Fundamental Atomic Constants.** Raymond T. Birge (*Phys. Rev.*, 1937, [ii], 52, (3), 241).—A note. The paper of von Friesen (preceding abstract) is discussed, and inconsistencies in the values for  $h/e$  obtained by different methods are emphasized. B. considers that the true values of  $h$  and  $\alpha$  are very uncertain.—W. H.-R.

**The Maximum Valency of the Elements and Atomic Structure. VIII.—Maximum Valencies of the Elements in Compounds, and the Melting Points of Simple Bodies.** B. Ormont (*Acta Physicochimica U.R.S.S.*, 1936, 5, (3), 405-416).—[In German.] In continuation of previous work (*Acta Physicochimica U.R.S.S.*, 1936, 4, 409, 427), O. criticizes the work of Friederich and Sittig concerning the relation between valency and the melting point of simple bodies. It is shown that the melting point of such bodies, possessing a

metallic and atomic lattice, is related to the mean maximum valency of the elements concerned.—J. S. G. T.

**Metallic Combination in Accordance with the Combined Method of Approximation.** H. Hellmann and W. Kassatotschkin (*Acta Physicochimica U.R.S.S.*, 1936, 5, (1), 23-44).—[In German.] The method of wave-mechanics, taking into account interactions between valency electrons and atomic residues, is applied to determine values of the atomic constants of potassium, rubidium, caesium, magnesium, and calcium. Agreement between theoretical and empirical data relating to magnesium establishes the correctness of the assumptions made. The theory is applied, with satisfactory results, to calculate values of the lattice constants, heats of sublimation, and compressibilities of the elements referred to. Making certain assumptions, the theory gives values of the energies of electron emission of the alkali metals which are of the correct order of magnitude.—J. S. G. T.

## II.—PROPERTIES OF ALLOYS

(Continued from pp. 325-336.)

**Determination of the Resistance of Various Aluminium Alloys to Sustained Heating.** R. Irnann and W. Müller (*Schweiz. Archiv angew. Wiss. Tech.*, 1936, 2, (10), 231-239).—The influence of the duration of heating on the physical properties of various aluminium alloys is reviewed. The principal methods for the determination of these effects in the case of steel are described and are used as a basis for the application to aluminium alloys.—W. A. C. N.

**\*Thermal and Electrical Conductivities of Aluminium Alloys.** L. W. Kempf, C. S. Smith, and C. S. Taylor (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 287-298; discussion, 298-299).—See *Met. Abs.*, this vol., p. 84.—S. G.

**\*On the Composition of the Quaternary Phase in the System Al-Cu-Mg-Si.** D. A. Petrov (*Acta Physicochimica U.R.S.S.*, 1937, 6, (4), 505-512).—[In English.] Using results obtained by Dix and his collaborators (*Met. Abs. (J. Inst. Metals)*, 1932, 50, 222; 1933, 53, 120), the limits of atomic ratios in the quaternary phase Al-Cu-Mg-Si are established, as follows:  $1 < \text{Mg} : \text{Si} < 1.33$  and  $0.74 < \text{Cu} : \text{Si} < 1.10$ . The atomic ratio Cu : Mg : Si in the phase Al-Cu-Mg-Si is approximately 4 : 5 : 4. The quaternary phase has to exist, together with  $\text{Mg}_2\text{Si}$ , in ordinary Duralumin containing more than 0.5% of silicon. In alloys of the American Superduralumin (C 17 S and 14 S) the quaternary phase must exist alone, without  $\text{Mg}_2\text{Si}$ . Structurally free silicon, however, is present in these alloys.—J. S. G. T.

**\*The Influence of Copper, Iron, Silicon, Manganese, Magnesium, and Titanium on the Recrystallization of Duralumin-Type Alloys.** K. I. Bokuniaeva and E. M. Helfand (*Zvetnye Metally (Non-Ferrous Metals)*, 1935, (8), 111-117; *C. Abs.*, 1937, 31, 3855).—[In Russian.] The alloys studied contained copper 3.5 to 5, magnesium 0.5 to 1.4, manganese 0.5 to 1.5, titanium 0 to 1.7, iron 0.03 to 2.0, and silicon 0.03 to 2.0%, singly or in combination. Samples of alloys were deformed by compression or rolling, then heated to 550° C. and cooled in air. The specimens were then again deformed on the Brinell press and again heat-treated as before. It is concluded that: (1) addition of copper up to 4.5% decreases the grain-size in the primary and secondary recrystallization zones; further addition has no effect on grain-size; (2) titanium decreases grain-size in the primary recrystallization zone; in the secondary, the addition of titanium up to 0.3% increases, and above 0.5 to 1.7% decreases, the grain-size; (3) addition of 0.5 to 1.4% magnesium has no effect on grain-size; (4) manganese in amounts from 0.5 to 1.0% increases the grain-size, but above 1.5% decreases it in the primary recrystallization zone; in the secondary recrystallization zone manganese decreases grain-



size; (5) increase of iron content from 0.5 to 2.0% refines the grain, both in the primary and in the secondary zones; (6) silicon increases grain-size in the primary, and decreases it in the secondary, recrystallization zone—S. G.

**\*Experience with Gas Flasks of Light Alloys.** N. Christmann (*Wärme*, 1936, 59, 549-554; *Eng. Abs.*, 1936, (71), 32).—Improvements in the mechanical qualities of Lantal, Bondur, and Duralumin have enabled them to be used for solid-drawn gas-flasks made on the Erhard principle, and, while the margin of safety given by steel flasks hitherto used has been retained, the weight has been halved. The flasks must be solid-drawn because, although they can be welded, a serious reduction of the mechanical properties of these alloys is caused thereby. Lantal is heated for several hours in a salt-bath at 500° C. and quenched in water; it is then tempered for 36 hrs. at 140° C. The alloy must not be reheated, as annealing even to 350° C. would cause segregation of the solid solution of aluminium and silicon, which might set up local galvanic action and increased corrosion. With Bondur and Duralumin the state of molecular equilibrium is attained by ageing for a certain period without heat-treatment. For a corrosion test over a period of time, the flasks were subjected for 1 year to filling at fortnightly intervals, alternately with oxygen and with cold water under pressure. The original test pressure was 225 kg./cm.<sup>2</sup>, and this was repeated at intervals of 4 months. When the Lantal flasks, which were filled with oxygen for some time, were cut open, they exhibited an efflorescent decomposition of the inner surface, consisting mostly of hydrate of alumina and, to a smaller degree, of iron oxide and sodium aluminium silicate. The exterior had been subjected to damp sea-air and sea-water, and was also corroded. All flasks are now required to be varnished inside and outside. Experiments were carried out with Bondur and Duralumin protected on the inside by a varnish containing no oil, applied at 80° C., dried by a current of air; the outside was covered with aluminium bronze. The flasks were subjected to an internal pressure of 150 atm., while charged with oxygen or carbonic acid, by repeated fillings. When the flasks were cut open at the end of the year, it was found that in one or two cases the internal varnish had flaked off and signs of corrosion were evident; most of the flasks, however, were unaffected and withstood the required tensile and other mechanical tests.—S. G.

**\*Surface Improvement of Light Metals by Diffusion.** W. Bungardt (*Luftfahrtforschung*, 1937, 14, 204-208; *Eng. Abs.*, 1937, (75), 31).—In connection with a general investigation of the improvement of light metal surfaces by diffusion, B. has studied the aluminium-magnesium system and the phase and property changes resulting therefrom. Commercially-pure aluminium and magnesium were used and, after maintaining the alloys in contact at temperatures up to 435° C. for up to 450 hrs., the diffusion was examined by microscopic and X-ray methods. Owing to the affinity of both metals for oxygen at these temperatures, and the unsatisfactory nature of the methods previously used for dealing with this, B. placed a slightly conical plug of magnesium in a fitting cavity in an aluminium cylinder and closed the top with an aluminium plug. The whole was then gently pressed and annealed, producing a close contact of the metals out of contact with air. The results indicate that: (1) a useful surface hardening by diffusion of magnesium is possible only up to the saturation concentration of the  $\alpha$ -solid solution in the basic alloy; the higher magnesium intermediate phases are hard and very brittle; (2) the extent of this surface hardening is considerable only with pure aluminium; merely a trifling increase in the hardness of alloys is possible by surface enrichment of the ternary  $\alpha$ -solid solution in magnesium up to saturation and subsequent ageing; (3) the diffusion process requires a long period, which is detrimental to the properties of the alloy and is uneconomical.

—S. G.

\*Diffusion of Copper and Magnesium into Aluminium. R. M. Brick and Arthur Phillips (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 331-347; discussion, 347-350).—See *Met. Abs.*, this vol., p. 181.—S. G.

\*Age-Hardening of Aluminium Alloys. II.—Aluminium-Magnesium Alloy. William L. Fink and Dana W. Smith (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 162-167; discussion, 168-171).—See *Met. Abs.*, this vol., p. 34.  
—S. G.

\*Equilibrium Relations in Aluminium-Magnesium-Zinc [and Magnesium-Aluminium] Alloys of High Purity. William L. Fink and L. A. Willey (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 78-109; discussion, 109-110).—See *Met. Abs.*, this vol., p. 35.—S. G.

[Discussion on] Age-Hardening and Improved Light Alloys. — (*Met. Ind. (Lond.)*, 1937, 50, (18), 506-509).—Report of a discussion at the London (1937) conference of the International Association for Testing Materials.—S. G.

Manufacture and Characteristics of Hyduminium R.R. Alloys. J. Towns Robinson (*Metallurgia*, 1937, 16, (94), 131-134).—The characteristics and manufacture of eleven Hyduminium R.R. alloys are considered, with special reference to their chemical composition, heat-treatment, and physical properties. The proof stress, maximum stress, elongation, and Brinell hardness are given for sand- and chill-cast alloys, and also for forgings, extrusions, and sheets. A brief review is made of melting conditions, preparation of hardener alloys, cleansing and degasifying methods, and casting and pouring conditions. Reference is also made to the uses of the various alloys.—J. W. D.

\*The Coexistence of Dia- and Paramagnetism in Single Crystals of Antimony-Tin Alloys. Harold M. Hart (*Phys. Rev.*, 1937, [ii], 52, (2), 130-131).—Single crystals were prepared of antimony, and of antimony-tin alloys containing up to 4% of tin, and the magnetic properties were studied. If  $\chi_{\parallel}$  and  $\chi_{\perp}$  are the magnetic mass susceptibilities parallel and perpendicular to the principal axis, the magnetic anisotropy is represented by the ratio  $\chi_{\parallel}/\chi_{\perp}$ , which is + 2.52 for pure antimony, but becomes negative for alloys containing more than about 1.2% of tin. Most of the change in  $\chi_{\parallel}/\chi_{\perp}$  is due to change in  $\chi_{\parallel}$ ,  $\chi_{\perp}$  remaining comparatively constant. With increasing tin content, the crystals therefore become paramagnetic parallel to the trigonal axis, and diamagnetic at right angles to it.—W. H.-R.

\*Investigations of the System Iron-Chromium-Silicon. V. N. Svechnikov and N. S. Alferova (*Teoriya i Praktika Metallurgii*, 1937, (3), 60-69; *C. Abs.*, 1937, 31, 4942).—[In Russian.] The alloys were prepared from (a) electrolytic iron (silicon 0.002% and traces of manganese); (b) electrolytic chromium (carbon 0.02, silicon 0.005, iron 0.48, chromium 98.38%); (c) ferro-silicon (carbon 0.15, silicon 78.70, iron 20.00%). The samples contained up to 15% chromium and up to 4.5% silicon, 0.01-0.08% carbon, and 0.0045-0.0054% nitrogen. The amounts of chromium were 0.5, 1.0, 2.0, 3.1, 4.0, 7.5, 10.2, and 14.7%, and those of silicon were 0 to 4.5%. On the basis of thermal, dilatometric and micro-analyses of 56 samples, vertical sections of the iron-chromium-silicon diagram were constructed.—S. G.

\*On the Mechanism of the Precipitation-Hardening of Some Cobalt-Tungsten-Iron Alloys. H. Cornelius, E. Osswald, and F. Bollenrath (*Metallwirtschaft*, 1937, 16, (17), 393-399).—Alloys containing cobalt 40-70, tungsten 40-20, and iron 20-10% are homogeneous (cubic face-centred) when quenched from above 1000° C., but on heating the cobalt-rich alloys at 600°-700° C. precipitation of new phases occurs simultaneously with the transformation of the cobalt-rich matrix into the hexagonal form ( $\beta \rightarrow \alpha$  change). Above 750° C. precipitation only occurs without transformation, and this is also true at all temperatures for alloys with only 40% cobalt. The creep limit of the alloys at 700° C. is small compared with that of austenitic steel.—v. G.



\***Fatigue Properties of Five Cold-Rolled Copper Alloys.** William B. Price and Ralph W. Bailey (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 271–282; discussion, 282–286).—See *Met. Abs.*, this vol., p. 182.—S. G.

\***The Solid Solubilities of the Elements of the Periodic Sub-Group Vb in Copper [and the Lattice Spacings of the Primary Solid Solutions].** J. C. Mertz and C. H. Mathewson (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 59–77).—See *Met. Abs.*, 1936, 3, 508.—S. G.

\***Studies on Beryllium.—II.** Ichirō Iitaka and Riuzō Shiota (*Rikwagaku-Kenkyū-jo Ihō (Bull. Inst. Phys. Chem. Res.)*, 1937, 16, (7), 397–407).—[In Japanese.] Beryllium bronze ingots, containing 2, 3, 3·5, and 4% beryllium, were forged and wires were made by cold-drawing. The influence of various heat-treatments on the mechanical properties of the wires was studied. Aluminium, nickel, cobalt, chromium, and manganese were then added to the alloys and the experiments repeated. Good results were obtained with ternary and quaternary alloys containing aluminium, nickel, or chromium.

—S. G.

\***Precipitation-Hardening and Double Ageing [of Copper-Cobalt-Beryllium and Copper-Chromium-Beryllium Alloys].** R. H. Harrington (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 172–186; discussion, 186–188).—See *Met. Abs.*, this vol., p. 36.—S. G.

\***The System Cu-Fe-S.** H. E. Merwin and R. H. Lombard (*Econ. Geol.*, 1937, 32, 203–284).—The experimental results are presented in tables and diagrams. (*Note by abstractor*: A full abstract is published in *C. Abs.*, 1937, 31, 4881).—S. G.

\***[Contribution] to Our Knowledge of the System Copper-Lead-Nickel.** W. Claus (*Metallwirtschaft*, 1937, 16, (24), 578–579).—The miscibility gap in the liquid state in the copper-lead system disappears on the addition of only 5% of nickel, and that in the lead-nickel system on the addition of 2% of copper.—v. G.

**Copper-Nickel-Zinc Alloys.** J. Schramm (*Rev. Nickel*, 1936, 7, (6), 188–189).—This is a short abstract from a book by S. with the same title (see *Met. Abs.*, 1936, 3, 350). Diagrams of the liquidus and solidus surfaces are given, and also those for the phases existing at 900°, 850°–830°, 775°, 650°, and 25° C., respectively.—W. A. C. N.

**Physical Properties and Ageing of Nickeliferous Bronzes.** R. W. Müller (*Tech. Zentr. prakt. Metallbearbeitung*, 1937, 47, (3/4), 151–152).—Additions of nickel are made to bronzes in order to produce harder alloys, to increase fluidity, or to refine the grain-size. The additions may be made at the expense of some of the tin. Wise and Eash have studied especially the alloys containing 7·5% nickel and 8% tin, although the full range embraced alloys with up to 20% nickel. 0·05–0·1% barium was used as deoxidizer in melting. Charcoal was not a suitable cover. Tensile strength, elastic limit, and hardness increase almost in proportion with an increase in nickel content. With up to 7% nickel the elongation is greater than for ordinary bronzes, but diminishes when this limit has been passed. The alloy with superior physical properties—Brinell hardness 93, tensile strength 38·5 kg./mm.<sup>2</sup>, elastic limit of 19 kg./mm.<sup>2</sup>, and an elongation of 35%—contained nickel 8 and tin 5%. By ageing, the hardness of the alloy containing nickel 7·5 and tin 8% was raised from 75 to 277. Superior physical properties after ageing were obtained with an alloy having approximately equal quantities of nickel and zinc.—W. A. C. N.

**Self-Lubricating Bearings.** — (*Tech. Zentr. prakt. Metallbearbeitung*, 1936, 46, (23/24), 837–840).—These materials consist essentially of graphited asbestos or bronze powders, sintered with graphite. There are, in addition, bearings of wood saturated with oil. Numerous types of self-lubricating bearings are described; they embrace copper-tin powder mixed with graphite

and then sintered and immersed in oil. With such a bearing only comparatively small stresses can be employed; bearings using graphite paste. Chrysler developed a bearing containing copper 88.5, tin 10, and graphite 1.5%, which is used where speeds are low and the pressure less than 350 kg./cm.<sup>2</sup>. For higher pressures powdered iron in which about 30% graphite has been incorporated has been suggested. In Germany "capillary" copper bearings have been developed.—W. A. C. N.

**Adherence of Anti-Friction Alloys in Bushings.** Albert Portevin (*Metal Progress*, 1937, 31, (1), 71-72, 82).—Adhesion between anti-friction metal and metallic bushings is most conveniently produced by an alloying action between both materials and an intermediate metal or alloy which forms non-brittle products in both instances. Binary alloys recently developed for this purpose include 67% copper-lead and 70% copper-thallium; both contain large proportions of the constituent metals in the free state, each metal forming a solid solution with either bearing metal or shell material.

—P. M. C. R.

**\*Tests on the Strength of Thin, Unstiffened [Brass] Cylinders Subjected to Shearing and Longitudinal Forces.** W. Ballerstedt and H. Wagner (*Luftfahrtforschung*, 1936, 13, 309-312; *Eng. Abs.*, 1936, (71), 48).—Results are given of tests on the strength of thin, unstiffened brass cylinders, which were rigidly fixed at the ends. These were subjected to compressive forces in the direction of, and to shearing forces parallel to, the principal axes of the cylinders. The manner in which the longitudinal forces affect the pure shear strength of such cylinders was also studied. The testing arrangements are described in detail. [Note by abstractor: Details of the formulae derived from the test results are given in *Eng. Abs.*, 1936, (71), 48].—S. G.

**\*A Decrease in the Electrical Resistance of Gold[-Silver Alloys] with a Magnetic Field at Low Temperatures.** W. F. Giauque, J. W. Stout, and C. W. Clark (*Phys. Rev.*, 1937, [ii], 51, (12), 1108).—A note. The resistance of a sample of gold wire containing 0.1 per cent. of silver has been studied, and passes through a minimum at about 8° K.; this phenomenon has also been noted by de Haas, de Boer, and van den Berg (*Physica*, 1934, 1, 1115; 1936, 3, 440). At 4.23° K. the resistance increased when a magnetic field was applied, but at 1.63° K. the resistance decreased by over 1% in a field of 8000 gauss; the wire was wound on a spool, the axis of which was parallel to the magnetic field. A series of gold-silver alloys covering the range 10-90 mole % was also studied. Those alloys have no appreciable temperature coeff. of resistance below 10° K., and their resistance is practically independent of the magnetic field up to 8000 gauss.—W. H.-R.

**\*Lead-Coating of Steel.** [Equilibrium Diagram of Lead-Rich Lead-Zinc Alloys.] J. L. Bray (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 199-206; discussion, 206-207).—See *Met. Abs.*, this vol., p. 184.—S. G.

**\*Properties of Metallic Solutions. II.—Surface Tension of Amalgams.** B. P. Bering and N. L. Pokrovsky (*Acta Physicochimica U.R.S.S.*, 1936, 4, (6), 861-872).—[In English.] See *Met. Abs.*, 1936, 3, 523.—S. G.

**\*On the Hysteresis of Magnetostriction for Alloys of the Systems Iron-Nickel, Nickel-Cobalt, and Iron-Cobalt.** Yosio Masiyama (*Sci. Rep. Tōhoku Imp. Univ.*, 1937, [i], 26, (1), 65-85).—[In English.] The hysteresis of magnetostriction and magnetization were measured for the systems iron-nickel, nickel-cobalt, and iron-cobalt. In all alloys the descending and ascending branches of magnetization curves plotted against magnetizing field have each a maximum in weak fields slightly displaced from zero field, but in alloys containing 20, 50, and 70% of iron, the curves show minima nearly at zero field.—S. G.

**\*On Gerlach's Thermomagnetic Electromotive Force in Nickel, Iron, and Nickel-Iron Alloys.** (Yamanaka.) See p. 372.



\*On the Effects of Stress on Gerlach's Electromotive Force in Nickel, Iron, and Nickel-Iron Alloys. (Yamanaka.) See p. 372.

\*On the Effect of Temperature on the Discontinuous Process of Magnetization in Nickel and Nickel-Iron Alloy (40% Ni). (Takagi.) See p. 373.

\*Inertia and Chemical Activity of the Rare Gases.—Density and Thermal Decomposition of the System Palladium-Helium. H. Damianovich and J. Piazza (*Anales soc. quim. argentina*, 1936, 24, 142; *C. Abs.*, 1937, 31, 4865).—See also *Met. Abs.*, this vol., pp. 132, 143. In an apparatus such as that previously described, a study was made of the Pd-He obtained by electric discharge in a helium atmosphere at low pressure, by the use of palladium electrodes and cooling the product continuously on the walls of the U-tube. The product contained 19.8 c.c. helium at 0° and 760 mm. per gm. of palladium. With a 0.1650 gm. sample, it was found that decomposition begins at 120° C. Up to 125° C., during heating for 9 hrs. and 32 minutes, 3.82 c.c. of helium was evolved. The temperature was increased to 225° C. in 3 hrs., giving further evolution of 1.57 c.c. of helium. The total volume of helium evolved from 125° to 235° C. was 3 c.c. Further heating gave 2 c.c. from 235° to 302° C. in 2 hrs., 2.3 c.c. from 302° to 350° C. in 3 hrs., 2.1 c.c. from 350° to 400° C. in 3 hrs., and 0.1 c.c. from 400° to 460° C. in 4 hrs., or a total of 13.24 c.c. The residue contained initially 30% helium. The total evolved during the operation thus corresponds to the analysis. The initial density was 10.8, but became 11 after heating to 235° C., and 11.8 after heating to 400° C., the theoretical value being 11.5. The total variation in density is greater than the experimental error. The results, shown by graphs, demonstrate that thermal decomposition does not correspond to an adsorption. The discontinuity observed is due to the presence of definite compounds. The variation in density, although less pronounced than with Pt-He, shows an intimate alteration of structure of the solid phase during thermal decomposition.—S. G.

\*Solidification and Electrical Conductivity Diagram of the Rubidium-Cæsium Alloys. Émile Rinck (*Compt. rend.*, 1937, 205, (2), 135-137).—The rubidium-cæsium alloys were studied in a manner previously described (*Met. Abs.*, 1936, 3, 354). All the operations were conducted in a high vacuum. The solidification diagram showed that the metals form an uninterrupted series of solid solutions. The liquidus and the solidus have a minimum at 9° C. for an equimolecular mixture of the two metals. Thermal analysis does not indicate whether the eutectic is a compound or a simple homogeneous mixture. The alloys were therefore poured into a tube carrying four platinum contacts, and then compressed with argon. A small current was passed between the two extreme contacts and the electrical conductivity measured. The resulting isothermal conductivity-composition curves show a minimum at the composition Rb + Cs, and indicate that this is not a compound but a simple mixture. These results are in absolute contradiction to those of Gorja (*Met. Abs.*, 1936, 3, 354). G., however, did not use a vacuum but an inert atmosphere, and it is suggested that the eutectic that he found at -39° C. is really a ternary or quaternary mixture of Cs-Rb-O-OH.—J. H. W.

\*Magnetic Properties of Iron Alloys with Ruthenium and Osmium. Maurice Fallot (*Compt. rend.*, 1937, 205, (3), 227-230).—For alloys containing up to 20% of those metals, the  $\alpha$ -ferromagnetic state exists from 0-14% ruthenium and 0-11% osmium. The Curie points are reversible and diminish rapidly as the content of the rare metals increases: 16° C. per atom of ruthenium, and 11° C. per atom of osmium. Since the transformation  $\gamma \rightarrow \alpha$  takes place at a temperature below the Curie point, the  $\alpha$ -paramagnetic state can only be observed by heating the alloy when it is in the ferromagnetic state. For higher contents a time occurs when the ferromagnetic Curie point can no

longer be directly observed. Although the  $\gamma \rightarrow \alpha$  transformation takes place below  $600^{\circ}\text{C}$ ., it becomes incomplete and a deficiency in magnetization results. For lower contents of osmium, the mean atomic moment diminishes linearly with the content; in the same range, the mean atomic moment of the ruthenium alloys remains unchanged. This phenomenon was observed in the nickel-palladium alloys by Sadron (*Ann. Physique*, 1932, 17, 371), but the explanation given for those alloys does not apply to the ruthenium and osmium alloys, which behave in a different manner quantitatively.—J. H. W.

**\*The Accurate Determination of the Freezing Points of Alloys, and a Study of Valency Effects in Certain Alloys of Silver [with Cadmium, Indium, Tin, and Antimony].** William Hume-Rothery and Peter William Reynolds (*Proc. Roy. Soc.*, 1937, [A], 160, (901), 282-303).—(a) A technique is described for the accurate measurement of the freezing points of alloys, by means of cooling curves, in which the temperatures are measured by a thermocouple. The sources of error are examined in detail, with particular attention to the effects of supercooling, and the determination of the exact composition of the melt at the instant of freezing. (b) The liquidus curves of silver-rich silver-cadmium, silver-indium, silver-tin, and silver-antimony alloys are studied in detail. If the freezing points of the different alloys are plotted against the equivalent compositions (i.e. the atomic percentage of solute multiplied by its valency), the points for silver-tin and silver-antimony alloys lie on a single curve in the range  $960.5^{\circ}$ – $880^{\circ}\text{C}$ . The points of silver-cadmium and silver-indium alloys lie on a single curve to a high degree of accuracy in the range  $960.5^{\circ}$ – $920^{\circ}\text{C}$ ., and in the range  $920^{\circ}$ – $880^{\circ}\text{C}$ . they differ by not more than  $1.1^{\circ}\text{C}$ ., the difference being in the direction to be expected from experimental errors. The equivalent composition curve for the silver-tin and silver-antimony alloys is, however, definitely higher than that for the silver-cadmium and silver-indium alloys, the maximum difference being about  $3^{\circ}\text{C}$ . in the range considered. The initial atomic depressions of freezing point produced by the above solutes are therefore not proportional to factors 2 : 3 : 4 : 5, but to factors of the form  $2a : 3a : 4b : 5b$ .—W. H.-R.

**\*Ageing Phenomena in a Silver-Rich Copper[Silver] Alloy.** Morris Cohen (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 138-157; discussion, 157-161).—See *Met. Abs.*, 1936, 3, 518.—S. G.

**\*The Hall Effect and Some Other Physical Constants of Alloys. VI.—The Silver-Tin Series of Alloys.** W. G. John and E. J. Evans (*Phil. Mag.*, 1937, [vii], 23, (158), 1033-1048).—Measurements have been made of (a) the electrical resistance, (b) the Hall effect, (c) the temperature coeff. of resistance, and (d) the mean thermoelectric power ( $15^{\circ}$ – $100^{\circ}\text{C}$ .) with reference to copper, for 17 silver-tin alloys and the pure metals silver and tin. The results are discussed with reference to the equilibrium diagram of Murphy (*J. Inst. Metals*, 1926, 35, 107), with which they are in general agreement.—W. H.-R.

**\*An Investigation to Develop Hard Alloys of Silver for Lining Ring Grooves of Light Alloy Pistons.** Claus Guenter Goetzcl (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 194-198).—See *Met. Abs.*, this vol., p. 186.—S. G.

**Chemical Equilibria in Inorganic Systems. IV.—The System Tin-Carbon-Oxygen.** A. F. Kapustinskii, A. Zilberman, and B. K. Veselovskii (*Trudi Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Mineralnogo (Trans. All-Russian Sci. Res. Inst. Econ. Mineral.)*, 1936, (109), 68-94).—[In Russian.]—S. G.

**Obtaining Cupro-Titanium and the Effect of Adding It to Alloys of Non-Ferrous Metals.** P. S. Kusakin (*Uralskii Gosudarst. Nauch.-Issledovatel. Inst. Zvetnyy Metal., Sbornik Nauch.-Issledovatel. Rabot*, 1935, (1), 95-109; *C. Abs.*, 1937, 31, 3864).—[In Russian.]  $\text{TiO}_2$  is best reduced with aluminium on a copper bath at  $1500^{\circ}\text{C}$ . Properties of its alloys are discussed.—S. G.



\***Electrolytic Production of Alloys of Zinc and Barium, and Their Constitutional Diagram.** I. I. Kornilov (*Zvetnye Metally (Non-Ferrous Metals)*, 1935, (10), 73-84; *C. Abs.*, 1937, 31, 3792).—[In Russian.] Alloys of zinc and barium were made by electrolysis of molten  $\text{BaCl}_2$  with molten zinc serving as a cathode. Barium, separated electrolytically, alloys with molten zinc. The maximum barium content obtained was 11%; alloys with a greater barium content could not be obtained, because of evaporation of zinc. Microscopic and chemical examination, thermal analysis, and hardness tests of cast and heat-treated alloys indicated absence of solid solutions. The alloys were found to consist of a matrix of pure zinc and a second phase roughly corresponding to the formula  $\text{Zn}_{12}\text{Ba}$ . The melting point of the alloys increases from that of pure zinc to about  $900^\circ\text{C}$ . at 10.6% barium. The freezing point of the alloys is that of pure zinc. The microstructure is typical of anti-friction alloys. 7 references are given.—S. G.

**Zinc-Base Die-Casting Alloys.** H. L. Evans (*Met. Ind. (Lond.)*, 1937, 51, (5), 105-109; (6), 139-142).—The development of the Zamak alloys is related, the effects of composition on structure and properties being outlined, with particular reference to the influence of impurities on resistance to inter-crystalline corrosion and on dimensional stability. The mechanical properties of the standard alloys are listed and the methods used for routine testing, described. Typical applications of the alloys are suggested. A bibliography of 31 references is given.—H. W. G. H.

**The Zamak Alloys.** — (*Automobiltech. Z.*, 1937, 40, (12), 321-322).—The Zamak die-casting alloys are of three types, the analyses of which are given. Microstructures of the alloys in the chill-cast and die-cast states are illustrated, and the physical and mechanical properties of the materials are tabulated. Suitable casting conditions are briefly discussed.—P. M. C. R.

**The "Incubation" of Alloys.** Kotarò Honda (*Metal Progress*, 1937, 31, (5), 536, 546-547).—See also *Met. Abs.*, this vol., pp. 90, 144. The interval between the quenching of certain alloys and the inception of age-hardening is known as the "incubation period." Its nature has been investigated in the case of a copper-beryllium alloy and a specially pure Duralumin, and is explained by H. as the combined effect of two opposite processes, the softening action due to the separation of fine particles, and the hardening arising from refinement of structure. The associated phenomena connected with electrical resistance, density, and the effect of ageing temperature are explicable on the same basis.—P. R.

\***Properties of Metallic Solutions.**—I. V. K. Sementchenko (*Acta Physico-chimica U.R.S.S.*, 1936, 4, (5), 695-704).—[In English.] See *Met. Abs.*, 1936, 3, 523.—S. G.

\***Segregation in Single Crystals of Solid Solution Alloys.** Arthur Phillips and R. M. Brick (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 313-329; discussion, 329-330).—See *Met. Abs.*, this vol., p. 186.—S. G.

\***The Exact Measurement of Specific Heats at High Temperatures.** VIII.—On the Additive Rule of the Specific Heats of Metals in Binary Combinations. (Jaeger and Poppema.) See p. 375.

\***A Theory of the Ferromagnetism of Alloys.** F. Bitter (*Phys. Rev.*, 1937, [ii], 51, (5), 383).—Brief abstract of a paper read before the American Physical Society. Excluding pressure effects, the magnetization of an alloy may be considered to be a function of three variables—the concentration of the alloy, the temperature, and the magnetic field. A theory is developed which gives the dependence of spontaneous magnetization on temperature for any homogeneous phase. The expression obtained reduces to the usual form  $I/I_0 = \tanh(CI/KT)$  for pure substances. The equations contain five arbitrary constants, four of which are  $C$ , and  $I_0$  for the two pure phases. Among the new points brought out are that in alloys spontaneous magnetization

need not increase with decreasing temperature, and that there may be more than one critical temperature. Further, the conditions for the existence of a single homogeneous phase are discussed, and it is shown that a chemical separation may take place at the critical temperature, analogous to the chemical separation that takes place on freezing, and that this chemical separation may be modified by the application of a magnetic field.—S. G.

**The Development of Magnetic Materials.** Carl Hölecke (*Teleg. Praxis*, 1937, 17, (9), 133-137).—A brief survey of the development both of permanent magnetic materials and of materials of low coercivity. In the former case values of remanence and coercive force for eight types of alloy are tabulated; in the latter, values of the initial and maximum permeability, coercive force, and specific resistance for fifteen alloys of the silicon steel and Permalloy types are given.—R. T.

### III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 336-339.)

\***The Validity Range of Hume-Rothery's Law.** H. Witte (*Metallwirtschaft*, 1937, 16, (10), 237-245).—The compositions of all known intermetallic crystal phases are tabulated. About half of them conform to the Hume-Rothery rule. The greatest degree of conformity is shown by phases with a  $\gamma$ -brass structure and the next by those with a  $\beta$ -brass structure. Phases with a close-packed hexagonal structure show the greatest deviations.—v. G.

†**Ordered Distribution in Metallic Solid Solutions.** R. Becker (*Metallwirtschaft*, 1937, 16, (24), 573-578).—A review of the work of Bragg, Williams, Sykes, and others (cf. *Met. Abs.*, 1935, 2, 589).—v. G.

**Physical Methods in Metallurgy. III.—Methods of Investigating Local Variations of Composition.** Bruce Chalmers (*Met. Ind. (Lond.)*, 1937, 51, (2), 31-34).—Methods are considered for determining, at a point that can be identified microscopically, the constitution of a binary alloy. These include measurement of variation in depth of etching by an interference method; contact potential and thermoelectric measurements (the latter of which is shown to be inapplicable); observation of polarized light reflected from the surface, the incident beam being circularly polarized; and the use of the electron microscope.—H. W. G. H.

\***Notes on Etching and Microscopical Identification of the Phases Present in the Copper-Zinc System.** J. L. Rodda (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 189-193).—See *Met. Abs.*, 1936, 3, 526.—S. G.

\***Primary Crystallization of Metals.** F. R. Hensel (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 300-312; and *Metals Technology*, 1937, 4, (4); *A.I.M.M.E. Tech. Publ.* 803, 13 pp.).—Existing theories of the crystallization of metals are discussed, with special reference to factors affecting the size and shape of the crystals in castings. Experiments are described showing the change in temperature of the liquid and the mould during the solidification of tin, and the effects of mould temperature and casting temperature were investigated. Experiments with zinc, 5% tin bronze, and 30:70 brass are also described.—W. H. R.

**On the Formation of Centres of Phase-Transformations in Condensed Systems.** E. Andronikaschwili (*Acta Physicochimica U.R.S.S.*, 1937, 6, (5), 689-700).—[In German.] Thermodynamic formulæ are derived for the conditions of production, and the size of stable centres of crystallization in supercooled liquid melts. Data relating to the crystallization of supercooled mercury are tabulated.—J. S. G. T.



\*The Eddy Arrangement of Micro-Crystals in Metal Wire Caused by Drawing. Takeo Fujiwara and Yoshinori Seiki (*J. Sci. Hiroshima Univ.*, 1936, [A], 6, 307-312).—[In English.] The arrangement of micro-crystal grains in the cross-section of drawn wires of aluminium and tungsten was studied by X-rays and microscopic examination. It was found that in the cross-section of the drawn wire the micro-crystal grains crushed by wire-drawing are so arranged that they are somewhat rotated around the axis of the wire. The amount of angular displacement of each crystal grain is so varied that the displacement is greater the nearer the layer in which the crystals are situated lies to the surface; as a whole arrangement it seems as if the crystal grains are deformed in an eddy shape by wire-drawing.—S. G.

Structure of Polish. G. I. Finch (*Sci. J. Roy. Coll. Sci.*, 1937, 7, 32-42).—A lecture.—S. G.

†Comparative Properties of Metallic Surfaces Polished Mechanically and Electrolytically. P. A. Jacquet (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 11 pp.).—See *Met. Abs.*, this vol., p. 188.—S. G.

\*Optical Research of Thin Layers. L. S. Ornstein and P. J. Haringhuizen (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 4 pp.).—See *Met. Abs.*, this vol., p. 239.—S. G.

X-Ray Diffraction as a Means of Detecting Impending Fatigue Failure. C. S. Barrett, R. F. Mehl, and R. L. Templin (*Proc. Amer. Soc. Test. Mat.*, 1936, 36, (1), 125-126).—Appendix to the report of the Research Committee on the Fatigue of Metals. The possibility of measuring damage, or of predicting impending failure, in metallic parts has been investigated by the examination of spot patterns from fatigue specimens in aluminium, a light alloy copper, and 3 steels. The amount of cold-working revealed appears to depend on the stress intensity as related to the yield-strength, rather than to the endurance limit, and the diffraction patterns register the progress of cold-work, not of fatigue failure.—P. M. C. R.

\*Lattice Dimensions of Electroplated and Normal Chromium. W. A. Wood (*Phil. Mag.*, 1937, [vii], 23, (157), 984-988).—The lattice spacing of pure annealed chromium is determined as  $a = 2.879_6$  Å. at 18° C.; this value was obtained from a specimen with sufficiently large crystals to give single spots, the positions of which on the diffraction photograph were accurately measured. A technique is developed by means of which the diffuse diffraction rings from electrodeposited chromium can be superimposed on the sharp spots from larger crystals of the pure metal. The lattice spacing of electrodeposited metal is greater than that of the pure metal; for the bright type of electroplated chromium, the increase is  $\Delta a/a = +0.00205$ , and for the dull matt type of chromium plate  $\Delta a/a = +0.0015$ . On normalizing at 700° C. *in vacuo*, the fractional increase is reduced to  $\Delta a/a = +0.00093$ , but it is impossible to reduce the lattice spacing to normality. W. concludes that, on electrodeposition, most of the gas is deposited on the surface of the crystallites ( $10^{-6}$  to  $10^{-7}$  cm.), and a comparatively small amount within the lattice.

—W. H.-R.

\*The Crystal Structure of Copper Electrodeposits.—I. Arthur Phillips and Walter R. Meyer (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 6 pp.).—See *Met. Abs.*, this vol., p. 239.—S. G.

\*The Structure of Thin Coatings of Copper Electrodeposited on Crystalline Copper. P. A. Jacquet (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 15 pp.).—See *Met. Abs.*, this vol., p. 197.—S. G.

\*The Superlattice in  $\beta$  Brass. F. W. Jones and C. Sykes (*Proc. Roy. Soc.*, 1937, [A], 161, 440-446).—Using zinc radiation, superlattice lines have been observed in powder photographs of a copper-zinc alloy containing 49% zinc annealed at 425° C. The superlattice lines occur in the places expected for a structure with one kind of atom at the cube corners and the others at the

cube centres of the body-centred cubic structure. The distinction between copper and zinc atoms is made possible by the anomalous scattering power found when an atom is irradiated by a wave-length nearly equal to that corresponding to its absorption edge (Bradley and Rodgers, *Met. Abs.*, 1934, 1, 299).—W. H.-R.

\***Lattice Relationships Developed by the Peritectic Formation of Beta in the Copper-Zinc System.** Alden B. Greninger (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 379-390; discussion, 390-392).—See *Met. Abs.*, this vol., p. 190.—S. G.

\***On the Crystal Structure [and Magnetic Properties] of Sputtered Nickel Films.** Sirō Ogawa (*Kinzoku no Kenkyū (J. Study Metals)*, 1937, 14, (4), 113-119 (in Japanese); and *Sci. Rep. Tōhoku Imp. Univ.*, 1937, [i], 26, (1), 93-105 (in English)).—The crystal structures of nickel films sputtered in hydrogen or nitrogen atmospheres were determined by electron diffraction. The films showed hexagonal close-packed structures, having lattice constants slightly different from each other. On annealing in vacuum, they each transformed into the normal lattice. When ground materials, on which the films were deposited, were cooled by liquid nitrogen, the crystal size of nickel films was refined, and the diffraction rings were consequently diffused. The magnetic properties of films sputtered in an atmosphere of hydrogen were also investigated. The films deposited on a cooled anode had a face-centred cubic lattice, and became more magnetic with increase in thickness; those deposited on an anode which was not cooled had, however, an hexagonal lattice and were always non-magnetic, irrespective of thickness.—S. G.

\***The Crystal Structures of  $\text{Ni}_2\text{Al}_3$  and  $\text{NiAl}_3$ .** A. J. Bradley and A. Taylor (*Phil. Mag.*, 1937, [vii], 23, (158), 1049-1067).—The structures of  $\text{Ni}_2\text{Al}_3$  and  $\text{NiAl}_3$  were determined from powder photographs.  $\text{Ni}_2\text{Al}_3$  is trigonal, space group  $D_{3d}^3(C3m)$ . There are 2 nickel and 3 aluminium atoms in the unit cell, of which the dimensions are  $a = 4.0282 \text{ \AA}$ ,  $c = 4.8906 \text{ \AA}$ ,  $c/a = 1.2141$ . The aluminium atoms lie at the corners of a deformed cube, and the nickel atoms very near to the centres of two-thirds of these pseudo cubes; the remaining one-third are empty.  $\text{NiAl}_3$  is orthorhombic, space group  $D_{2h}^8(Pnma)$ , with  $a = 6.5982 \text{ \AA}$ ,  $b = 7.3515 \text{ \AA}$ ,  $c = 4.8021 \text{ \AA}$ . The unit cell contains 4 nickel and 12 aluminium atoms, arranged in a peculiar type of close-packing intermediate between the face-centred cubic type, where each atom has 12 neighbours, and the body-centred cubic type, where each atom has 8 neighbours. In  $\text{NiAl}_3$ , the nickel atoms have 9 neighbours, and the aluminium atoms 11. Relations between the interatomic distances in the different nickel-aluminium phases are discussed.—W. H.-R.

\***The Crystal Structure of  $\text{Ni}_3\text{Sn}$ .** P. Rahlfs (*Metallwirtschaft*, 1937, 16, (15), 343-345).— $\text{Ni}_3\text{Sn}$  has a hexagonal close-packed lattice,  $a = 5.275$ ,  $c = 4.234 \text{ \AA}$ ;  $c/a = 0.803$ ; the phase has a superstructure similar to that of  $\text{Mg}_3\text{Cd}$ .—v. G.

\***The Crystal Parameters [and Coefficients of Thermal Expansion] of Osmium and Ruthenium at Different Temperatures.** E. A. Owen and E. W. Roberts (*Z. Krist.*, 1937, 96, (6), 497-498).—[In English.] The lattice parameters of osmium and ruthenium were measured at temperatures between 20° and 600° C. Tables are given showing the dimensions and axial ratio of the unit cell, the axial ratios, atomic volumes, and the mean coeffs. of thermal expansion. In both metals the axial ratios increase slightly with increase of temperature, the values at 600° C. being 1.5810<sub>0</sub> for osmium, and 1.5867<sub>7</sub> for ruthenium, as compared with 1.5790<sub>1</sub> and 1.5835<sub>3</sub> at 20° C.—W. H.-R.

\***The Exchange of Energy Between a Platinum Surface and Helium Atoms and Its Dependence upon the Structure of the Surface.** [Structure of Platinum Surface After Heating in Oxygen.] W. B. Mann (*Proc. Roy. Soc.*, 1937, [A], 161, (905), 236-247).—In experiments on the transfer of energy across a platinum-helium interface, the surface of the platinum is much more resistant



to contamination after it has been heated in oxygen. A thin protective film is formed on the surface of the platinum, and the structure of the film has been investigated by electron diffraction methods. The film is composed of light and heavy atoms situated respectively at the body-centre and corner positions of a tetragonal lattice, the constants of which are  $a = b = 5.38$  A., and  $c = 4.43$  A. The chemical composition of the film is not known.

—W. H.-R.

\*The Structure of Glasseous Selenium. K. Lark-Horovitz and E. P. Miller (*Phys. Rev.*, 1937, [ii], 51, (5), 380).—Brief abstract of a paper read before the American Physical Society. Thin rods of glassy selenium were studied with Ag  $K_{\alpha}$  and Cu  $K_{\alpha}$  radiation. Three bands were observed in the diffraction pattern,  $\lambda/2 \sin \theta$  of which are equal to 3.42, 1.73, 1.13. These values agree with Prins' recent results on liquid selenium, 3.38, 1.79, 1.15 (*Trans. Faraday Soc.*, 1937, 33, 110). Exposures in a vacuum camera with monochromatic Cu radiation were evaluated by the Fourier method in a manner previously described (*Phys. Rev.*, 1936, [ii], 51, 61). Three sharp peaks are found in the distribution curve at distances  $r = 2.35, 3.7, 4.8$  A.; these peaks correspond to the distances for next neighbours in the crystal, 2.32, (3.46, 3.69), 4.34 A. Also, the number of atoms at these distances corresponds to the number of atoms in the crystal.—S. G.

\*Contact Potential Difference Between Different Faces of Silver Single Crystals. H. E. Farnsworth (*Phys. Rev.*, 1937, [ii], 51, (5), 378).—Brief abstract of a paper read before the American Physical Society. Two crystals were cut and etched so as to expose (100) facets on a plane surface of one, and (111) facets on a plane surface of the other. Measurements by the Kelvin null method of the potential difference between these faces are being made in a high vacuum as a function of heat-treatment. Outgassing has been continued at various temperatures below visible red heat for a period of 160 hrs. After this time the (111) face is positive with respect to the (100) face by about 0.4 v. While this is a preliminary value only, the results indicate that the true value is probably greater than this.—S. G.

\*The Effect of Temperature on the Intensity of Reflection of X-Rays from Zinc Crystals. E. O. Wollan and G. G. Harvey (*Phys. Rev.*, 1937, [ii], 51, (12), 1054–1061).—The intensities of X-rays reflected from the different planes of powdered zinc crystals at room temperature, and at the temperature of liquid air, were measured and compared. The structure factors are calculated, and indicate that the zinc atoms in the crystal do not possess spherical symmetry, but are drawn out in the direction of the  $c$  axis. The amplitudes of vibration of the atoms along different directions were calculated, and are in good agreement with the average value obtained from specific heat data.

—W. H.-R.

\*Atomic Structure and Vibrations in Zinc Crystals. IV.—Diffuse Scattering of X-Rays at Different Temperatures. G. E. M. Jauncey and W. A. Bruce (*Phys. Rev.*, 1937, [ii], 51, (12), 1062–1065).—The effects of surface irregularities on the diffuse scattering of X-rays from single crystals of zinc are discussed, and methods are described for the preparation of accurately plane surfaces free from strain and amorphous metal. The diffuse scattering was measured at orientations of  $3^{\circ}$  and  $90^{\circ}$ , at a scattering angle of  $30^{\circ}$ , at temperatures between  $100^{\circ}$  and  $550^{\circ}$  K. A method of obtaining the approximate ratio of the mean square displacements parallel and perpendicular to the principal axis is described, and discussed in Part VI (see abstract below).

—W. H.-R.

\*Atomic Structure and Vibrations in Zinc Crystals. V.—The Diffuse Scattering of X-Rays at Various Scattering Angles. W. A. Bruce and E. M. McNatt (*Phys. Rev.*, 1937, [ii], 51, (12), 1065–1067).—Accurate measurements of the diffuse scattering of X-rays at scattering angles from  $\phi = 15^{\circ}$

to  $\phi = 40^\circ$  for the two orientation angles  $\psi = 14^\circ$  and  $\psi = 90^\circ$  are described. The results are discussed in Part VI (following below).—W. H.-R.

**\*Atomic Structure and Vibrations in Zinc Crystals. VI.—Determination of Electron Asymmetry and the Two Principal Characteristic Temperatures.** G. E. M. Jauncey and W. A. Bruce (*Phys. Rev.*, 1937, [ii], 51, (12), 1067-1073).—The results of previous papers (see preceding abstracts) are discussed. The true atomic structure factor,  $f$  (the effect of atomic vibrations having been removed), is a function of the orientation angle  $\psi$  as far as  $(\sin \frac{1}{2}\phi)/\lambda = 0.6$ , where  $\phi$  is the scattering angle. The  $f$  curves are examined, and indicate an asymmetry in the spatial distribution function of the valency electrons. The characteristic temperatures associated with vibrations parallel and perpendicular to the principal axis are determined. The characteristic temperature for parallel vibrations decreases, whilst that for perpendicular vibrations remains almost constant with rise of temperature in agreement with the theory of Zener (*ibid.*, 1936, 49, 122). The ratio of the mean square displacements parallel and perpendicular to the  $c$  axis varies from 2.6 at  $100^\circ \text{K.}$  to 4.5 at  $370^\circ \text{K.}$ , and are considerably higher than the value 1.8 required by Zener's theory. The average characteristic temperature for vibrations in all directions is slightly greater than the characteristic temperature for specific heat, in agreement with Zener's theory.—W. H.-R.

**Physical Methods in Metallurgy. IV.—X-Rays.** Bruce Chalmers (*Met. Ind. (Lond.)*, 1937, 51, (6), 135-138).—Discusses the nature of X-rays; the Bragg law; Laue, powder, and rotating crystal methods of analysis; and applications to the determination of lattice structure and grain-size, and the investigation of equilibrium diagrams and order-disorder changes.—H. H.

**\*Note on the Indexing of Powder Photographs.** Ludo K. Frevel (*J. Applied Physics*, 1937, 8, (8), 553-557).—By taking two successive Debye-Scherrer-Hull pictures of a powder specimen at two different temperatures, there is obtained, on a single film, a direct temperature shift of the diffraction pattern of the substance. An interval of  $150^\circ \text{C.}$ , or more, will generally suffice to produce easily-measurable temperature shifts that can be related to the anisotropy of a crystalline substance. A systematic treatment of the various crystal systems has shown that the first four systems (cubic, tetragonal, hexagonal, and orthorhombic) can be indexed in a straightforward manner. Two cases of the monoclinic system: (1)  $\partial\beta/\partial T = 0$  and (2)  $\alpha_3/2 = (1/b)(\partial b/\partial T) > \alpha_3 > \alpha_2 > \cot \beta \partial\beta/\partial T$ , can be solved without time-consuming mathematical calculations.—S. G.

**A Note on "The Employment of Contoured Graphs of Structure Factor in Crystal Analysis."** L. Chrobak (*Z. Krist.*, 1937, 96, (6), 503).—[In English.] A note, referring to the paper by Bragg and Lipson (*Met. Abs.*, this vol., p. 95).—W. H.-R.

**\*A Note on Absorption and Weissenberg Photographs.** A. F. Wells (*Z. Krist.*, 1937, 96, (6), 451-453).—[In English.]—W. H.-R.

#### IV.—CORROSION

(Continued from pp. 339-343.)

**\*Dissolution Potentials of Aluminium and Light Alloys.** Paul Lacombe and Georges Chaudron (*Rev. Mét.*, 1936, 33, (12), 697-704; and (abstract) *Light Metals Research*, 1937, 5, (10), 224-225).—The effect of aeration on the solution potentials of various metals is studied. The solution potential of aluminium-magnesium alloys with 0-15% magnesium is affected by the condition of the alloy, the least trace of free  $\beta$  or  $\text{Al}_3\text{Mg}_2$  giving a very negative potential. Alloys of systems aluminium-copper, aluminium-zinc, aluminium-silicon, and aluminium-manganese are also studied. The effect of reheating the quenched, metastable solid solution alloys is examined.—H. S.



**\*Behaviour of Aluminium with Fruit Products.** G. Reif and H. J. Steinbeck (*Z. Untersuch. Lebensm.*, 1937, 73, 431-440; *C. Abs.*, 1937, 31, 4736).—These experiments were conducted to determine just how far aluminium could be used as a substitute for metals such as tin, produced in foreign countries, in the food industry. The experiments were first conducted with fruit products of an acid character, such as cherry confectionery, apple sauce and plum sauce, often protected in tinplate containers. Different types of aluminium were studied, such as aluminium of various purities (99.5 and 99.8%) and of different characteristics, such as hard-rolled and heated at different temperatures. Other samples of aluminium were protected by the Eloxal or M.B.V. processes. Some alloys were likewise tested. The tests consisted of a study of the effect of the fruit products on the metal surface, the loss in weight of the aluminium plate after immersion in the fruit products, and the amount of aluminium taken up by the fruit products. For the determination of the aluminium, the hydroxyquinoline method of R. Berg was used, as modified by K. B. Lehmann (*Arch. Hyg.*, 1931, 106, 336). The attack of these acid fruit products on aluminium is particularly dependent on their water and ext. content. The greater the water content, the greater is the activity. In general, aluminium of 99.8% purity is better than that of 99.5% purity. Sheet aluminium that has been tempered at 380° and 550° C. shows greater resistance than the hard-rolled metal. Through the attack of these acid fruit products, aluminium tempered at 550° C. shows a greater development of crystalline etch figures. The most resistant of all the aluminium sheets was that protected by the Eloxal process. The M.B.V.-treated aluminium sheet was not quite so good, but it was better than all the other samples tested. The aluminium alloys were the least satisfactory of all. Their loss in weight and the aluminium content of the fruit products in which they had been placed was remarkably high, in some cases being twice that found with other samples of aluminium sheet.—S. G.

**\*An Investigation of Aluminium Die-Casting Alloys, Nos. IVa and Va.** E. E. Thum (*Proc. Amer. Soc. Test. Mat.*, 1936, 36, (I), 182-192).—Appendix I to the Report of Committee B-6 on Die-Cast Metals and Alloys. Specimens of aluminium die-casting alloys containing 5 and 12% silicon were exposed to salt-spray corrosion tests in two laboratories, and to outdoor alternate immersion tests, the attacking medium throughout being 3.5% aqueous sodium chloride solution. The tensile strength, yield-point, and elongation of exposed specimens were compared periodically with those of unexposed "blanks." The salt-spray attack proved more severe than the alternate immersion test. The high-silicon alloy was found to be more resistant to both types of attack than the 5% silicon alloy, and to be less affected by slight variations in manufacturing or exposure conditions.—P. M. C. R.

**\*The Oxidation of Beryllium "Bronzes."** Haidun N. Terem (*Compt. rend.*, 1937, 205, (1), 47-49).—The oxidation of beryllium "bronzes" in a liquid medium has previously been described (*Met. Abs.*, this vol., p. 290), and the oxidation in a gaseous medium at temperatures from 610° to 910° C. has now been studied. The beryllium content of the specimens varied from 0.5 to 10%. The results showed that: (1) Pilling and Bedworth's parabolic law (*J. Inst. Metals*, 1923, 29, 529) is not obeyed; (2) the addition of very small quantities of beryllium to copper suffices to diminish the oxidation of the latter considerably. The alloys containing 2% and more beryllium are practically unoxidizable. A 12.5% chromium steel was found to be four times more oxidizable at 610° C. than 2% beryllium "bronze," and to oxidize to the same extent at 810° C.; (3) the 2% alloy appears to oxidize a little less than alloys of the higher beryllium content; (4) the 0.5 and 1% alloys become covered with a layer of black oxide, while the alloys containing 2% and more retain their initial colour up to 710° C., when they become

covered with a very thin film of beryllium oxide. These alloys become brown at 810° C. The film of oxide formed has a retarding effect on the attack by nitric acid on the alloys.—J. H. W.

**Effect of Thermo-Galvanic Currents in Metallic Corrosion by Electrolysis.** H. Krenn (*Arch. Wärmewirtschaft*, 1936, 17, 115–118; *Eng. Abs.*, 1936, (69), 25).—K. states that in combating corrosion of the blades of a Kaplan hydraulic turbine, he has concluded that it is caused by thermo-galvanic currents, generated in a liquid medium by abstraction of heat. A hydro-electric power station in Austria commenced service in 1923. It contained two 1000 h.p. Kaplan turbines, each with a capacity of 16 m.<sup>3</sup>/minute. The fall was 6 m. (19.68 ft.), of which 3 m. was suction fall; the speed was 930 r.p.m., and the efficiency 87%. The turbines were direct-coupled to vertical generators. The running blades of the turbines, when examined after 3 months' operation, showed corrosion-pitting on the under side of the blades covering  $\frac{1}{4}$  of the surface, and extending from the rim to the middle of the blade; at some places the pitting was 17 mm. (0.67 in.) deep. The blades were of phosphor-bronze, and experiments with this alloy as anode in a plating plant yielded similar results, demonstrating that the damage was caused by electrolytic action. One of the turbines was then protected by the Cumberland method for protecting surface condensers in ships. After 6 weeks the pitting was practically arrested and the casing had not suffered, whereas corrosion in the unprotected turbine had made considerable progress. The blades of the second turbine were repaired by autogenous welding and the Cumberland protection was adopted. Other hydro-electric plants on the same river had operated for 10 years without trouble with turbine blades, but in every case the power from the turbine was transmitted by bevel wheels with wooden teeth, and leather belt, or other elastic couplings, whereas in the plant discussed the generator is keyed on the vertical shaft of the turbine, which enables it, in the absence of insulation, to transmit some of the heat generated to the turbine blades. Experiments indicated that the galvanic action arose at the point where the transmitted heat met with the cooling liquid. K. cites other cases of corrosion of flow-meters, superheaters, and boilers, and discusses protective measures.—S. G.

**\*Corrosion of Lead in Tower Systems.** I. E. Adadurov and A. N. Tseitlin (*Ukrainski Khemitchnii Zhurnal*, 1936, 11, 368–385; *C. Abs.*, 1937, 31, 3215).—[In Ukrainian, with German summary.] Cf. *Met. Abs.*, 1936, 3, 459. The corrosion of lead plates in sulphuric acid of 55°, 57°, 59°, and 60° Bé for 12 hrs. at 90° C. was determined gravimetrically. Corrosion is least in 59° Bé acid. Increase of N<sub>2</sub>O<sub>2</sub> in acids of low Bé promotes corrosion considerably, but in stronger acids the increase in corrosion is not so great. By increasing the temperature, the corrosion increases in all cases.—S. G.

**Corrosion of Safety Plugs.** M. Drits (*Novosti Tekhniki*, 1937, (4), 36–37; *C. Abs.*, 1937, 31, 4253).—[In Russian.] Several lead and tin alloys used for safety plugs in locomotives were treated in an autoclave at 10 atm. pressure in the presence of water containing Na<sub>2</sub>PO<sub>4</sub>·12H<sub>2</sub>O 25 mg./litre, or chloride 5000 mg./litre. Lead and its alloys with antimony and tin were more stable than alloys consisting mainly of tin. Contact of lead with iron decreased the loss of weight of the former. Resistance to corrosion of lead-tin alloys decreases with increase in the tin content.—S. G.

**\*The Corrosion of Magnesium Alloys. II.—Magnesium Ternary Alloys.** Hikozi Endō and Susumu Morioka (*Sci. Rep. Tōhoku Imp. Univ.*, 1937, [1], 26, (1), 106–124).—[In English.] The corrodibility of ternary alloys of magnesium with the metals zinc, cadmium, tin, lead, aluminium, and antimony was studied, taking into consideration test results previously obtained with binary alloys (*Met. Abs.*, this vol., p. 97). Fifteen series of ternary alloys



were prepared by adding to magnesium, systematically, two of the elements mentioned above, and limiting the amount of addition to 1-8%, except in the case of antimony, for which the limit was 0.3-3%. The corrosion in the cast state was observed. The results obtained show that the ternary systems magnesium-zinc-tin, magnesium-zinc-cadmium, magnesium-tin-cadmium, magnesium-tin-lead, magnesium-zinc-antimony, and magnesium-tin-antimony have a comparatively high resistance to corrosion, especially in the ranges: zinc 1-3, tin 2-8; zinc 3-6, cadmium 1-6 (zinc + cadmium < 10); tin > 3, cadmium 1-3; tin > 4, lead 1-6; zinc 1-6, antimony 0.3-0.6; and tin 2-3, antimony < 0.8%, and that the effect of the added metals varies remarkably with the kind or amount of the second element. The effects of small amounts of bismuth or calcium added to some binary alloys of magnesium was also studied.—S. G.

**\*Corrosion Tests on Magnesium and Ultra-Light Alloys Protected by Surface Deposits.** Jean Cournot and Louise Halm (*Compt. rend.*, 1937, 204, (26), 1941-1943).—The corrosion of unprotected magnesium and ultra-light alloys was previously investigated (*Met. Abs.*, this vol., p. 291), and the principal methods of surface protection are now described. *A.* (Fournier, *Rapports de la Commission française de corrosion*, 1932-33-34, 5, 51). Immersion for 2 minutes in a boiling solution of 15% chromic anhydride and a small quantity of sulphuric acid. *B.* (Lewis and Evans, *J. Inst. Metals*, 1935, 57, 221). Immersion for 8 minutes in a cold solution of 5% zinc sulphate and 5% ammonium nitrate. *C.* (Sutton and Le Brocq, *J. Inst. Metals*, 1931, 46, 53; and 1935, 57, 343). Immersion for 30 minutes in a boiling solution of 1.5% potassium bichromate and 1.5% sodium sulphate. *D.* (Sutton and Le Brocq, *loc. cit.*). Immersion for 45 minutes in a boiling solution of 0.75% potassium bichromate, 0.65% ammonium bichromate, 3% ammonium sulphate, and 33% ammonia. *E.* (Bengough and Whitby, *J. Inst. Metals*, 1932, 48, 147; and 1933, 52, 85). Immersion for 8 minutes in a cold solution of 10% arsenious acid with or without 0.3% sodium chloride. Corrosion was effected by total immersion in a 3% aqueous solution of sodium chloride, the rate of attack being measured by the volume of gas evolved and by the loss in weight after 72 hours. *I. Rolled Alloys.* The compositions of the alloys tested were: (1) magnesium 99.8%, (2) aluminium 6, zinc 1, manganese 0.4%, (3) manganese 1.8%. Initial treatment consisted of simple sand-blasting (*S*), or sand-blasting followed by 30 seconds immersion in 10% nitric acid (*SN*). The treatment (*SN*) gave appreciably better results than sand-blasting alone. Insufficiently pure magnesium was seriously corroded. The best methods of protection were *A*, *E*, and then *D*. The heat content of sulphuric acid in the sulpho-chromic solutions had to be accurately established for each alloy. *II. Cast Alloys.* These consisted of: manganese 0.4% and (1) aluminium 6, zinc 3%; (2) aluminium 4, zinc 3%; (3) aluminium 3, zinc 1%; (4) aluminium 10%. An additional pretreatment consisted of sand-blasting, followed by immersion for 2 minutes in 15% chromic anhydride and 1 grm./litre sulphuric acid (*SA<sub>s</sub>*). Alloy (4) showed considerable corrosion. With the other alloys, treatment (*SA<sub>s</sub>*) gave much the best results, and the final treatment, *E*, appeared to be the most dependable.—J. H. W.

**\*Some Properties of Magnesium Sheet and Alloys.** (Goto, Nito, and Asada.) See p. 371.

**\*Some Experiments on Tinned Copper Water Tubing.—II.** Kenzo Inamura and Hidekichi Ohashi (*Sumitomo Kinzoku Kōgyō Kenkyū Hōkoku (Res. Rep. Sumitomo Metal Ind., Ltd.)*, 1937, 2, (10), 1081-1092).—[In Japanese.] Cf. *Met. Abs.*, this vol., p. 149. An investigation was made of the effects of various inorganic salts on the corrosion of tin, copper, and lead by water. The salts used in the experiments were sodium chloride, calcium chloride,

magnesium sulphate, calcium sulphate, magnesium chloride, sodium sulphate, ammonium chloride, sodium carbonate, and  $\text{CaH}_2(\text{CO}_3)_2$ .—S. G.

**\*Attack on Tinned Containers by Spinach and Other Preserved Foods Coloured Green by Copper Compounds.** G. Heuser and E. Krapohl (*Z. Untersuch. Lebensm.*, 1937, 73, 338-346; *C. Abs.*, 1937, 31, 4407).—This investigation shows that the tin coating of containers is more readily attacked by foodstuffs coloured green by copper compounds than when such copper compounds have not been used. In spinach as much as 115 mg. of tin has been found in 100 gm. Experiments on the action on tin foil of copper sulphate solutions of different concentrations, alone or with other salts, or with acetic or tartaric acid, or of these acids alone, gave results as follows: Copper salts gave a relatively strong attack, with the appearance of corrosion; this is doubtless due to electrolytic phenomena. Of all the organic acids acting alone, tartaric acid showed the strongest attack, but without the appearance of any corrosion. It is proposed that the insides of tinned containers be covered with a suitable and stable lacquer to obviate the solution of tin, especially under acid conditions (tartaric), and any danger to health.

—S. G.

**\*The Influence of Small Additions of Iron, Cobalt, Nickel, &c., on the Resistance of Zinc to Sulphuric Acid.** H. Winter (*Metallwirtschaft*, 1937, 16, (22), 521-522).—Up to 0.2% of cadmium and lead has no deleterious effect on the stability of zinc in sulphuric acid. By the addition of lead or cadmium to a zinc of low stability, however, the attack can be diminished considerably. More than 0.01% iron, 0.0003% of nickel or cobalt, and more than 0.004% of tin or germanium have a very deleterious effect, but less than 0.01% iron may have a beneficial action in the less pure grades of zinc. The low resistance of "Nor" zinc to attack by sulphuric acid has been much improved in recent years by eliminating its small content of nickel and cobalt.—v. G.

**Galvanized Tank Corrosion on Automatic Water Heaters.** A. F. Craver (*Amer. Gas J.*, 1936, 5, (4), 29-32, 56; (5), 27-28; *Brit. Chem. Abs.*, 1936, [B], 720).—The causes and prevention of corrosion in galvanized steel water-storage tanks are discussed. Data are given showing the effect of employing various metals for tank fittings.—S. G.

**Attacks on Metal Structural Units by Domestic Sewage.** L. W. Haase (*Gesundheits-Ing.*, 1937, 60, 69-74; *C. Abs.*, 1937, 31, 4029).—Domestic sewage is always very low in dissolved oxygen, and for this reason a lime-rust-protective deposit does not form. The actions of the oxygen, carbon dioxide, hardness, chlorides, organic substances, nitrogen compounds (especially ammonia, which attacks copper), and sulphur compounds are considered. Changes in the composition of the sewage from the time it first enters the mains until it reaches the disposal plant are particularly noted. During this time the dissolved oxygen content rapidly decreases. The  $p_{\text{H}}$  is also decreased, partly because of the precipitation of carbonates, partly because of the increase in carbon dioxide content (from oxidation of organic matter), with a resulting shift in the lime-free carbon dioxide equilibrium. For these reasons, the fresher the sewage remains the less is the corrosion.—S. G.

**Corrosion Damage in Beet Sugar Factories.** H. Claassen (*Centr. Zuckcrind.*, 1936, 44, 1049-1050; *C. Abs.*, 1937, 31, 3319).—*Cf. Met. Abs.*, 1936, 3, 538. Corrosion due to acidity and sand occurs in the beet washers, beet elevators, cutters, diffusion battery, measuring tanks and auxiliary apparatus. The alkaline juices do not cause corrosion. In the sulphite tower corrosion also occurs. In the evaporator, corrosion occurs on the vapour side of the tubes because of the air, carbon dioxide, and ammonia contents of the vapours which attack the brass heating tubes. Electrolytic corrosion damage may also



result. Corrosion always occurs after the campaign in pipes, empty vessels, and steam chests that have not been properly drained and dried.—S. G.

\*A Study of Corrosion Inhibitors in Sugar Solutions. F. Baerts, P. Delvaux, and S. Lange (*Sucr. belge*, 1937, 56, 265-273, 287-297).—Tests were made with inorganic and organic compounds, and the results are reported.—S. G.

Corrosion in the Refrigerating Industry. Ulick R. Evans (*Proc. Brit. Assoc. Refrig.*, 1936-37, 33, (1), 45-51).—Principally a review.—S. G.

Internal Corrosion in the Refrigerating Circuit of Vapour Compression Refrigerating Plants. W. R. Sinclair (*Proc. Brit. Assoc. Refrig.*, 1936-37, 33, (1), 52-56; *C. Abs.*, 1937, 31, 3743).—It is almost impossible to eliminate water from new installations. It cannot form from anhydrous ammonia. If dehydrators are used, they are placed either in gas or liquid circuit. A mixture of water and sulphur dioxide produces a fluid which may be corrosive. Generally, all refrigerants based on the halogens break down and produce traces of acids in the presence of water. Hydrochloric acid is the usual product, and for this reason aluminium cannot be used with  $\text{CH}_2\text{Cl}$  systems.—S. G.

The Most Important Corrosion Problems With Which the [Refrigerating] Industry Has to Deal. A. E. McRae Smith (*Proc. Brit. Assoc. Refrig.*, 1936-7, 33, 72-77; *C. Abs.*, 1937, 31, 4944).—Problems of corrosion are classified by cause: (1) natural water and atmosphere; (2) brine; and (3) refrigerants. To minimize corrosion in each class, S. suggests the use of protective coatings of metals, paints, the production of resistant oxide films, the use of vitreous coatings, inhibitors, maintenance of optimal  $p_{\text{H}}$ , elimination of occluded oxygen in brine and water flowing over metal, and the use of materials suited to the conditions met in practice.—S. G.

Chemical Action of Water and Its Effect on Water Mains and Joint Packing Materials. W. Austen (*Gas- u. Wasserfach*, 1936, 79, 55; *J. Amer. Water Works Assoc.*, 1937, 29, 911).—Various corrosion theories are reviewed and the rôle of oxygen in forming coatings resistant to further corrosion, especially in presence of carbon dioxide and hardness, is stressed. Addition of oxygen may be necessary in some waters, to minimize corrosion. External corrosion of mains may be caused by dissolved substances in ground water; hydrogen sulphide causes corrosion of cast iron mains, with formation of ferrous sulphate and traces of sulphuric acid, leading to further corrosion. Lead has been found satisfactory for joints, and aluminium has now been suggested. Pure aluminium is corrosion-resistant, but its alloys are not.—S. G.

Radio Equipment and the Risk of Corrosion. J. S. (*Teleg. Praxis*, 1936, 18, (22), 339-341).—Aerials, leading-in wires, earth conductors, masts, and stays are liable to atmospheric or electrolytic corrosion. The article indicates the precautionary measures that can be taken in the choice of materials and in design and by using protective coverings.—R. T.

Rapid Corrosion Tests ("Mylius Number"). Federico Giolitti (*Metal Progress*, 1937, 31, (2), 175-176).—The resistance to chemical corrosion of aluminium alloys may be rapidly tested by the following methods, the first two of which are due to Mylius: (a) observations of the increase in temperature of a standard hydrochloric acid solution reacting on the alloy, the "Mylius number" being the average increase per minute between 20° C. and the maximum; (b) immersion of a standard test-piece in oxidizing salt solution, with observation of loss of weight; (c) measurement of the volume of gas evolved in known time by interaction of the material with standard hydrochloric acid. The necessary precautions are indicated.—P. R.

On the Corrosion of Metals. S. Kurosawa (*Chem. Technology (Japan)*, 1937, 21, (3), 14-17).—[In Japanese.]—S. G.

†The Corrosion Problem and the Engineer. F. Hudson (*Metallurgia*, 1937, 16, (92), 51-54; (93), 85-88).—The practical aspect of the wastage of metals

due to corrosion by sea and natural waters is outlined, and H. discusses the factors which affect the corrosion of metals, and which are intimately associated with either the properties of a metal or its service conditions, e.g. electrochemical action resulting from the presence of dissimilar metals, or of oxygen, and the rate of corrosion. Various types of corrosion are also considered, such as pitting and cavitation, and the prevention of corrosion, particularly in iron and steel structures by means of protective coatings, including paint and the spraying of metallic coatings of non-ferrous metals, are also dealt with.—J. W. D.

## V.—PROTECTION

(Continued from pp. 343-315.)

**Heat-Treating and Anodic Oxidation Equipment.** V. Korvin-Kronovosky (*Aero Digest*, 1936, (Jan.), 24).—The plant of the Edo Aircraft Corpn. was built specifically for the production of aluminium alloy seaplane floats and flying boat hulls. K.-K. describes the equipment used for heat-treating and anodic oxidation.—S. G.

**\*Variation in Thickness of the Tin Coating on Tinplate, and Its Effect on Porosity.** W. E. Hoare (*Iron Steel Inst. Advance Copy*, 1937, Sept., 22 pp.).—The general relation of tin coating thickness to porosity was studied. It was found that the number of pores per 100 sq. cm. decreases from 8000 to 300, as the coating thickness is increased from 1 to 3 lb. per basis box, and decreases more slowly from 300 to 2 as the coating thickness is further increased to 15 lb. per basis box. From a consideration of the shape of the tin-yield/porosity curve, it is shown that local variation of the coating thickness tends to produce over-sheet increases of porosity. "Bridging-over" of potential sites of normal pores has been established, and the implications are commented on. The theoretical findings of Chalmers with regard to the minimum pore size possible for any particular coating thickness have been confirmed. The three orders in which the coating thickness varies are detailed, and the corresponding porosity effects are discussed. A new technique has been evolved, which enables a quick estimation to be made of the presence and type of macroscopic irregularities of coating thickness, and comments are made on the modes of formation of such irregularities. Possibly the most important finding in this respect is that a periodic variation of coating thickness occurs across the direction of tinning (i.e. lines of convexity in the direction of tinning), this periodicity being coincident with that of the grease lines. These periodic variations have been termed "tin ridges," and their existence has been confirmed by the application of several methods. By receiving tin from other parts of the surface, these ridges cause the tin yield at the corresponding troughs to decrease to approximately 60% of the mean value. The effect of cleaning on porosity was examined.

—S. G.

**\*Estimation of the Thickness of Tin-Coatings on Steel by a Magnetic Method.** W. E. Hoare and Bruce Chalmers (*J. Sci. Instruments*, 1937, 14, (7), 248-249).—An instrument is described for the rapid estimation of the thickness of coatings of non-magnetic materials deposited on ferromagnetic bases, e.g. tin on steel. The instrument consists essentially of a lever with a weight at one end. At the other end is a magnet and a variable load which is adjusted until the magnet is just pulled away from the specimen. The instrument is calibrated by comparing the loads with thickness values obtained by chemical dissolution methods.—W. H.-R.

**\*Report of Sub-Committee VIII [of Committee A-5] on Field Tests of Metallic Coatings.** R. F. Passano (*Proc. Amer. Soc. Test. Mat.*, 1936, 36, (1), 107-113).—The report correlates the results of three series of exposure tests on



(a) galvanized sheet, (b) hardware or structural shapes protected by zinc or cadmium plating or by sherardizing, (c) samples electroplated with zinc, cadmium, or other metals. The progress of attack was measured by the percentage of exposed surface covered with rust, this method being in close agreement with the numerical rating scheme adopted by the Inspection Committee. The rate of attack is compared graphically with the weight of coating per unit area in each class of material: rusting proceeds most quickly over the surface of lightly coated specimens, indicating the greater uniformity of light than of heavy coatings. Uniformity is greater in laboratory-plated samples than in galvanized sheet. Coatings on hardware were less uniform than those on sheet, and electroplated zinc specimens appeared rather more resistant than galvanized samples in the early stages only. Cadmium coatings were less resistant than those of zinc.—P. M. C. R.

**Proposed Tentative Specifications for Zinc-Coated (Galvanized) Iron or Steel Farm-Field and Railroad Right-of-Way Wire Fencing.** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 41-43).—Appendix to Report of Committee A-5 on Corrosion of Iron and Steel. Cover 3 classes of zinc-coated iron or steel wire fencing (galvanized before fabrication), Classes 1, 2, and 3, as designated by the weight of coating in oz. of zinc per sq. ft. of bare wire surface.—S. G.

**Proposed Tentative Specifications for Zinc-Coated (Galvanized) Iron or Steel Barbed Wire.** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 44-46).—Appendix to Report of Committee A-5 on Corrosion of Iron and Steel. Cover 3 classes of zinc-coated iron or steel barbed wire (galvanized before fabrication), Classes 1, 2, and 3, as designated by the weight of coating in oz. of zinc per sq. ft. of bare wire surface.—S. G.

**\*Metallic Cementation. XII.—Cementation of Vanadium on Some Metals [Iron and Nickel].** Tsutomu Kase (*Kinzoku no Kenkyu (J. Study Metals)*, 1937, 14, (4), 120-129).—[In Japanese.] Using powdered ferro-vanadium (80-97% vanadium, 0-02% carbon, rest iron), the cementation of vanadium on iron and nickel was studied at various temperatures between 850° and 1300° C. for 1 to 5 hrs. Measurements of depth of penetration, microscopic examination, chemical analyses, and corrosion tests with some acids were carried out on the surface layers of the cemented specimens. Vanadium diffuses into iron and nickel at < 900° C., and the rate of diffusion increases with increase in temperature. The relation between the increase in weight of the specimen ( $\Delta W$ ), or the depth of penetration ( $P$ ), and the absolute temperature of cementation ( $T$ ), or the time ( $\theta$ ) required for the treatment, is given by an exponential function  $\Delta W = ae^{-b/T}$ , or  $\Delta W = ae^{b\theta}$ , where  $a$  and  $b$  are different constants in each case. The cemented surfaces are somewhat harder than the original materials. Although iron cemented with vanadium has a sturdy resistance to corrosion by nitric acid, owing to its passivity, there is little advantage in other cases as regards corrosion-resistance.—S. G.

**\*Metallic Cementation. XIII.—Cementation of Tantalum on Some Metals [Iron and Nickel].** Tsutomu Kase (*Kinzoku no Kenkyu (J. Study Metals)*, 1937, 14, (4), 130-137).—[In Japanese.] Using powdered ferro-tantalum (84-24% tantalum, 0-11% carbon, rest iron), the cementation of iron and nickel by tantalum was studied between 800° and 1300° C. for iron, and between 800° and 1100° C. for nickel, for 1 to 5 hrs. Measurements were made of the depth of penetration, and microscopic and chemical analyses, as well as corrosion tests with some acids, were carried out on the cemented specimens. Tantalum diffuses into iron and nickel at < 800° C., and the rate of diffusion increases with increase in temperature. The relation between increase in weight of the specimen ( $\Delta W$ ), or depth of penetration ( $P$ ), and the absolute temperature of cementation ( $T$ ), or the time ( $\theta$ ) required for the treatment is given by an exponential function  $\Delta W = ae^{-b/T}$ , or  $\Delta W = ae^{b\theta}$ ,

where  $a$  and  $b$  are different constants in each case. The cemented surfaces of iron are harder than the original material, but those of nickel are only slightly harder. Although surfaces cemented with tantalum resist dilute hydrochloric and sulphuric acids, there is little advantage with regard to corrosion-resistance.—S. G.

†**Porosity in Spraying Coatings and its Measurement.** E. C. Rollason (*Metallurgia*, 1937, 16, (94), 125-128).—The formation of coatings is briefly described, and a number of methods for measuring the porosity of coatings are discussed. Results are given showing the interconnected porosity of various metals and alloys as determined by Rollason; the comparative porosity for different wire pistols using coal-gas, acetylene, or nitrogen as determined by Ballard and Harris, and the conditions for producing sound castings and the effect of treatments such as heating, grinding, and polishing on the soundness of the coating of various metals and alloys as determined by Everts. Chemical tests for indicating the porosity of metallic coatings, and the vacuum method of estimating porosity are also considered, as well as methods for reducing porosity by mechanical treatment, chemical treatment, and painting.

—J. W. D.

**Improved Coatings for Duralumin.** Herbert Chase (*Aero Digest*, 1936, (May), 40).—A report of paint vehicles developed after prolonged research at the Massachusetts Institute of Technology. The vehicle is described as a "combination of pure vegetable gums and heat-treated oils made in a unique manner." The vehicle does not contain linseed oil, turpentine, or synthetic resin, and is said to produce a non-porous film which is not only water-tight, but impervious to atmospheric gases. Test-specimens are stated to have withstood a salt-spray test of 4700 hrs.' duration without appreciable deterioration.—S. G.

\***Painting Galvanized Iron.** L. P. Hart and C. R. Cornthwaite (*Nat. Paint, Varnish Lacquer Assoc., Sci. Sect., Circ.*, 1937, (527), 58-67; *C. Abs.*, 1937, 31, (3305)).—Galvanized iron panels with various types of pre-treatment and priming coats were subjected to exposure at wide ranges of temperature, and to sudden shock, and then rated for the amount of adhering paint. Pre-treatment with solutions which etched the metal was successful, although several proprietary solutions were better than copper sulphate. Soft primers containing bodied and treated oils gave better adhesion than those containing hard films of the resin or varnish type.—S. G.

**Chlorinated Rubber as a Protective Coating for Light Metals.** R. Strauss (*Metallwirtschaft*, 1937, 16, (18), 422-423).—Lacquers with a chlorinated rubber base, instead of an oil base, have a higher resistance to corrosion, are non-inflammable, and are unaffected by petrol and oil. They must be applied either above another special lacquer or on an M.B.V. or Elloxal oxide film.—v. G.

## VI.—ELECTRODEPOSITION

(Continued from pp. 345-346.)

†**The Cyanide Cadmium Plating Solution.** Gustaf Soderberg (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 12 pp.).—See *Met. Abs.*, this vol., p. 152.—S. G.

**Air Agitation in Chromium Plating.** J. Nugen (*Met. Ind. (Lond.)*, 1937, 50, (22), 612).—S. G.

\***A Method of Obtaining Adherent Electrodeposits on Chromium and Stainless Steel.** G. E. Gardam (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 154.—S. G.



**Developing Applications of Thick Electrodeposited Coatings of Chromium and Nickel.** M. Gillet (*Pratique Indust. mécaniques*, 1937, 20, (3), 103-104).—A short review is given of the applications of chromium or nickel plating in the facing of tools and rolls, and in the paper, printing, gun-making, briquetting, textile, and motor industries.—P. M. C. R.

**Pyrene Pioneers Profitable [Chromium] Plating Practice.** Edwin Smith (*Products Finishing*, 1937, 1, (9), 7-12; *C. Abs.*, 1937, 31, 4905).—A description of the chromium plating of small tools, moulds and dies.—S. G.

**\*The Etching of Copper by Ferric Chloride Solutions.** B. Barrs and L. S. Ornstein (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 152.—S. G.

**Modern Developments in the Electrodeposition of Gold.** H. W. J. Pope, (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 4 pp.).—See *Met. Abs.*, this vol., p. 152.—S. G.

**French Nickel Plating Practice.** M. Ballay (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 11 pp.; also (condensed) *Met. Ind. (Lond.)*, 1937, 50, (10), 310-312; *Met. Ind. (N.Y.)*, 1937, 35, (5), 216-218).—Developments during the past 10 years and the present position of nickel plating in France are reviewed. Some account is given of methods currently used for the preparation of the basis metal, and the salient features of French nickel plating technique are summarized by means of a description of equipment and working conditions employed for slow, semi-rapid, and rapid plating. Bright nickel plating is discussed, with special reference to a process which has been in use in France for some years, and to a new process employing egg albumen as brightening agent. Particulars are given of specifications, drawn up in 1933 by the French railways, for controlling the quality of nickel and chromium coatings.—S. G.

**\*The Adhesion of Electrodeposited Nickel to Nickel.** A. W. Hothersall (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 152.—S. G.

**†Electrodeposition of Platinum. Historical and General Review.** R. H. Atkinson (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 14 pp.).—See *Met. Abs.*, this vol., p. 153.—S. G.

**\*Platinum Plating from Alkaline Solutions.** E. C. Davies and A. R. Powell (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 7 pp.).—See *Met. Abs.*, this vol., p. 153.—S. G.

**Developments in the Electrodeposition of the Platinum Metals.** K. Schumpelt (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 6 pp.).—See *Met. Abs.*, this vol., p. 153.—S. G.

**A Résumé of Silver Plating.** Frank C. Mesle (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 249.—S. G.

**Non-Tarnishing Silver Plate Made by Alloying.** C. C. Downie (*Metal Progress*, 1937, 31, (3), 292, 294).—The liability of silver-plated goods to tarnish may be eliminated by the use of electrolytes containing elements of the platinum group, usually rhodium.—P. R.

**Analysis and Control of Silver Plating Solutions.** (Egeberg and Promisel.) See p. 403.

**The Use of Tin in Refrigerating Equipment.** E. J. Daniels and D. J. Macnaughtan (*Proc. Brit. Assoc. Refrig.*, 1936-37, 33, (1), 78-86; *C. Abs.*, 1937, 31, 4212).—A review of methods of tin-plating on copper, and its application to refrigeration installations, with 29 references.—S. G.

**Zinc and Cadmium Plating in the U.S.S.R.** N. A. Isgarischev (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 6 pp.; also (summary) *Met. Ind. (N.Y.)*, 1937, 35, (5), 218).—See *Met. Abs.*, this vol., p. 153.—S. G.

**Electroplating on Zinc-Base Die-Castings.** K. Altmannsberger (*Metallwirtschaft*, 1937, 16, (22), 525-527).—Recommended methods are given for nickel- and chromium-plating zinc-base die-castings.—v. G.

**Comments on the Electrolysis of Solutions of Complex Salts.** A. Glazunov and M. Schlötter (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 154.—S. G.

**Control of Throwing Power in Electrolytic Baths.** Albert Portevin (*Metal Progress*, 1937, 31, (2), 172-173).—The minimum thickness of electrodeposited coatings depends on the throwing power of the solution. The influence of several factors on throwing power has been studied by means of a standard test-piece consisting of coaxial helices presenting a known surface. The dangers of high temperatures, considerable current densities, and excessively rapid deposition are emphasized.—P. R.

†**Inclusions in Electrodeposits, Their Origin and Their Effect on the Structure and Mechanical Properties.** Michel Cymboliste (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 14 pp.).—See *Met. Abs.*, this vol., p. 198.—S. G.

**Measuring the Thickness of Electrodeposits.** — (*Metallurgia*, 1937, 16, (93), 97-98).—Several methods which have been devised for measuring the thickness of electrodeposits are briefly discussed, and special attention is given to the B.N.F. jet test, which is fully described. Results are given for nickel coatings on steel, copper, brass, aluminium, and a zinc-base die-casting.—J. W. D.

\***Studies in Evaluating the Brightness of Electrodeposits.** B. Egeberg and N. E. Promisel (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 11 pp.).—See *Met. Abs.*, this vol., p. 250.—S. G.

**Pickling of the Basis Metal Before Electroplating.** V. P. Sacchi (*Industria meccanica*, 1936, 18, 757-762; 1937, 19, 17-21, 94-101; *C. Abs.*, 1937, 31, 4213).—The physicochemical phenomena involved in electrodeposition are discussed. Pickling the surface of a metal is not primarily for the purpose of forming cavities in order to obtain firm adhesion of the deposit; pickling removes the amorphous skin present on the surface. The structural characteristics of the transition zone are described. 33 references are given.—S. G.

**Modern Electroplating Machinery.** John Kronsbein (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 155.—S. G.

**Tanks for the Plating Room.** Nathaniel Hall (*Products Finishing*, 1937, 1, (7), 5-10).—A review.—S. G.

†**British Electroplating Practice.** E. J. Dobbs (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 6 pp.; also *Aluminium and Non-Ferrous Rev.*, 1937, 2, (7), 255-257; and (condensed) *Met. Ind. (N.Y.)*, 1937, 35, (5), 212-213).—See *Met. Abs.*, this vol., p. 154.—S. G.

**German Electroplating Practice.** Richard Springer (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.; also (condensed) *Met. Ind. (N.Y.)*, 1937, 35, (5), 214-215).—See *Met. Abs.*, this vol., p. 199.—S. G.

†**American Practice in Electroplating.** George B. Hogaboom (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 9 pp.; also (condensed) *Met. Ind. (N.Y.)*, 1937, 35, (5), 219-220).—See *Met. Abs.*, this vol., p. 154.—S. G.

**Protection of the Health of Workers During the Surface Treatment of Metals [Electrodeposition].** J. Klotz (*Maschinenbau*, 1936, 15, 139-143).—Cf. *Met. Abs.*, 1936, 3, 323. K. describes the protective methods adopted at a plant for the electrodeposition on base metals.—S. G.



## VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from p. 347.)

\*On the Structure and Properties of Insulating Layers Formed on Aluminium Electrodes During Anodic Polarization. I. Zlotowski (*Bull. Internat. Acad. Polonaise Sci. Lettres*, 1936, (3-4 A), 164-194.—[In French.] Apparatus for studying the anodic polarization of aluminium in aqueous solutions under conditions of constant current density is described. It is found that the insulating layer formed by anodic polarization on aluminium in an aqueous solution of oxalic acid consists of two parts: (1) an extremely thin layer of dielectric solid, practically non-porous, and contiguous to the electrode surface, and (2) a relatively thick, very porous layer impregnated with electrolyte laid upon (1). The former layer determines practically entirely the ohmic resistance and electrostatic capacity of the electrode. The thickness of the "active" dielectric layer is of the order  $10^{-7}$ - $10^{-6}$  cm. with a resistivity of the order  $10^{10}$ - $10^{11}$  ohm cm. The results accord with recent X-ray determinations of the structures of the deposits.—J. S. G. T.

Electrical Properties of Anodically-Oxidized Aluminium. J. W. Holst (*Tids. Kjem. Bergvesen*, 1936, 16, 73-76; *C. Abs.*, 1937, 31, 4175).—The dry layer of alumina has low electrical conductivity, only slightly unidirectional, probably owing to the presence of  $\text{Al}(\text{OH})_3$ . The rectifying properties of the oxidized aluminium electrode cannot be due to a pure electron flow through the oxide layer.—S. G.

\*Electrolytic Production of Beryllium-Copper Alloys. Colin G. Fink and Tsing-Nang Shen (*Electrochem. Soc. Preprint*, 1937, (Oct.), 69-76). On investigating the electrolytic production of beryllium-copper alloys by discharging beryllium into molten copper serving as cathode in a fused beryllium oxyfluoride bath, it was found that the efficiency of the cell increased as the quantity of beryllium carbide formed was reduced. The conductivity of the electrolyte composed of equal parts of beryllium oxyfluoride and barium fluoride is markedly improved by the addition of sodium fluoride. Of the various baths tried, the one consisting of 50 parts by weight of beryllium oxyfluoride, 34 parts of sodium fluoride, and 16 parts of barium fluoride gave the best results. The current efficiency, on the basis of beryllium metal deposited, was 48.7% and the yield was 0.863 gm. of beryllium per kw.-hr. Alloys containing over 3% beryllium were thus produced.—S. G.

\*Notes on the Electrographic Effect. Elizabeth Schickele and Percy H. Carr (*J. Applied Physics*, 1937, 8, (8), 558-560).—A portion of a metal surface was protected by means of a stencil during exposure in air to 100 kilovolt cathode rays. An attempt was then made to "develop" an image of the stencil on the metal surface by the action of some chemical or other reagent. Results confirm previous reports that water vapour is helpful, if not essential, to satisfactory development. On silver, copper, tin, zinc, lead, brass, and bismuth, the inorganic materials studied for developing properties were superior to the organic materials tried. The image was not developed directly by electroplating by any method yet tried on any material except carbon. Attempts to produce an image in relief by first developing it in the ordinary way and then electroplating the specimen failed, except when anthraquinone was used as developer. Results by this method were, however, uncertain. Cadmium vapour as a developer produces images of low relief.—S. G.

Industrial  $p_{11}$  Control with the Antimony Electrode. W. N. Greer (*Electrochem. Soc. Preprint*, 1937, (Oct.), 77-88).—The history of industrial types of electrodes is briefly outlined, after which the construction of the antimony electrode assembly is discussed. Factors which affect automatic control in

industrial processes are reviewed. Some specific (not metallurgical) applications of automatic control with the antimony electrode are described.—S. G.

**\*Change of Electrode Polarization with Time. I.—Over-Polarization Due to Copper Deposition on a Copper Cathode.** O. Essin, L. Antropov, and A. Levin (*Acta Physicochimica U.R.S.S.*, 1937, 6, (3), 447-454).—[In German.] The occurrence of an abnormally high initial polarization is experimentally established for copper deposition on a copper cathode, in the case where no new phase is produced; the phenomenon occurs at all copper-concentrations. Associated phenomena, e.g. the maximum and stable polarizations, are dependent on the ratio of the  $\text{Cu}^+$  and  $\text{Cu}^{2+}$  concentrations. Over-polarization increases with increase of current density and decreases with increase of  $\text{Cu}^{2+}$  concentration and with increase of temperature.—J. T.

**\*Hydrogen Over-Voltage at Mercury (Electrodes) and the  $\zeta$ -Potential.—I.** S. Lewina and W. Sarinsky (*Acta Physicochimica U.R.S.S.*, 1937, 6, (4), 491-504).—[In German.] A method is described for determining hydrogen over-voltage ( $V$ ) at a stationary mercury electrode, and values of  $V$  are given, in the form of curves, for 0.001*N*, 0.01*N*, and 0.1*N* solutions of hydrochloric acid with current densities of  $10^{-1}$ - $10^{-3}$  amp./cm.<sup>2</sup>. The effect of impurities in the cathode surface is investigated.—J. S. G. T.

**\*The Over-Voltage of Hydrogen at Large Current Densities.** B. Kabanow (*Acta Physicochimica U.R.S.S.*, 1936, 5, (2), 193-200).—[In German.] Hydrogen over-voltages at platinum, silver, and silver amalgam electrodes in 5*N* hydrochloric and sulphuric acids at current densities up to 100 amp./cm.<sup>2</sup> are determined. The over-voltage ( $V$ ) is found to be related linearly to the logarithm of the current density for values of  $V$  as high as 1.5 v.—J. S. G. T.

**The Platinum Electrode. III.—Adsorbed Atoms and Ions on the Surface of a Platinum Electrode.** A. Frumkin and A. Slygin (*Acta Physicochimica U.R.S.S.*, 1936, 5, (6), 819-840).—[In English.] Experimental results relating to the adsorption of gases by a platinum electrode, contained in previous papers (*Met. Abs.*, 1936, 3, 557; and *Acta Physicochimica U.R.S.S.*, 1936, 4, 911), are discussed theoretically and a mechanism of the phenomenon is suggested.—J. S. G. T.

**\*The Capacity of a Bright Platinum Electrode in Various Electrolytes, and its Dependence on the Treatment of the Electrode.** B. Ershler and M. Proskurnin (*Acta Physicochimica U.R.S.S.*, 1937, 6, (2), 195-204).—[In English.] The electrical capacity of a bright platinum electrode depends largely on the purity of the electrolyte and on the previous treatment of the electrode. Heating in hydrogen produces an electrode with a small capacity for hydrogen. The difference between a bright and platinized platinum electrode is very pronounced in the oxygen region.—J. S. G. T.

**\*Application of Aluminium Amalgam Electrode to the Determination of the Activity of Aluminium Ions in Aqueous Solutions.** Z. Berestneva and V. Kargin (*Acta Physicochimica U.R.S.S.*, 1937, 6, (3), 320-326).—[In English.] A new form of aluminium amalgam electrode containing not more than  $6 \times 10^{-3}$  % by weight of aluminium is used to determine the potential ( $V$ ) of aluminium amalgams in aqueous solutions correct to  $\pm 1$  mv. Values of  $V$  for aqueous solutions of pure aluminium trichloride of concentrations 1*N* to 0.001*N* are tabulated.—J. S. G. T.

## IX.—ANALYSIS

(Continued from pp. 347-349.)

**A New X-Ray Method for Chemical Analysis of Plane Polished Surfaces.** L. von Hámos (*Teknisk Tidskrift*, 1937, 67, Uppl. A-C: *Bergsvetenskap.*, 1-4).—[In Swedish, with English summary.] A new spectrograph is described,



having a curved crystal for collecting rays. Instead of the usual X-ray lines, a series of monochromatic X-ray images is obtained, showing the distribution of chemical elements on the surface. Diagrams, based on calculations by v. H., show the positions on the film occupied by spectral images belonging to different elements. Typical spectrograms of metals and ores are included.—S. G.

**The Quantitative Spectrographic Analysis of Lead, Tin, and Cobalt.** R. Breckpot (*Ann. Soc. Sci. Bruxelles*, 1937, [i], 57, (2), 129-140).—The technique of the arc between metallic electrodes, and powdered oxide on graphite electrodes, is discussed for these elements. The analysis is rendered quantitative by the use of a stepped logarithmic sector (see *ibid.*, 1935, 55, 30; and 1936, 56, 385). For Pb the arc between metallic electrodes is best; tables are given for Tl from 0.0001 to 1 and Bi 0.0001 to 1%. Special attention was given to Bi in Pb; chemical analyses were made by two methods as well as syntheses. Arcing Pb oxide on graphite electrodes is also applicable. For Sn the arc between metallic electrodes is best. Tables are given for Sb from 0.003 to 1% and Cd 0.001 to 1%, and also for tin oxide on graphite electrodes for Pb 0.003 to 1%. For Co the powdered oxide on graphite is recommended, as the metal is not usually homogeneous and not easily cast. A table is given for the determination of Fe, Ni, Mg, Mn, Al, Si, Ca, between 0.01 and 1%, and for Zn between 0.1 and 1%. Cu, Pb, Ag were also detected in concentrations down to 0.001%.—E. H. v. S.

**Quantitative Spectrographic Analysis of Magnesium Alloys for Manganese and Silicon.** J. S. Owens and T. M. Hess (*Met. Ind. (Lond.)*, 1936, 48, (2), 38-40).—Paper contributed to a symposium on Spectrographic Analysis held by the American Society for Testing Materials. The method adopted utilizes the Gaertner densitometer, and more recently the Hilger non-recording microphotometer for the measurement of line densities. The conditions of spark production are fully standardized. The method of relating the logarithms of the intensities of the selected lines to the percentage of the element under test is described, and a tabulated comparison shows the order of agreement between the results of chemical and spectrographic analyses.

—P. M. C. R.

**\*Studies of Quantitative Spectral Analysis. The Spectrographic Analysis of Zinc.** R. Breckpot and W. Körber (*Ann. Soc. sci. Bruxelles*, 1936, [B], 56, 384-403).—This paper is one of a series. In a previous one (*Met. Abs.*, 1935, 2, 706) it has been shown that some of the impurities in zinc can be estimated spectrographically by chemical precipitation of the element with Cu, and examination of the Cu as oxide in the arc on graphite electrodes. This paper describes the spectrographic analysis of zinc oxide for Ag, As, Bi, Cd, Cu, Fe, Ge, In, Mg, Ni, Pb, Sb, Sn, and Tl. The metallic oxide is placed on the anode of two graphite electrodes and an arc of 1 amp. used. The spectrum is recorded in a spectrograph of medium dispersion, and a logarithmically-stepped rotating sector is used to evaluate the relative intensity of the impurity lines and Zn lines. Lines of other elements which may interfere with the analysis are separately tabulated. The presence of other elements in normal quantities causes no interference; Pb has been specially tested and up to 1% of Pb in spelter may be ignored. A table shows the effect of additions of Pb up to 25% on the relative intensity of Sn lines in the estimation of Sn in zinc oxide. Tables are given for the estimation of Bi, Cd, Cu, Ge, In, Mg, Ni, Pb, Sn, Tl in concentration of 0.001 to 1%; for Ag from 0.0001 to 1%, for As 0.03 to 1%, for Fe 0.003 to 1%, and for Sb 0.01 to 1%.—E. H. v. S.

**Analysis and Control of Silver Plating Solutions.** B. Egeberg and N. E. Promisel (*Products Finishing*, 1937, 1, (7), 12-16; *C. Abs.*, 1937, 31, 3794).—For correct control of Ag plating solutions, analysis of the Ag and free cyanide should be made at frequent intervals, and often less frequently, of carbonate.

In addition, periodical analyses of sulphate, chloride, Fe, Cu, Ni, and Zn are desirable. The determination of  $\text{NH}_3$  and caustic may also be desirable, especially if they have been added deliberately, but the necessity for this is very rare. Strike solutions are analyzed like plating solutions; with strikes, however, usually only the Ag and free cyanide contents are important. The usual simple and rapid analytical control methods are described.—S. G.

**Sensitive Test for Cadmium.** J. A. B. Forster (*J. Austral. Chem. Inst.*, 1937, 4, 84–87; *Austral. Sci. Abs.*, 1937, 16, 25).—The micro-analysis of Cd in electrolytic Zn solutions is best made with  $\beta$ -naphthoquinoline in presence of KI and  $\text{H}_2\text{SO}_4$ . Sensitivity is 0.5 mg./litre. F. makes a plea for more uniform practice in the statement of sensitivities and concentrations.—S. G.

**Determination of Chloride in Metallic Magnesium.** K. M. Popov and E. A. Alferova (*Kalii (U.S.S.R.)*, 1936, (6), 45–47; *C. Abs.*, 1937, 31, 4922).—[In Russian.] A nephelometric method is used when the Cl is present in amounts < 0.01%. Using a 5 gm. sample, dissolve in 125 c.c. of 10%  $\text{H}_2\text{SO}_4$ , filter, and determine Cl nephelometrically in the filtrate by adding  $\text{AgNO}_3$  solution (6 gm. per litre). If the amount of Cl is > 0.01%, weigh a 5 gm. sample, dissolve in 125 c.c. dilute  $\text{HNO}_3$ , filter, add to the wash solution a few drops of 0.1N  $\text{AgNO}_3$ , filter off  $\text{AgCl}$ , wash, dissolve in  $\text{NH}_4\text{OH}$ , wash, add KCN solution (5 gm. per litre) and electrolyze (6 v. for 2 hrs.).—S. G.

**A New Method for the Colorimetric Estimation of Cobalt.** G. Spacu and C. Ch. Macarovicu (*Bul. Soc. Ştiinţe Cluj*, 1935, 8, (2), 245–256; *Chim. et Ind.*, 1937, 37, (4), 653).—Into two beakers pour respectively equal quantities (10 to 15 c.c.) of the solution under examination and of a standard solution. To each add 0.5 cm.<sup>3</sup> of a 1% alcoholic solution of dimethylglyoxime. Agitate the solution and then add 0.2 cm.<sup>3</sup> of 1% alcoholic solution of benzidine or tolidine. Allow to stand for 5 minutes and then compare. The colour obtained with tolidine is deeper than that with benzidine. The sensitivity is said to be about 1 : 4,000,000.—W. A. C. N.

**Determination of Nitrogen in Metallic Magnesium.** K. M. Popov and E. A. Alferova (*Kalii (U.S.S.R.)*, 1936, (6), 43–45; *C. Abs.*, 1937, 31, 4922).—[In Russian.] The N present in Mg as  $\text{Mg}_3\text{N}_2$  was determined by dissolving Mg in HCl or  $\text{H}_2\text{SO}_4$ , adding an excess of NaOH, distilling off  $\text{NH}_3$  and absorbing it with 0.1N HCl and either back titrating with 0.1N NaOH or comparing with Nessler standards.—S. G.

**Micro-Determination of Zinc by Means of 8-Hydroxyquinoline.** C. Cimerman, D. Frank, and P. Wenger (*Compt. rend. Soc. phys. hist. nat. Genève*, 1936, 53, 57–59 (in *Arch. sci. phys. nat.*, 1936, 18, Mar.–Apr.); *C. Abs.*, 1937, 31, 3816).—Treat the neutral solution containing 1–3 mg.  $\text{Zn}^{++}$  with 1 drop of Merck's Universal Indicator, 2 drops of 10%  $\text{AcOH}$ , and 6–7 drops of 40% NaOAc to yield a  $p_{\text{H}}$  of 5–6. Heat to the boiling point, and add an excess (0.1 to 1 c.c.) of freshly-prepared EtOH solution of 8-hydroxyquinoline. Stir, boil for 1–2 minutes and filter through porcelain. Wash the precipitate 8 times with  $\text{H}_2\text{O}$  (1–2 c.c.) and dry at 155°–158° C.—S. G.

## X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from p. 350.)

**The Application of Modern Microscopes in Metallurgy.** A. Salmony (*Metalurgia*, 1937, 16, (94), 115–117).—Developments in the design and applications of the microscope, which have resulted in more compact instruments, in increasing refinement, in integrating devices, and in instruments for the surface investigation of materials are discussed, and some of the more modern



instruments are described. Consideration is also given to advances in the technique of microscopy in relation to metallurgical research and in routine applications.—J. W. D.

**A Simple Method for the Determination of the Thermal Conductivity of Metals.** Fritz Gabler (*Physikal. Z.*, 1937, 38, (3), 78–82).—Apparatus is described, comprising means for heating a rod of metal which radiates heat radially, for the determination of the thermal conductivity ( $K$ ) of metals. Values of  $K$  for copper and nickel containing a little copper were found to be at about atmospheric temperature: copper,  $K = 0.915 \pm 0.007$ , and nickel alloy,  $K = 0.157 \pm 0.002$  cal. cm.<sup>1</sup> sec.<sup>-1</sup> °C.<sup>-1</sup>.—J. S. G. T.

**A New Electron Microscope.** L. C. Martin, R. V. Whelpton, and D. H. Parnum (*J. Sci. Instruments*, 1937, 14, (1), 14–24).—S. G.

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

(Continued from pp. 351–354.)

**\*Calibration of Testing Machines Under Dynamic Loading.** Bruce Wilson and Carl Johnson (*J. Research Nat. Bur. Stand.*, 1937, 19, (1), 41–57; *Research Paper No. 1009*).—The errors of the indicated loads of testing machines used to determine the mechanical properties of engineering materials are usually determined for static loads. Testing machines are often used to load specimens continuously to failure at a given rate of loading. The additional errors, due to rate of loading, of 6 testing machines comprising 4 types widely used in the U.S.A., were determined by means of a special elastic calibrating device for rates of loading up to 50,000 lb./minute. The additional errors in the indicated loads of these machines, due to rate of loading, at rates currently used in testing, exceeded in several cases the tolerances specified for such testing machines. These errors, therefore, cannot in general be neglected when determining the rates of loading to be used in testing materials. The results of these tests, although they cannot be used to correct the indicated loads of other testing machines of the same types, because of small inherent differences in the weighing systems and slight differences of adjustment, are useful in that they indicate the magnitude of the errors to be expected.—S. G.

**Methods for the Determination of Surface Quality.** G. Depiereux (*Tech. Zentr. prakt. Metallbearbeitung*, 1937, 47, (5/6), 201–206, 286–293).—Descriptions and illustrations are given of various methods and instruments for the evaluation and comparison of surface properties. The methods include those which depend on the following principles: visual comparison with standard surfaces, microscopic examination, counting of surface defects, use of dual microscopes for direct comparisons, stereoscopic observation, determination of reflective power, intensity and diffusion of reflected light, sorting by means of a selenium cell, effect on a passing air stream, friction variations which affect a swinging pendulum, determination of the volume of irregularities. A good *bibliography* is included.—W. A. C. N.

**\*The Destruction of Metallic Materials by Water Hammer. Investigations Employing a Drop-Impact Device.** M. v. Schwarz and W. Mantel (*Z.V.d.I.*, 1936, 80, (28), 863–867).—Apparatus for the investigation of the resistance of metals and alloys to cavitation is described, and its applications are illustrated by results obtained with steel, cast-iron, various brasses and bronzes, and other alloys. It is concluded that for cavitation to occur, very high pressures, of the order 30,000 atm., must occur at certain points. These pressure blows need be of small energy content and of short duration. Materials of small energy of elastic deformation are readily destroyed provided that they are not capable of plastic deformation. Otherwise such a degree of cold-hardening is produced that the surface fractures only after the limit of deformability

of the material is exceeded. In the case of materials of large energy of elastic deformation, destruction generally occurs mostly at flaws in the material. Copper alloys possessing extremely high resistance to cavitation are available. Two such are an iron-bronze and cast Rbel bronze.—J. T.

**Damage Caused to Metal by Water-Impact.** M. von Schwarz and W. Mantel (*Schweiz. Bauzeit.*, 1937, 109, 225-227; *Eng. Abs.*, 1937, (75), 47).—The authors have continued their experiments (cf. preceding abstract), and give micrographs and corrosion curves for cast iron, steel, and bronze surfaces, subjected to water-impact, and state that the impact sets up surface deformation similar to that of cold-working of the metal. They suggest that a surface-hardness coeff. of the form  $H = a \frac{4}{\pi}$  can be determined, where  $a$  is the load producing an impression of 1 mm. diam. with a ball of 10 mm. diam. Water-impacts exceeding this value set up deterioration by penetrating the pores of the metal and the crystal boundaries.—S. G.

**The Relative Wear of Some Hard Metals.** Robert B. Freeman (*Metal Progress*, 1937, 31, (3), 281-284).—A wear-testing machine is described and illustrated. The specimens are held within a cast-iron housing in contact with rings keyed to a rotating horizontal shaft. Speed and load are controllable. Wear is determined by the loss of weight of the specimen, the worn surface of which is also examined microscopically. Typical structures are illustrated.—P. R.

**\*Equipment for Routine Creep Tests on Zinc and Zinc-Base Alloys, and an Example of Its Application.** J. Ruzicka (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 252-267; discussion, 267-270).—See *Met. Abs.*, this vol., p. 297.—S. G.

**\*Mechanical Amplifier With a Magnification of More Than 1000. Application to the Registration of the Viscous Deformation of Metals at High Temperatures.** Pierre Chevenard and Eugne Journer (*Compt. rend.*, 1937, 205, (2), 107-109).—The objection to various forms of amplifiers for use with very small alterations of length over long periods of time are pointed out. The method of amplification here described consists of two levers, the second being operated by an electric servo-motor actuated by the first lever. The electrical contact is made or broken by an extremely small displacement at the end of the first lever, and the second lever is fitted with a disc which turns on its axis by the action of the servo-motor. The friction of the pen on the paper is obviated, the pen being carried by a movable guide block on a rectangular slide bar. An example is given of the use of this apparatus for measuring the viscous deformation of a soft steel, the elongation being amplified 1300 times.—J. H. W.

**\*The Plastic Flow of Metals.** E. B. Norris (*Virginia Polytechnic Inst., Eng. Exper. Sta. Bull.*, 1937, (27), 28 pp.; *Eng. Abs.*, 1937, (73), 18).—N. discusses the construction of normal stress-strain diagrams, in which the ratio of the load to the original cross-section is used, and emphasizes the necessity for stipulating the gauge-length in elongation tests. He states that in such tests the axial elongation is made up of a general elongation and a local stretch in the region of necking, and suggests that it would be more logical to relate the stress to the displacement of metal at the point of necking. N. has therefore computed the true stress as the ratio of the load to the cross-sectional area at the time the load is acting, and the true elongation as the elongation that would occur if the cross-section at the neck were uniform throughout the gauge-length. He describes tensile tests made on a number of non-ferrous alloys and steels and, by plotting the true stress against the true elongation, establishes the relation  $S = K\varepsilon^m$ , where  $S$  is the true stress and  $\varepsilon$  the true elongation,  $m$  and  $K$  being constants. N. found that heat-treatment, by producing internal stresses (*sic*), causes a break in the curve, where, presumably,



all internal stresses have been overcome, and beyond which all the material is undergoing plastic deformation. Cold-working in tension produces, in specimens cut after cold-working, the appearance of a curved line, which disappears when the line is transposed to terms of the original material before cold-working. The physical properties of the material cold-worked in tension may be predicted from the diagram of a tensile test of the material before it has been cold-worked.—S. G.

**Workability of Metals.** Albert Portevin (*Metal Progress*, 1937, 31, (5), 531-532).—The notched-bar bend test is recommended as a test of workability (capacity for hot-deformation). The test should normally be carried out without removing the test-piece from the furnace, and at two deformation rates at least. The influence of temperature at a given rate, and that of deformation rate at a given temperature, must both be known; the incidence of these factors in different materials is briefly noted.—P. R.

\***Study of a Method of Pressing by Fluid Under Pressure**, by Ch. Jovignot. Paul Bastien (*Rev. Mét.*, 1937, 34, (5), 339-346; and (translation) *Sheet Metal Ind.*, 1937, 11, 730-732, 744; 817-818).—An account of J's method of making cupping tests of sheet metals under fluid pressure, and of recently published results of Gough and Hankins (*Met. Abs.*, 1935, 2, 630) are given.—H. S.

**The Drawn-Wedge Impression Method for Testing Sheets for Deep-Drawing.** H. Kaysler and W. Püngel (*Techn. Zentr. Metallbearbeitung*, 1937, 47, (5/6), 228-231).—After describing various methods of testing which resemble the Erichsen test, a new method is described, in which the test-piece is rectangular in the lower portion and spreads out into a wedge-shape piece in the upper. This is drawn out in a special machine until the whole sample is rectangular. Erichsen tests are then performed on the sheet in various parts which have been subjected to different degrees of working. An engraved network on the original piece enables the degree and form of the movement of the metal to be judged.—W. A. C. N.

\***Relations Between Stress and Reduction in Area for Tensile Tests of Metals.** C. W. MacGregor (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 208-226; discussion, 227-228).—See *Met. Abs.*, this vol., p. 298.—S. G.

**Proposed Revision of Tentative Method of Test for Short-Time High-Temperature Tension Tests of Metallic Materials (E 21-34 T).** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 10-12).—Appendix I to Report of Joint Research Committee on Effect of Temperature on the Properties of Metals. Changes are made to Sections 3, 5, 6, 7, and 8, and to Figs. 1 and 2 and Form I.—S. G.

**Proposed Revision of Tentative Method of Test for Short-Time High-Temperature Tension Tests of Metallic Materials (E 21-34 T).** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 13-14).—Appendix II to Report of Joint Research Committee on Effect of Temperature on the Properties of Metals. Relates to chromium-nickel, chromium-nickel-iron, and chromium irons. The additional sections proposed relate to casting pattern, casting specimen, and testing apparatus and procedure.—S. G.

**Hot-Hardness.** John H. Hruska (*Iron Age*, 1937, 140, (3), 30-34).—The hardness of metals and alloys at elevated temperatures is measured on the Brinell system, using tungsten carbide or other thermally stable carbides as ball materials. The ball is either cold-pressed or raised to the temperature of the material under test. A further modification consists in pressing two specimens of the material together. If the material is to be used under static load, ball or mutual indentation is satisfactory; if it is to be used under repeated or dynamic stress, a dynamic method of hardness testing, i.e. elastic rebound of a physical shock, should be used. For very pure metals within the temperature range  $-50^{\circ}$  to  $+200^{\circ}$  C.:  $\log H_2 - \log H_1 = k(t_2 - t_1)$ , where  $H_2$  is the hardness at temperature  $t_2$ , and  $H_1$  that at tem-

perature  $t_1$ ,  $k$  being a constant. Alloys with a range of melting require a considerable modification of this formula at and above a given "turning-point," which lies some distance below the melting point of the alloy.—J. H. W.

### RADIOLOGY.

**Two Examples of the Application of X-Rays in Metallurgy.** R. Michaud (*Rev. Mét.*, 1937, 34, (2), 195-203).—An investigation of transformer irons (3 to 4% silicon) gave results which do not confirm the relationship put forward by G. L. Clark ("Applied X-Rays," New York: 1932; see *Met. Abs. (J. Inst. Metals)*, 1933, 53, 606) between grain-size and hysteresis loss. Application of X-rays to commercial rolled aluminium permits precise determination of the time and temperature of annealing to remove structural irregularities.—H. S.

**\*The Non-Destructive Testing of Heavy Metal Structures With Ultra-Short Wave X-Rays.** Max Widemann (*Z.V.d.I.*, 1936, 80, (24), 741-745).—Apparatus for testing metallic structures for the presence of flaws, more especially in welds, by means of X-rays of wave-length 0.1-0.09 A. is briefly referred to, and its applications briefly described. Plant of thickness of metal up to 5 cm. can be examined. 10 references are given.—J. S. G. T.

## XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from pp. 354-355.)

**The Brown Optimatic System. A New Self-Balancing Automatic Optical Pyrometer.** — (*Metallurgia*, 1937, 15, (89), 161-162).—S. G.

**Electric Temperature Measurement Up to 550° With Particular Consideration of the Platinum-Glass Thermometer.** W. Goedecke (*Elektrowärme*, 1934, 4, 278-281; *C. Abs.*, 1935, 29, 1692).—A comparison of the thermoelectric with the resistance method of temperature measurement for temperatures up to 550° C. shows the superiority of the resistance thermometer. A special construction is described in which the platinum wire is melted into a glass of very high melting point. The error of such instruments is about  $\pm 0.15\%$ .—S. G.

**\*A Sulphur Boiling-Point Apparatus with Internal Electric Heating.** C. R. Barber (*J. Sci. Instruments*, 1937, 14, (7), 227-229).—A sulphur boiling-point apparatus is described for calibrating thermocouples. It is made of Pyrex glass, and contains a platinum heater completely immersed in the molten sulphur. This method increases the speed of operation, and diminishes the risk of fracture of the tube on remelting the sulphur. The boiling point is realized to within 0.1° C.—W. H.-R.

## XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 355-356.)

**Remelting Aluminium in the Foundry.** H. Röhrig (*Met. Ind. (Lond.)*, 1937, 51, (1), 5-8; and *Found. Trade J.*, 1937, 57, (1090), 30-31, 34).—Read before the Institute of British Foundrymen. Difficulties in sorting aluminium scrap are discussed, it being pointed out that it is almost impossible to remove unwanted constituents in the remelting process, except in the case of magnesium, which can be eliminated by adding copper sulphide or manganese chloride to the melt. It is emphasized that the refining of secondary aluminium requires close control of furnace practice to prevent metallic losses and contamination by gases or oxides. The use of fluxes and degasification processes are briefly considered.—H. W. G. H.



**Degasification of Aluminium Alloys—Treatment with Aluminium Chloride.** G. Mann (*Met. Ind. (Lond.)*, 1937, 51, (4), 89-90).—The beneficial effects in eliminating pinholes are described in the cases of "Y" alloy, R.R. 50, Hydronalium, and Z. 3.—H. W. G. H.

**Problems in Bronze; Manufacturing and Selling.** Harold J. Roast (*Metal Progress*, 1937, 31, (5), 511-516).—From addresses to the Toronto Chapter of the American Society for Metals and the Annual Convention of the American Foundrymen's Association, 1937. The soundness and uniformity of structure of bronze castings are considered of more importance than the exact control of composition. The design of test-bars is discussed, and the extent to which such bars may be taken as representative is considered. The importance of co-operation between designer, pattern-maker, and foundry is emphasized.—P. R.

**Practical Foundry Problems. IV.—Fluid Shrinkage in Bronze Castings.** E. Longden (*Met. Ind. (Lond.)*, 1937, 51, (7), 155-156).—Describes a feeder-gate for use when several small and heavy castings are made in one box.

—H. W. G. H.

**A Croydon Bell Works.** — (*Engineer*, 1937, 164, (4258), 214).—A short description, with photographs, of the Gillett and Johnston bell foundry.—R. Gr.

**\*Some Properties of Magnesium Sheet and Alloys.** (Goto, Nito, and Asada.) See p. 371.

**\*On Nickel Oxide in the Metallurgy of Nickel.** W. Lange and E. J. Kohlmeier (*Metallwirtschaft*, 1937, 16, (25), 598-602).—When molten copper-nickel alloys with 5-90% nickel are exposed to the action of atmospheric oxygen the nickel is oxidized first, the oxide dissolving in the molten metal in appreciable quantities. When a section of the cast metal is prepared, only nickel oxide can be detected.—v. G.

**\*Deoxidation of Nickel and Nickel-Copper Alloys.** H. Nishimura, M. Morinaga, and T. Ikeda (*Suiyokwai-Shi (Trans. Min. Met. Alumni Assoc.)*, 1937, 9, (4), 251-255).—[In Japanese.] If molten nickel and nickel-copper alloys absorb oxygen their fluidity is much decreased; they should therefore always be deoxidized with magnesium. Oxidized nickel and nickel-copper alloys were analyzed by the hydrogen reduction method, and their micro-structures were examined. The eutectic point between Ni and NiO was found to be at 1.1% oxygen, as reported by Merica and Waltenberg. Nickel did not dissolve more oxygen in the liquid state and separated into 2 liquid layers. When nickel was added to copper containing  $\text{Cu}_2\text{O}$ , the eutectic point between copper and  $\text{Cu}_2\text{O}$  was observed to be much displaced to the copper side. The poor fluidity of nickel-copper alloy which had absorbed oxygen was ascribed to primary separation of an unknown oxide (probably a double oxide between  $\text{Cu}_2\text{O}$  and NiO). Industrial nickel-copper alloys such as Monel metal and cupro-nickel contained about 0.02% oxygen, and even if magnesium was added as deoxidizer, an oxygen content of this order was found always to remain in the alloys.—S. G.

†**The Casting of Bearings.** E. Meier (*Z.V.d.I.*, 1936, 80, (21), 652-654).—The necessity for the substitution of tin in bearing metals by some home-produced metal, e.g. lead, in Germany has introduced some problems, which are here reviewed. Amongst matters discussed are: the preparation of the bearing, turning the bearing, mould temperatures, hand casting, centrifugal casting, and casting under pressure. Plant for the various types of casting is illustrated.—J. S. G. T.

**Laboratory Research on the Re-Usability of Low-Zinc Bearing Metal.** Aug. Graebing (*Braunkohle*, 1936, 35, 613-618; *C. Abs.*, 1937, 31, 4628).—The operating behaviour of 5 bearing alloys indicates the inadvisability of additions of used metal to new in the pouring of bearings.—S. G.

**Notes on Difficulties in the Construction and Maintenance of Anti-Friction Bearings.** G. Mahoux (*Mécanique*, 1937, 21, (273), 182-187).—The increasing power of aero-engines imposes very considerable dynamic stresses on certain parts, notably the connecting-rod and its bearings; these stresses are tabulated for a modern engine and for a 1914-1918 model. Examples of excessive wear due to such stresses, as distinguished from failures caused by overheating and/or faulty lubrication, are illustrated and discussed. The design and manufacture of the thin bearings now in general use is described. Special emphasis is laid on the importance of temperature control in tinning and in melting and pouring the bearing metal, which is usually a tin-copper-antimony alloy. Destructive tests on bearings are illustrated and described.

—P. R.

**Simplified Alloying for Wear- and Corrosion-Resistance.** Miles C. Smith (*Iron Age*, 1937, 140, (3), 35-38).—Boride crystals have been formed into a "mother" with various percentages of pure electrolytic nickel. The introduction of this "mother" into baths of molten cast iron, steel, and copper is described, the procedure resulting in greatly increased corrosion- and wear-resistance of the base metal.—J. H. W.

**American Sand Testing Technique.** Earl Woodliff (*Found. Trade J.*, 1937, 57, (1093), 79-80, 85).—Read at the New England Regional Foundry Conference. A procedure is recommended for controlling moisture content, permeability, strength, and grain-size distribution in a mass-production foundry. The importance of determining the amount of deformation under load, and of sintering tests is also explained.—H. W. G. H.

**Soybean Oil in the Foundry.** Lamar Kishlar (*Proc. 15th Ann. Meeting Amer. Soybean Assoc.*, 1935, 19-20; *C. Abs.*, 1937, 31, 3840).—Soybean oil meets all the requirements for an excellent oil in the making of foundry cores. Castings that have been cleaned, dipped in soybean oil, and allowed to drain and dry, remain clean and bright even after several weeks of outside storage.—S. G.

## XV.—FURNACES AND FUELS

(Continued from p. 356.)

**Effect of Water Vapour on Hot Metal.** A. G. Hotchkiss (*Metal Progress*, 1937, 31, (4), 375-379).—The presence of water vapour in the atmosphere of bright-annealing furnaces necessarily influences the oxidizing range. Methods for drying furnace gases are discussed, and the percentage of water vapour in air or gas is tabulated for a range of dew-points from  $-28^{\circ}$  to  $+130^{\circ}$  F. ( $-33^{\circ}$  to  $54^{\circ}$  C.). A recently developed "dew meter" is described.—P. R.

**The Rolling Furnace.** — (*Gas World: Indust. Gas Suppl.*, 1937, 9, (5), 13-14).—A cylindrical furnace can be oscillated about its (horizontal) axis, thereby prolonging the life of its refractory lining and giving a more homogeneous product. Results in melting ferrous and non-ferrous metals are given.—A. R. Pe.

**Application of Vertical Gas-Fired Tubes to Galvanizing Furnaces.** A. M. Thurston (*Iron Age*, 1937, 140, (5), 38-39; and *Indust. Heating*, 1937, 4, (7), 550-552, 566).—Abstracts of a paper read before the National Conference on Industrial Gas Sales, Cleveland.—J. H. W.

**The Combustion of Gases.** W. F. Kopitow (*Acta Physicochimica U.R.S.S.*, 1936, 5, (6), 813-818).—[In German.] Temperature distribution in the Bunsen flame of town's gas burning in air is investigated by means of a thermocouple of nickel-Nichrome wires 0.22 mm. diameter. The law of Mallard and Chatelier is confirmed. Ignition temperature is attained at a distance of about 1 mm. in advance of the flame front.—J. S. G. T.



**Fuel Economy in Melting and Reheating Furnaces.** R. J. Sarjant (*Iron Steel Ind.*, 1937, 10, (13), 560-566).—An article, written to present the salient facts emerging from S.'s recent paper to the Institute of Fuel, deals with the bearing of the fuel used on economy, methods of fuel economy, reheating furnaces, analysis of furnace performances, comparison on the basis of utilization of heating surface, thermal efficiency *versus* heat utilized per unit area of heating surface, operation control, air/fuel ratio control, description of a modern control panel, heat flow into the charge, and heat storage and insulation.—J. W. D.

**Refinements in Annealing Furnaces for Sheets.** Charles Heurtey (*Rev. Mét.*, 1937, 34, (2), 161-165).—The main features of modern annealing furnaces of different types are mentioned, and a mobile bell-furnace heated by vertical radiating-tubes is described.—H. S.

**Range of Application and Economics of Electrically Heated Melting Furnaces for Light Metals.** U. Schwedler (*Tech. Zentr. prakt. Metallbearbeitung*, 1937, 47, (3/4), 147-151).—This is a critical review of types of electric melting furnaces for use with light alloys, principally those in which metallic resistors are used, those in which the crucible itself is the resistor, and those employing inductive heating. It is pointed out that the construction and shape of the containing vessel materially affect the melting process, and, furthermore, it is asserted that particular furnaces are more suitable for the preparation of metal for sand castings than, say, for billets which are to be rolled or pressed and *vice versa*. Graphite crucibles are preferred to iron ones, but on account of their lesser conductivity the resistors must be raised to a higher temperature. Cross-sectional diagrams are included to illustrate the text.—W. A. C. N.

**Melting and Annealing of Electrical Alloys.** D. F. Mincer and J. B. Seastone (*Metal Progress*, 1937, 31, (6), 611-617).—Alloys of special electrical or magnetic properties are usually produced in comparatively small quantities, melting being effected in induction furnaces and annealing in bell furnaces, where the requisite control of atmosphere, temperature, and composition is possible. The melting and annealing equipment are fully described, and the manufacture of a typical alloy (Hipernik) is described in illustration.—P. R.

## XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 304-305.)

†**Refractories.** R. S. Hutton (*Trans. Amer. Inst. Min. Met. Eng.*, 1937, 124, 13-28; and *Metals Technology*, 1937, 4, (4); *A.I.M.M.E. Tech. Publ.* 817, 16 pp.).—Institute of Metals Division Lecture. A general lecture on the properties and structure of refractories, with special reference to metallurgical problems. The defect of the usual refractories lies in the fact that refractory particles of one material are held together by a bonding material of a different substance with inferior properties. The great possibilities of sintered materials are emphasized, and recent advances and future developments are discussed.—W. H.-R.

**Refractory Materials.** J. H. Partridge (*Met. Ind. (Lond.)*, 1937, 51, (4), 81-86; (5), 111-114).—Based on a lecture to the London Local Section of the Institute of Metals. Refractories are divided into three groups: (1) those made from more or less plastic "clays," (2) those made from non-plastic materials to which a plastic bond is added, and (3) those made from non-plastic materials without the addition of permanent bonding agents. In each case, the processes of manufacture, properties, applications, and methods of testing are fully described. The results of recent research on the properties of the bond, particle size, plasticizing agents, and the effects of impurities, are clearly explained.—H. W. G. H.

**Graphite in the Metal Industry. Crucibles and Facing Materials.** H. N. Bassett (*Met. Ind. (Lond.)*, 1937, 51, (4), 87-88).—A brief review.—H. W. G. H.

\***The Thermal and Electrical Conductivities of a Sample of Acheson Graphite from 0° C. to 800° C.** R. W. Powell (*Proc. Phys. Soc.*, 1937, 49, (4), 419-425; discussion, 426).—Experimental values of the thermal ( $K$ ) and electrical ( $\sigma$ ) conductivities of Acheson graphite at 0°-800° C. are plotted as smooth curves.  $K$  decreases from 0.40 at 0° C. to 0.16 at 800° C. The value of  $\sigma$  is 1518 ohm<sup>-1</sup> cm.<sup>-1</sup> at 0° C., and increases to a max. value of 1518 ohm<sup>-1</sup> cm.<sup>-1</sup> at 450° C., thereafter decreasing to 1444 at 800° C. The Wiedemann-Franz-Lorenz law is not obeyed but is replaced by the relation  $K\sigma^{-1}T^{0.8} = \text{const.}$ —J. S. G. T.

**Proposed Tentative Methods of Test for Cold Crushing Strength and Modulus of Rupture of Refractory Brick and Shapes.** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 5-9).—Appendix to Report of Committee C-8 on Refractories.—S. G.

**Proposed Tentative Methods of Chemical Analysis of Refractory Materials.** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 11-27).—Appendix to Report of Committee C-8 on Refractories. Describes procedures for the chemical analysis of fireclay, silica, and high-alumina refractories, chrome ores and chrome brick, and magnetite refractories.—S. G.

## XVIII.—WORKING

(Continued from pp. 357-360.)

**Draw-Casting Metal Rods and Tubes. Continuous Production Direct From Molten Metal. Details of the Eldred Process.** — (*Met. Ind. (Lond.)*, 1937, 51, (6), 133-134).—Describes the Eldred process for the continuous production of copper or bronze rod and tube direct from molten metal. The metal is melted in a resistance furnace, in the bottom of which are a number of holes containing water-cooled graphite dies. The metal passes through the dies to water coolers and thence to spring-loaded rolls.—H. W. G. H.

**Rolling Mills for Metallurgical Research.** — (*Metallurgia*, 1937, 15, (89), 162-163).—S. G.

\***Some Properties of Magnesium Sheet and Alloys.** (Goto, Nito, and Asada.) See p. 371.

**The Tinplate Industry.** — (*Engineer*, 1937, 164, (4257), 174-176, 180).—An illustrated outline of the manufacture of tinplate, describing and comparing pack rolling and continuous cold-reduction processes. General tendencies in the technique are given.—R. Gr.

**Electric Drives for Rolling Mills.** — (*Metallurgia*, 1937, 15, (87), 67-68, 84).—S. G.

**Cold-Extrusion of Aluminium and Copper. The Hooker Process and Impact Extrusion.** — (*Met. Ind. (Lond.)*, 1937, 50, (8), 235-236).—S. G.

**Extruded Zinc Parts Produced by Impact Methods.** Herbert Chase (*Machinist (Eur. Edn.)*, 1937, 81, (24), 349-350E).—Describes the impact extrusion of zinc, wherein the extrusion is effected by a single blow, and discusses the applications and advantages of the process.—J. H. W.

\***The Eddy Arrangement of Micro-Crystals in Metal Wire Caused by Drawing.** (Fujiwara and Seiki.) See p. 387.

**The Properties of Sheet Metal. I.—Behaviour of Metal During Deep-Drawing.** J. D. Jevons (*Met. Ind. (Lond.)*, 1937, 51, (6), 127-131; (7), 157-161; (8), 181-184).—The desirable properties of sheet metal from the point of view of the user are surveyed. Freedom from harmful impurities and control of grain-size are generally recognized to be important, but the ambiguity of the term "average grain-size," and the detrimental effects of



irregularity in grain-size, are not always appreciated. Ductility and tenacity, as required for deep-pressing, are not measured exactly by the simple tensile test, but the work of Sommer has shown the "actual" stress-strain curve to be very informative, although ductility is influenced by the nature of the imposed stresses. Tenacity is related to the rate of work-hardening, a property which is of extreme importance. The hardness test is valuable for routine testing, but hardness as a fundamental property is unimportant. Directional properties are caused by segregation and inclusions, by preferred elongation of the crystals, and by a directionality of the grains which is not obvious under micro-examination, but which is readily shown by X-rays. Directionality may cause a difference of some 12% in the tensile strength and 100-300% in tear length. The limiting values do not always lie in directions of 0° and 90° to the direction of rolling; steel and brass have been shown to possess minimum ductility at 45° to the direction of rolling. When annealing is required between pressing operations, the recrystallization behaviour and the effect of composition must be considered. Smooth surface and close dimensional tolerance are essential. Finally, it is emphasized, economies effected by cutting down the first cost of the purchased metal are often illusory. 16 references are given.—H. W. G. H.

**The Behaviour of Non-Ferrous Metals in Plastic Shaping.** E. Kaczmarek (*Metallwirtschaft*, 1937, 16, (16), 372-375).—Practical hints are given on deep-drawing and hot-forging.—v. G.

**Powder Metallurgy.** J. C. Chaston (*Metallurgia*, 1937, 15, (87), 95-96).—See *Met. Abs.*, this vol., p. 358.—S. G.

**The Machining of Magnesium and Its Alloys.** — (*Pratique Indust. mécaniques*, 1937, 20, (2), 57-58).—Directions for the mounting and cutting angle of tools, optimum rate of feed, and depth of cut are tabulated for the machining of magnesium and its alloys, and precautions are indicated. The volumes of turnings produced per minute in the machining of brass, bronze, aluminium, and magnesium alloys, and two ferrous alloys are compared graphically, and suitable forms and methods of mounting for tools are shown by diagrams.—P. M. C. R.

**Temperature Distribution in Metal Cutting.** W. Reichel (*Maschinenbau*, 1936, 15, 495-499; *Eng. Abs.*, 1936, (71), 94).—R. discusses metal cutting problems, and describes apparatus by which he has measured the work during cutting. This consists of a nickel wire buried in the work, forming part of a thermocouple circuit from which oscillograph diagrams can be produced. As the junction approaches the cutting tool, the temperature increases and attains its maximum at a short distance ahead of the cutting-edge, where the incipient splitting away of the chip begins. By this method a diagram of temperature-distribution in the work is produced. The temperatures at various points in the tool are measured by means of thermocouples and are plotted in a quasi-polar diagram. They indicate that the maximum temperature in the work is higher than that at the point of the tool; and the difference appears to be independent of the cutting speed. For a given cut and feed the tool pressure decreases (*e.g.* from 50 to 40 kg.) as the cutting speed increases from 50 m. to 650 m./minute. R. considers that the future of metal cutting may depend on the suitable choice or preparation of materials, and he tabulates comparative maximum temperatures. For example, in cutting aluminium at speeds of about 4000 ft./minute the maximum temperature is about 390° C.; in cutting steel having an ultimate strength of 30 tons/in.<sup>2</sup> at a speed of 3300 ft./minute it is about 850° C.—S. G.

## XIX.—CLEANING AND FINISHING

(Continued from p. 360.)

**Bullard-Dunn Process.** Edwin Smith (*Products Finishing*, 1937, 1, (7), 18-20, 22-24, 26; *C. Abs.*, 1937, 31, 3794).—In the Bullard-Dunn process of descaling, the scale is completely eliminated, without attacking the underlying metal, by depositing a thin, but impervious, coating of tin on the base metal as soon as the scale is removed. Parts to be descaled are first degreased in a solvent degreaser and then put through the following cycle: (1) anode in electrolytic alkali at 93° to remove the remaining grease, handling marks and dirt; (2) cold-water rinse; (3) descaling in a solution containing 10% by volume of 68° Bé. sulphuric acid, 25 oz./gal. Glauber salt and 15 oz./gal. glue at 60°-65° C. and cathode c.d. of 60 amp./ft.<sup>2</sup> and 4-5 v.; (4) cold-water rinse; and (5) hot-water rinse. The equipment, materials, and method employed are described in detail, and various stages in the procedure are shown in 9 illustrations.—S. G.

**A Chemical Study of Alkaline Cyanide Degreasing and Coppering Baths.** A. Chaybany (*J. Electrodepositors' Tech. Soc.*, 1937, 13, 8 pp.).—See *Met. Abs.*, this vol., p. 263.—S. G.

**New Materials Aid Progress in Metal Cleaning.** R. W. Mitchell (*Metal Cleaning and Finishing*, 1937, 9, (1), 11-18).—S. G.

**Exhaust Hoods and Piping Systems.** W. O. Vedder (*Metal Cleaning and Finishing*, 1937, 9, (1), 67-69).—S. G.

**Aluminium Finishing Procedure.**—I. Robert T. Griebing (*Products Finishing*, 1937, 1, (8), 18-24; *C. Abs.*, 1937, 31, 4627).—A review, dealing with polishing, roughing, oiling, buffing, colouring, other mechanical finishes, scratch-brush and satin finishes, and the high-lighted finish.—S. G.

**Suggestions for Successful and Economical Polishing [of Metals].** James J. Manderscheid (*Products Finishing*, 1937, 1, (8), 12-16).—S. G.

**Fitting the Lacquer to the Job.** Gustave Klinkenstein (*Monthly Rev. Amer. Electroplaters' Soc.*, 1937, 24, (1), 35-38).—S. G.

## XX.—JOINING

(Continued from pp. 360-361.)

**When and How Silver Solders are Used.** R. H. Leach (*Met. Ind. (Lond.)*, 1936, 49, (21), 511-514).—Read before the American Welding Society. The advantages and limitations of silver-soldering are reviewed. Chemical attack can be minimized by adopting a suitable design for joints, and the selection of the solder must be guided by the nature of the materials to be joined and the temperature at which the soldered pieces are to be used. Tensile strengths are tabulated for joints of various thicknesses. The importance of the flux is emphasized. Recent advances in practice are illustrated by the results of hardness and tensile tests on lap joints in copper sheet, and reference is made to the production of high-strength joints in naval practice.—P. M. C. R.

**Autoheaters Furnace Brazed.** Burnham Finney (*Machinist (Eur. Edn.)*, 1937, 81, (22), 463).—Briefly describes a system of brazing, the chief novelty of which consists in the temperature control. Lens-type radiation pyrometers are used, with Leeds and Northrup "Rayotube" assemblies, instead of ordinary thermocouples. The thermocouple elements are outside the furnace, being hermetically sealed in heads in which the temperature never exceeds 150° F. (65° C.). Thus the hot junctions are kept away from the heat and reducing atmosphere in the furnace.—J. H. W.

**Liquid Brazing.** J. M. G. Turnbull (*Engineer*, 1936, 162, 622-625, 648-650; and (abstract in *extenso*); *Metal Progress*, 1937, 31, (1), 73-74, 87).—Chromium alloy turbine blades are brazed to the rotors by immers-



ing assembled segments in 70:30 brass under a borax flux. The use of stainless steel liners protects the container but increases the iron content of borax and brass. Attempts to produce a less destructive flux included viscosity determinations on a variety of mixtures, and it was found that the use of borax at a reduced temperature was practicable under certain conditions, which are enumerated.—P. R.

**The Gas-Welding of Alpac.** H. Reiningger (*Leichtmetall.*, 1937, (2), 6-16).—A preliminary review of the literature, relating to the welding of aluminium and aluminium alloy castings, occupies 5 pages and involves 30 references. The oxy-acetylene process is recommended for Alpac, without the use of any flux. Mechanical and metallographic examinations of welded joints are described, from which it is shown that the weld metal has higher tensile strength and elongation than the original casting. This is attributed to the rapid cooling of the weld. It is emphasized that the reducing zone of the flame should not be allowed to touch the molten metal during welding, which should be as rapid as possible. Large castings should be stress-relieved at 300°-350° C. for at least 4 hrs. The recommendations are not intended for Alpac  $\beta$  and  $\gamma$ , for which special precautions are necessary.—H. W. G. H.

**\*Electric Spot Welding of Light Metals.** E. Osswald (*Luftfahrtforschung*, 1937, 14, 215-223; *Eng. Abs.*, 1937, (75), 73).—O. gives the results of static and dynamic tensile tests of spot-welded connections of Hydronalium 7 and Duralplat. The joints were made on two types of welding machines. One was of the normal type, fitted with grid-controlled, mercury-vapour current rectifiers in which the welding pressure was produced mechanically and transmitted to one of the electrodes by means of a cam gear. This was subsequently modified so that during the welding period the electrode pressure and the current could be adjusted accurately within wide limits, compressed air being used to generate pressure, whilst the current was adjusted by the action of a beam of light on a photoelectric cell. This machine thus permits the application of an increased initial pressure before the actual welding operation, as well as heat-treatment of the completed weld at reduced current and, if desired, at a pressure exceeding the welding pressure. O. discusses the characteristic forms of fracture which are obtained in the static tensile tests of single and double spot-welded joints of plates 0.5, 1, and 2 mm. (0.02, 0.04, and 0.08 in.) thick, and states that such fractures furnish indications for the correct adjustment of the welding machine. The metallographic structure of the welding zones, and the influence of the shape of the electrode on the strength of the joint, are discussed. The results of the static tensile tests are given in 2 diagrams indicating the static breaking load of joints of 2 mm. (0.04 in.) plates of Hydronalium 7 as a function of: (1) the welding current strength and the welding period at constant electrode pressure; and (2) the electrode pressure at constant welding period. The results of the dynamic pressure tests on 2 mm. (0.04 in.) plates of Hydronalium 7 and Duralplat are plotted in curves of breaking load to a base of the number of load alternations. The joints tested were made on a welding machine of the normal type. The results of tests of joints made on a machine of the variable electrode pressure and current type, indicate that the metallographic structure of the welding zone can be influenced appreciably by such variations.—S. G.

**Lead Welding.** A. E. Peters (*Machinist (Eur. Edn.)*, 1937, 81, (25), 362E).—Oxy-acetylene welding of lead must be effected quickly, owing to the low melting point and small heat conductivity of lead. Cleaning fluxes are somewhat objectionable. A neutral flame, or one having a slight excess of acetylene, should be used, and should be applied perpendicularly to the surface of the work.—J. H. W.

**\*The Present Position of Welding Non-Ferrous Metals.** C. Stieler (*Z.V.d.I.*, 1936, 80, (21), 657-660).—Recent developments in the welding of copper and

copper alloys, zinc, lead, nickel and nickel alloys, aluminium and its alloys, and magnesium alloys are briefly reviewed. Copper and its alloys present no fundamental difficulties in the matter of welding; the same cannot be said of all light metals and alloys. Processes and limits of their applicability are referred to. Gas-, "arc atomic," and resistance-processes of welding have all been considerably improved, and the last of these processes can now be applied almost generally.—J. S. G. T.

**Non-Ferrous Welding.** H. W. G. Hignett (*J. B'ham. Met. Soc.*, 1937, 17, (2), 36-45; discussion, 45-51).—See *Met. Abs.*, this vol., p. 266.—S. G.

**How to Weld Twenty-Nine Metals.** Charles H. Jennings (*Iron Age*, 1936, 138, (26), 30, 45; (27), 30-35; 1937, 139, (2), 27-31; (3), 32-33, 101-102; (5), 60-63; (6), 44-47; (10), 61-62).—A comprehensive discussion of the procedure, conditions and materials for welding modern alloys. Specific data are given for welding all types of joints with varying thicknesses of metal (mainly steels and alloy steels), and include information on electrode diameter, welding current, speeds, deposition, and other factors.—J. H. W.

**\*Current Distribution in Spot- and Seam-Welding.** H. Wilbert (*Z.V.d.I.*, 1936, 80, (14), 419-421).—A complete plant, incorporating two gas-filled valves for automatically controlling and interrupting the supply of current used in spot- or seam-welding of ferrous or non-ferrous plates, is described.

—J. S. G. T.

**Recent Developments in Resistance Welding, Hydrogen Furnace Brazing, and Other Assembly Methods.** J. L. Miller (*Coventry Eng. Soc. J.*, 1937, 18, (3), 68-90; discussion, 90-92).—Jointing methods used in the assembly of small parts are classified as: riveting; screwing and the use of screws or bolts and nuts; soft soldering; brazing; hot or cold pressing; and welding in various forms. The characteristics of each method are discussed, and its value, in mass-production work, estimated. Two methods, which are shown to have great advantages from this point of view—furnace brazing in a reducing atmosphere, and resistance welding—are described at greater length, practical details of technique being explained. Projection welding is not recommended for non-ferrous metals, but spot-welding of brass, aluminium, and other materials is said to be successful if high current density and short welding times are provided.—H. W. G. H.

**A Discussion of Automatic and Manual Arc Welding.** A. J. Moses (*J. Amer. Soc. Naval Eng.*, 1936, 48, (4), 523-531).—S. G.

**Arc Welding Electrodes.** A. F. Davis (*Transit J.*, 1937, 81, 130).—Welding electrodes for various purposes are listed.—S. G.

**\*Comparative Investigations of Cored and Cased Electrodes.** Franz Leitner (*Z.V.d.I.*, 1936, 80, (28), 851-856).—The comparative merits of cored and cased welding electrodes are investigated practically, from the economical, mechanical, microscopical, and chemical points of view.—J. S. G. T.

**\*The Question of the Sensitivity [to Fracture] of Welds.** K. L. Zeyen (*Z.V.d.I.*, 1936, 80, (32), 969-973).—The causes of failure of welds may be very different in character. In the case of steels the sensitivity to fracture of welds increases with: (1) decreasing thickness of the steel, (2) increasing tenacity, and (3) increasing difficulty of welding. Fractures in the neighbourhood of welds are often the results of stresses which are not properly relieved. Fracture may be attributable to faulty materials being employed. The effects of composition and mode of production of alloy steels upon the sensitivity to fracture of welds in the materials are investigated. In the case of chromium-molybdenum steels, welding fractures occur principally along the crystal grain boundaries. Faulty heat-treatment of the metal prior to welding is responsible for many fractures of welds. One authority recommends that heat-treatment be not carried out prior to welding.—J. T.



**Control of Fusion Welding by Mechanical Tests.** Albert Portevin (*Metal Progress*, 1937, 31, (3), 290-292).—The raw materials, operating technique, methods and standards in force, and the finished products of modern welding processes require careful testing and control at every stage, and a scheme for such control is outlined and discussed.—P. R.

The XIIth International Congress on Acetylene, Welding, and Allied Industries. (London, 8-13 June, 1936.) D. Séférian (*Rev. Mét.*, 1937, 34, (4), 276-293).—Deals mainly with welding of ferrous materials. Summaries are given of papers by A. Boutté on welding of aluminium bronze, by Fr. Eggelsmann on welding of an aluminium-rich light alloy, by A. B. Kinzel and C. W. Drury on superficial hardening by application of Stellite, by J. Fassbinder and P. Souliary on pistol-sprayed coatings. (For abstracts see *Mét. Abs.*, 1936, 3.)—H. S.

## XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 361-362.)

†**Light Metal Bearings.** R. Hinzmann (*Metallwirtschaft*, 1937, 16, (20), 477-481).—Duralumin, piston alloys containing silicon or copper, and R.R. 56 make satisfactory bearing when the bearing pressure is not too high, and can be used even under high bearing pressures if the shaft is hardened, the surfaces of the bearing and shaft are accurately machined, and bending of the shaft is prevented. For bearings operating under less favourable conditions the following light metal alloys are recommended: Borotal: Cu 3, Fe 2, Pb 3, graphite 0.1%; KS280: Si 21-22, Co 1.2, Cu 1.5, Mn 0.6, Ni 1.5, Mg 0.5%; KS13: Sb 6-8%; X: Fe 6, Mg 0.5%; Quarzal: Cu 5, Fe 1%. Many manufacturers insist that the structure must be refined by forging or pressing.—v. G.

**Development of Light Alloy Bearings.** — (*Metallurgia*, 1937, 16, (93), 103).—A brief review of light alloy bearings, dealing with the general characteristics of such alloys, their mechanical and physical properties, their behaviour as bearings under laboratory tests and under service conditions, and the composition, properties, and applications of some of the better known, and more recently developed alloys.—J. W. D.

**Aluminium for the Production of Highly Reflecting Surfaces.** H. von Klüber (*Metallwirtschaft*, 1937, 16, (16), 370-372).—The preparation of highly reflecting surfaces on astronomical mirrors by evaporating aluminium thereon in a high vacuum is described.—v. G.

**Architectural Uses of Aluminium Applied in the Building of New Laboratories.** — (*Metallurgia*, 1937, 15, (90), 169-171).—S. G.

**Aluminium in the Textile Industries.** — (*Brit. Aluminium Co., Ltd.*, No. 386, 1937, 35 pp.).—Briefly summarizes, with numerous illustrations, the uses of aluminium and its alloys in textile engineering. Recommendations are made of materials to use for specific purposes.—S. G.

**Stress Calculation for Thin Aluminium Alloy Sections.** S. A. Kilpatrick and O. J. Schaefer (*Product Eng.*, 1936, (March), 93).—An analysis of the design of the thin plate webs used as shear members, including an explanation of the tension field web and the taper tension field beams.—S. G.

**Domestic Materials in the Construction of Water Mains.** R. Schemel and S. Clodius (*Gas u. Wasserfach*, 1937, 80, 151-157, 187-191; *C. Abs.*, 1937, 31, 4027).—Tests on aluminium foil and wool as packing for joints in water mains indicated that it was superior to other packings in some respects as regards rigidity and permanence of seal, and satisfactory as regards conformability. Corrosion difficulties have not as yet been completely solved, but the best results are secured by packing the wool and foil firmly, with polished-surface material at least 99.3% pure, and with wool not less than

0.05 × 0.2 mm. and foil at least 0.03 mm. thick. Thinner materials corroded much more rapidly. Proposed German standards are given for these materials (and Sinterit) and joints packed therewith.—S. G.

[Alclad] Honeycomb Metal Wing Features New Eight-Passenger Airplane. William F. Sherman (*Iron Age*, 1937, 140, (1), 22–25).—Describes the application of Alclad in aeroplane construction and the methods of effecting joints with this material.—J. H. W.

Light Metal in Vehicle Construction. — (*Automobiltech. Z.*, 1937, 40, (12), 310–311).—The influence on vehicle design of the use of light metal is reviewed. The selection of suitable materials for heavily stressed members is considered: pressed pieces are preferred to rolled parts on account of the superior adaptability of the former process. Stress distribution in screwed or riveted assemblies should be assisted by the provision of more rivets or screws than are required in ferrous construction. The replacement of copper or brass by light alloys, e.g. in cooling gear, necessitates further modification in design.—P. M. C. R.

Aluminium Alloys v. Stainless Steels for Aircraft. Editorial note, with comment by Wilson S. Sutton (*Metal Progress*, 1937, 31, (1), 46–52).—The elastic properties, yield-strength, and welding properties of recently-developed structural light alloys are compared with those of “18:8” steel, in a discussion of the preference of many aircraft constructors for light alloys. The improved mechanical properties of a modified “18:8” containing added titanium are shown graphically. S. emphasizes the superiority of “18:8” to Alclad 24 S-T, which he describes as the only light alloy of comparable resistance to corrosion, especially in respect of the “proof stress” or limit of proportionality.—P. R.

Aluminium Telephone Wire. Federico Giolitti (*Metal Progress*, 1937, 31, (5), 534–535).—The relevant physical and mechanical properties of 8- to 12-gauge telephone wire in galvanized iron, standard copper-tin alloy, copper, 99.5% aluminium, and Aldrey are tabulated. Methods of installing Aldrey wires for use under special climatic conditions are discussed, and approximate factors of safety are given.—P. R.

Proposed Tentative Specifications for Aluminium-Base Alloys in Ingot Form for Permanent-Mould Castings. — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 16–18).—Appendix to Report of Committee B-7 on Light Metals and Alloys, Cast and Wrought. Cover commercial aluminium-base sand-casting alloys in ingot form for remelting for the manufacture of permanent-mould castings. The sp. gr. of these alloys does not exceed 3.0. Thirteen alloys are specified. The alloys may be made by any approved process.—S. G.

Proposed Revised Tentative Specifications for Aluminium-Base Alloys in Ingot Form for Sand-Castings. — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 19–21).—Appendix to Report of Committee B-7 on Light Metals and Alloys, Cast and Wrought. Cover commercial aluminium-base sand-castings in ingot form for remelting for the manufacture of sand-castings. The sp. gr. of these alloys does not exceed 3.0. Twelve alloys are specified. The alloys may be made by any approved process.—S. G.

Proposed Revised Tentative Specifications for Aluminium-Base Alloy Die-Castings. — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 5–7).—Appendix to Report of Committee B-6 on Die-Cast Metals and Alloys. The alloys are designated Nos. IV to VII, inclusive, and IX, XI, and XII. The requirements as to chemical composition are set forth, and an Appendix is provided to give the purchaser an idea of the tensile and Charpy impact values that may be expected of these materials.—S. G.

Locomotive Firebox Stays. M. Pignères (*Chaleur et Ind.*, 1936, 17, 357–361; *Eng. Abs.*, 1936, (71), 68).—P. discusses the problem of staying locomotive fireboxes, and the difficulty experienced in modern practice owing to



the increased boiler pressures and higher combustion rates, both of which increase the temperature of the firebox-plates. In the case of copper fireboxes, the higher coeff. of expansion as compared with that of steel of the outer firebox, subjects the stays to bending stresses, in addition to tensile stress. Whilst the steel firebox presents advantages in this respect, it has not hitherto proved entirely satisfactory in European practice, although the introduction of welding has facilitated repairs. P. describes various types of stays, and discusses the advantages and disadvantages of various materials. Finally, he describes a new type of flexible stay which consists of a relatively thin corrugated copper tube, expanded into the plates, which forms the water-tight seal; through the centre of this passes a steel bolt with spherical head and nut, to take the load, the spherical ends fitting in steel sockets let into the plates.—S. G.

**Spots on Paper-Machine Wires.** M. Marini (*Papier*, 1937, 40, 143-153; *C. Abs.*, 1937, 31, 4814).—A general discussion of the nature, causes, and removal of various types of spots that form on paper-machine wires.—S. G.

**\*Metallographic Study of the Longitudinal Wires from Two Screens of a Fourdrinier Machine.** — (*Canada Dept. Mines, Mines Branch*, No. 774, 1937, 182).—A brief note. Parts of two screens, one of which had worn twice as long as the other, were received from a paper company for examination of the longitudinal wires to determine whether structural differences would account for the superior wearing properties of one. The longitudinal bronze wires were untarnished, and the wear, as estimated by the area of the flats on the wire, was directly proportional to the time the screens had been in service. The mesh of the two screens was identical, but the diameter of the wires in the screen with the longer service was one half-thousandth of an inch greater than that of the wires in the other. The smaller wires would have a tensile strength approximately 10% less than the larger. Under the microscope no fundamental difference was noted, and the premature failure of one screen is believed to be due to the fact that it was made of finer wire, and probably to faulty alignment in the machine.—S. G.

**Lead-Bronze Bearings.** Kurt Springorum (*Tech. Zentr. Prakt. Metallbearbeitung*, 1937, 47, (1/2), 27).—In Germany this type of bearing is being developed in order to assist in the economy of tin. There are two main types—those in which only the two metals lead and copper appear, and those in which there are other added elements.—W. A. C. N.

**Uniform Details. The Production of Nickel-Silver Buttons and Badges.** — (*Nickel Bull.*, 1937, 10, (3), 53-55).—Describes the application of nickel-brass for the manufacture of buttons and badges, and the seven operations in which these are made.—J. H. W.

**Proposed Tentative Specifications for Copper and Copper Alloy Seamless Condenser Tubes and Ferrule Stock.** — (*Amer. Soc. Test. Mat. Preprint*, 1937, (June), 4-8).—Appendix to Report of Committee B-5 on Copper and Copper Alloys, Cast and Wrought. Cover seamless tubes and ferrule stock of copper and various copper alloys (Muntz metal, Admiralty metal, red brass, aluminium-brass, aluminium "bronze," 70:30 and 80:20 copper-nickel, and arsenical copper) for use in surface condensers, evaporators, and heat exchangers. The tubes are to be cold-worked to size from an alloy made from lake or electrolytic copper in combination with elements conforming to A.S.T.M. standards. Chemical compositions, and physical and metallographic tests are described.—S. G.

**A Condenser Tube for Difficult Conditions.** — (*Marine Eng.*, 1937, 60, (718), 191).—A brief description of a new condenser tube (Resisco), containing copper, nickel, aluminium, but no zinc, having a sp. gr. 10% lower than other brass alloys, a tensile strength of 41 to 45 tons/in.<sup>2</sup>, and an

elongation of 30% on 2 in. In the annealed condition, the tensile strength is 33 to 36 tons/in.<sup>2</sup> and the elongation 62 to 66% on 2 in.—J. W. D.

**Chemical Lead.** — (*Standards Assoc. Australia, Specification No. H 10*).

—Limits of permissible impurities and method of analysis are defined.—S. G.

**Presence of Lead in Canned Sardines.** H. Chefel and M. L. Pigeaud (*Ann. Falsif.*, 1937, 30, 10–18; *C. Abs.*, 1937, 31, 4006).—Living sardines, like most animal and vegetable organisms, normally contain traces of lead, so that canned sardines cannot be expected to be absolutely free from lead. During treatment preparatory to canning, the lead content of sardines increases progressively on account of contamination from various sources. By taking proper precautions (avoiding the use of lead in the solder used in containers and equipment) this contamination can be kept at a minimum. The cans themselves can contribute a certain amount of lead, which does not seem to be attributable to the solder (which is very low in lead), but rather to dust and other lead-containing contaminants which can be eliminated to a certain extent by efficient cleaning.—S. G.

**Lead Poisoning by Drinking Water. The Influence of Deacidification and Remineralization on the Solubility of Lead in Pipes.** A. Pellé and — Artus (*Bull. Acad. méd.*, 1937, 117, 156–160; *C. Abs.*, 1937, 31, 4027).—The solubility of lead in water is lowest at  $p_H$  7.6 to 7.8. If water is softened to a low mineral content, remineralization with calcium sulphate and calcium carbonate + carbon dioxide is necessary to prevent absorption of lead. Plating with tin gives good protection.—S. G.

**Nickel in the Radio Industry.** E. M. Wise (*Proc. Inst. Radio Eng.*, 1937, 25, (6), 714–752).—The thermal, electrical, chemical and mechanical properties of nickel and its alloys in relation to the requirements of the manufacturer of thermionic valves and other similar radio apparatus are discussed. The effects on the performance of such apparatus of occluded gases in the metals used in their construction are described. A *bibliography* of 55 references is given.—E. V. W.

**Some Characteristics of Monel and Other Nickel Alloys Relating to the Textile Industry.** G. L. Cox (*Amer. Dyestuffs Rep.*, 1937, 26, 217–224; *Nickel Bull.*, 1937, 10, (6), 132).—The mechanical strength of Monel metal, its high degree of resistance to chemical attack and its amenability to all forms of fabricating operation have secured its extensive use in many forms of textile dyeing plant. An interesting compilation of data relating to the behaviour of Monel metal in this type of service was recently presented to the American Association of Textile Chemists and Colourists. The tests reported included results of many laboratory investigations and of numerous exposures in large-scale industrial plant. Typical runs, for which tabulated summaries are given, relate to tests in diazotizing solutions, in print agers handling rapidogen colours, in rayon sulphurizing solutions, in rotary, skein-dyeing baths, in acetic acid-sodium dichromate wool-dyeing solutions, in oil sulphonators and in sulphuric acid of varying concentrations. The results of the laboratory and plant tests show the practical utility of these and other high-nickel alloys for textile processing service.—S. G.

**Scope of Monel in Dyeing and Finishing.** F. Scholefield and H. A. Turner (*Textile Mfr.*, 1937, 63, 164, 206; *C. Abs.*, 1937, 31, 4820).—For scouring and bleaching, Monel metal is satisfactory when the concentration of chlorine per litre does not exceed 3 grm. in the case of cold hypochlorite, or 2.5 grm. for bleaching-powder solutions. In the wool-finishing industry, the combination of moisture and high temperature may cause some reaction between the sulphur of the wool and the metal, and thereby limit its use.—S. G.

**The Application of Heat-Resisting Alloys to the Pottery Industry.** — (*Nickel Bull.*, 1937, 10, (4), 77–80).—Iron and steel are unsuitable for use in the construction of pottery kilns, owing to their weakness at high temperatures



and their tendency to scale. Fireclay, which is commonly used, is fragile, bulky, and has a high heat capacity. These difficulties are overcome by the use of nickel-chromium alloys, such as nickel 62, chromium 15, manganese 2%, iron the balance. The special applications of such alloys in the pottery industry are described.—J. H. W.

**Some Applications of Nickel Alloys in the Glass Industry.** — (*Nickel Bull.*, 1936, 9, (11), 229-233).—The heat-resisting alloys used in the glass industry may be grouped as: (1) cast iron containing up to 3% nickel with or without chromium; (2) high alloy cast iron containing up to 20% nickel; (3) wrought and cast austenitic steel containing up to 36% nickel and 30% chromium; (4) high nickel nickel-chromium and nickel-chromium-iron alloys. The applications of these alloys in the various stages of glass manufacture are described.—J. H. W.

**\*Platinized Silver Gauzes and Silver-Platinum Alloys in the Oxidation of Ammonia.** I. E. Adadurov, Ya. M. Deich, and N. A. Prozorovskii (*Zhurnal Prikladnoi Khimii (J. Applied Chem.)*, 1936, 9, 807-812; *C. Abs.*, 1936, 30, 7791).—[In Russian.] Experiments are described on the catalytic oxidation of ammonia with platinized silver gauze and silver-platinum alloys. By the use of silver gauze coated electrolytically with 20% platinum, 99% ammonia was oxidized at 690°-700° C. An intensive oxidation of ammonia is inadvisable because of the partial fusion of the silver gauze. An alloy of 90% platinum and 10% silver gave 87.9% oxidation at 946° C. Increasing the ratio of silver in the silver-platinum alloys decreased the rate of oxidation and the melting point of the alloy. An alloy of platinum 80, rhodium 10, and silver 10% is thermally resistant, giving 95.7% conversion of 10.5% ammonia-air mixture at 935° C.—S. G.

**Bimetals.** E. Erni (*Bull. Assoc. Suisse Élect.*, 1936, 27, 732-737; *Sci. Abs.*, 1937, [B], 40, 69).—A mathematical treatment of the mechanical, thermal, and electrical factors which affect the performance of a bimetallic strip. With externally applied heat, the solution is difficult; with internal heat due to current, the result for the bending is different. The thermal stability with a number of operations is considered.—S. G.

**Recent Specifications for Materials.** E. Hain (*Automobiltech. Z.*, 1937, 40, (12), 297-299).—This review contains brief summaries of a number of German standard specifications, including: testing (DIN 1605); aluminium bronzes; lead-base, zinc-base, and tin-base die-casting alloys; light metal die-casting alloys (aluminium- or magnesium-base); replacement of tin by other materials; base (copper content 64%); aluminium, including nomenclature and standard marking of sheet, tubing, rod, and semi-finished parts. The specification dealing with the replacement of tin includes a summary of approximate compositions and commercial names of several alloys, and a list of tin-rich alloys, the use of which is now prohibited in Germany.—P. M. C. R.

**Surmountable and Insurmountable Difficulties in the Preservation of Metals.** M. Werner (*Metallwirtschaft*, 1937, 16, (23), 545-550).—A number of interesting cases of faulty welding and corrosion of metals in the chemical industry are described, and the factors causing the trouble are discussed.—v. G.

**Worn Machine Parts Reclaimed by Spraying.** J. S. Martin (*Iron Age*, 1937, 140, (6), 36-38).—Describes the method of coating and resurfacing a wide variety of worn machine parts by spraying with Monel metal. The alloy, in depths up to 0.03 in. thick, is slightly harder than the hot-worked or annealed alloy. The method is not suitable for sheet, plate, or tank structures.—J. H. W.

## XXIII.—BIBLIOGRAPHY

(Publications marked \* may be consulted in the Library.)

(Continued from pp. 362-367.)

- \***American Society for Testing Materials.** *Proceedings of the Thirty-Ninth Annual Meeting, Held at Atlantic City, N.J., June 29-July 3, 1936.* Med. 8vo. Volume 36. Part I.—*Committee Reports, New and Revised Tentative Standards, Tentative Revisions of Standards.* Pp. xiv + 1245, illustrated. Part II.—*Technical Papers.* Pp. v + 846, illustrated. [1937.] Philadelphia, Pa.: The Society, 260 S. Broad St. (Paper, \$5.50; cloth, \$6.00; half-leather, \$7.00, per volume.)
- [These volumes maintain the high standard set by this Society. Part I contains reports from 45 standing committees, and also includes some 150 tentative specifications and test methods, either newly published or revised in 1930. Papers appended to reports cover an investigation of aluminum die-castings and the finishing of die-castings. Abstracts of all of non-ferrous interest appeared in *Met. Abs.*, 1936, 3, (13). Part II contains about 50 technical papers. Those of metallurgical interest are: W. H. Swanger and G. F. Wohlgenuth: "Failure of Heat-Treated Steel Wire in Cables of the Mt. Hope, R.I., Suspension Bridge"; H. C. Mann: "High-Velocity Tension-Impact Tests" (*Met. Abs.*, 1936, 3, 702); H. F. Moore, H. B. Wishart, and S. W. Lyon: "Slow-Bend and Impact Tests of Notched-Bars at Low Temperatures" (*Met. Abs.*, 1936, 3, 268); H. W. Russell and W. A. Welker, jr.: "Damage and Overstress in the Fatigue of Ferrous Materials"; A. E. White, C. L. Clark, and R. L. Wilson: "Influence of Time at 1000° F. on the Characteristics of Carbon Steel"; J. J. Curran and F. H. Morehead: "A Direct-Load Creep-Test Machine" (*Met. Abs.*, 1936, 3, 699); A. J. Phillips: "Some Creep Tests on Lead and Lead Alloys" (*Met. Abs.*, 1936, 3, 632); J. N. Kenyon: "The Effect of the Addition of Lead on the Endurance Limit of a Certain Tin-Base Bearing Alloy" (*Met. Abs.*, 1936, 3, 249); W. A. Gibson and J. H. Doss: "Effect of Iron Impurities on the Annealing of High Brass" (*Met. Abs.*, 1936, 3, 274); G. R. Gohn: "The Forming Properties of Some Non-Ferrous Sheet Metals" (*Met. Abs.*, 1936, 3, 302); P. R. Kosting: "Stress-Relief Annealing High-Strength Monel Metal Plate" (*Met. Abs.*, 1936, 3, 274); R. L. Templin: "Ductility Testing of Aluminum and Aluminum Alloy Sheet" (*Met. Abs.*, 1936, 3, 315); S. F. Borgeson: "Flexure and Torsion Testing of Copper Wire" (*Met. Abs.*, 1936, 3, 700); A. J. Phillips and A. A. Smith, jr.: "Effect of Time on Tensile Properties of Hard-Drawn Copper Wire" (*Met. Abs.*, 1936, 3, 631); W. J. Farmer and D. A. S. Hale: "Impact Bend Testing of Wire" (*Met. Abs.*, 1936, 3, 702); W. R. Koch: "The Spectrographic Determination of Magnesium in Aluminum Alloys" (*Met. Abs.*, 1936, 3, 696); D. Harvey: "The Testing of Rubber Insulated Wires and Cables" (*Met. Abs.*, 1936, 3, 373); W. C. Schroeder, A. A. Berk, and E. P. Partridge: "Effect of Solution Composition on the Failure of Boiler Steel under Static Stress at 250° C."; W. M. Wilson: "Applications of the Wedge Extensometer" (*Met. Abs.*, 1936, 3, 702).]
- \***British Aluminium Company, Limited.** *Aluminium in the Textile Industries.* (No. 386.) 7 × 9 in. Pp. 35, illustrated. 1937. London: The Company, Adelaide House, King William St., E.C.4. (Gratis.)
- \***British Standards Institution.** *Handbook of Information, including Annual Report, 1936-37, and Indexed Lists of British Standard Specifications and Methods of Test.* July, 1937. Demy 8vo. Pp. 185. London: The Institution, 28 Victoria St., S.W.1. (1s.)
- \***Cartwright, W., T. W. Collier, and A. Charlesworth.** *The Analysis of Non-Ferrous Metals and Alloys.* (Griffin's Industrial Textbooks. Edited by Percy Longmuir. No. 7.) Demy 8vo. Pp. x + 296. 1937. London: Charles Griffin and Co., Ltd. (8s. net.)
- \***Cazaud, R., et L. Persoz.** *La Fatigue des Métaux.* 16 × 25 cm. Pp. viii + 190, with 121 illustrations. 1937. Paris: Dunod. (Br., 80 francs; relié, 100 francs.)
- \***Gmelin.** *Handbuch der anorganischen Chemie.* Achte völlig neubearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. System-Nummer 35: *Aluminium.* Teil A, Lieferung 4: *Legierungen*



von Aluminium mit Zink bis Uran. Sup. Roy. 8vo. Pp. 683—886, illustrated. 1937. Berlin: Verlag Chemie G.m.b.H. (Auslandspreis R.M. 24.75.)

- \*Greenwood, H. *The Tensile Properties of a Series of White Metal Bearing Alloys at Elevated Temperatures.* (Technical Publications of the International Tin Research and Development Council, Series A, No. 58.) Med. 8vo. Pp. 9, with 2 illustrations. 1937. London: International Tin Research and Development Council, 378 Strand, W.C.2. (Gratis.)
- \*Grützner, A., unter Mitarbeit von G. Apel und C. Götz. *Magnesium Legierungen. Patentsammlung.* Geordnet nach Legierungssystemen. Zugleich Anhang zu Magnesium Teil A in Gmelins Handbuch der anorganischen Chemie. Achte völlig neubearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. Sup. Roy. 8vo. Pp. viii + 192. 1937. Berlin: Verlag Chemie G.m.b.H. (R.M. 15.)
- \*Haynes Stellite Company. *Hard-Facing with Haynes Stellite Products.* Fourth Edition, Revised. Demy 4to. Pp. 104, illustrated. 1937. Kokomo, Ind.: The Company.
- Herzog, E. *Les Méthodes d'essai de corrosion des métaux et alliages.* (Actualités scientifiques et industrielles, 437.) Roy. 8vo. Pp. 78. 1936. Paris: Hermann et Cie. (15 francs.)
- Hogness, T. R., and Warren C. Johnson. *Qualitative Analysis and Chemical Equilibrium.* Pp. 429. New York: Holt. (\$2.75.)
- \*Homer, C. E., and H. Plummer. *Mechanical Properties of Some White Bearing Metals and Other Tin-Base Alloys at Various Temperatures.* (Technical Publications of the International Tin Research and Development Council, Series A, No. 57.) Med. 8vo. Pp. 20, with 17 illustrations. 1937. London: International Tin Research and Development Council, 378 Strand, W.C.2. (Gratis.)
- \*Institution of Civil Engineers. *List of Members of the Institution of Civil Engineers.* Addresses corrected to July 1, 1937. Pp. 438. 1937. London: The Institution.
- \*Institution of Engineers and Shipbuilders in Scotland. *List of Members.* Demy 8vo. Pp. 59. 1937. Glasgow: The Institution, 39 Elmbank Crescent.
- \*International Congress of Acetylene, Oxy-Acetylene, Oxy-Acetylene Welding, and Allied Industries. *The XIth International Congress of Acetylene, Oxy-Acetylene, Oxy-Acetylene Welding, and Allied Industries, London, 1936. Proceedings.* 8½ × 11½ in. In six volumes. Pp. 1566, illustrated. 1936. London:

[All the papers are printed in English; many of them are also printed in French or German. In addition, each paper has a brief summary in English, French, and German. The papers of metallurgical interest are: Volume I.—“Oxy-Acetylene Welding and Cutting in Shipbuilding and Ship Repairing”; C. F. Keel: “Oxy-Acetylene Welding and Oxygen Cutting on Railways”; II. Melhardt: “Co-ordination of Welding Methods and the Training of Welders”; A. M. Portevin: “The Metallurgy, Properties, and Control of Welds”; E. Sauerbrel: “Acetylene Generators”; Volume II.—S. A. Eskillon: “Shrinkages and Contraction Stresses in Fusion Welding”; Y. Mercier: “Influence of Welding Methods on the Mechanical Properties of Welds (Oxy-Acetylene Welding)”; M. Cymbollste: “Plastic-Elastic Equilibrium in Weld Seams” (*Met. Abs.*, 1936, 3, 728); R. Sarazin: “Method and Apparatus for Determining Stresses Introduced into Structures by the Welding Operation”; P. Schoenmaker: “Resistance of Welds to Repeated Stresses”; J. Brillé: “Experiments with Welded Specimens, to Determine the Effect of Heterogeneity in the Ends of Impact Test-Bars on the Impact Value of their Middle Portion”; J. de Jessey: “Influence of the Conditions under which Cutting is Carried Out on the Depth to which the Structure of the Metal is Altered as a Result of Oxy-Acetylene Cutting”; C. F. Keel: “The Creep-Limit of Oxy-Acetylene

Welds"; J. Brillé and A. Roux: "Note on the Mechanical Testing of Deposited Metal"; L. C. Percival and C. Coulson-Smith: "Report on the Use of X-Rays in the Testing of Oxy-Acetylene Welds" (*Met. Abs.*, 1936, 3, 704); R. Berthold: "X-Ray Testing of Welds"; Volume III.—N. T. Belalew and D. Séférian: "A Study of the Widmanstätten Structure in Welds"; A. M. Portevin and A. Leroy: "Some Examples of the Analytical Cases of the Chemical Heterogeneity of Welds"; A. Leroy: "Notes on Several Practical Cases of Corrosion of Welded Joints"; J. Brillé and D. Séférian: "A Contribution to the Study of Weldability in Steels"; D. Séférian: "Influence of Nitrogen on the Weldability of Steel"; A. Portevin and D. Séférian: "The Formation of Metallic Nitrides in the Welding of Steels"; J. Brillé, A. Leroy, and A. Roux: "The Corrosion of Various Constructional Steels"; D. Séférian and A. Leroy: "The Relation between the Corrodibility of Steels and the Structural Modifications Caused by Welding and Oxygen Cutting"; A. B. Kinzel: "Alloying Elements in Welding Rods"; F. Eggelesmann: "Report on the Welding of Light Alloys Containing Magnesium" (*Met. Abs.*, 1936, 3, 725); Volume IV.—R. Meslier: "Comparison between the Results Obtained with Modern Methods of Oxy-Acetylene Welding and Electric Arc Welding"; E. Streb and H. Kemper: "Heat Effects of the Oxy-Acetylene Flame for Various Exit Velocities of the Gas Mixture"; C. F. Keel: "High-Speed Autogenous Welding"; E. Lewis: "A Few Considerations for Further Research on Low-Temperature Steel Welding"; A. Boutté: "Note on the Welding of Aluminium Bronze" (*Met. Abs.*, 1936, 3, 726); A. Horn: "A New Method for the Welding of Zinc Sheets" (*Met. Abs.*, 1936, 3, 728); R. Granjon: "A New Principle in the Practical Training of Oxy-Acetylene Welders" (*Met. Abs.*, 1936, 3, 730); J. Bloch-Sée: "Results of Psycho-Physiological Examinations for the Selection of Welders"; R. Salettes: "Note on a System of Simultaneous Training in Oxy-Acetylene and Electric Welding"; Volume V.—H. Gerbeaux: "Rolled Sections for Welded Construction, with Tables of Slit Joists Rolled by the Grey Process"; H. W. G. Hignett: "Oxy-Acetylene Welding for the Chemical Industry" (*Met. Abs.*, 1936, 3, 728); E. B. Partington: "Lead Welding (Lead-Burning) and Welding of Low Melting Point Metals and Alloys by the Oxy-Acetylene Process" (*Met. Abs.*, 1936, 3, 727); W. L. Kilburn and H. J. Metcalf: "The Development of the Jointing of Light-Gauge Copper Tubes, Bronze Welded Method, Employing the Oxy-Acetylene Blowpipe" (*Met. Abs.*, 1936, 3, 726); O. Bondy: "Gas-Welded Tubular Diving Towers"; T. E. Berry Nixon: "Fabrication by the Use of the Cutting Flame, the Welding Flame, and the Electric Welding Arc"; A. B. Kinzel and O. W. Drury: "Hard-Facing with Stellite" (*Met. Abs.*, 1936, 3, 727); A. Roux: "Suitability of Welds for Case-Hardening"; J. Fassbinder: "The Case-Hardening of Steel by Means of the Acetylene Flame"; J. Fassbinder and P. Soulay: "A Contribution to the Study of Metal Coating with the Pistol" (*Met. Abs.*, 1936, 3, 682); W. E. Ballard and D. E. W. Harris: "Some Observations on the Metal Spraying of Copper" (*Met. Abs.*, 1936, 3, 682); J. Blümmel: "Welding and Cutting Technique in Decoration and in Artistic Handicrafts"; A. Horn: "The Repairing of Large Bronze Bells by Oxy-Acetylene Welding" (*Met. Abs.*, 1936, 3, 726); H. Kleiner: "The Hardening of Brake Drums, with Special Regard to the Oxy-Acetylene Process"; Volume VI.—Various papers on welding in railway work and miscellaneous reports on progress in different countries, &c.; —Maier: "Welding Tests on Plated Sheets." The volumes are very nicely produced in paper covers, and supplied with a case.]

**Jankelewitsch, Sinaida Abramowna, and I. Scheka.** *Industrial Electrochemistry.* [In Ukrainian.] Pp. ii + 146. 1937. Kiev: Wid-wo Akad. nauk USSR. (Rbl. 3.50.)

**Koop, Hans.** *Werkstoffkunde und Werkstoffbearbeitung. Ein kurze Übersicht der im Metallgewerbe verwendeten Werkstoffe unter bes. Berücks. d. Kraftfahrzeugbaues.* (Koop: Kraftfahrzeugkunde, Teil 6.) Pp. 72. 1937. Berlin: R. C. Schmid & Co. (M. 2.70.)

\***Krause, Hugo.** *Metallfärbung. Die wichtigsten Verfahren zur Oberflächenfärbung und zum Schutz von Metallgegenständen.* Zweite, vollständig neu bearbeitete und vermehrte Auflage. 16 × 24 cm. Pp. vii + 183. 1937. Berlin: Julius Springer. (Geh., R.M. 7.50; geb., R.M. 8.80.)

\***Krüger, Richard.** *Leichtmetallkolben für Fahrzeugmotoren. Kolbenbaustoffe Bauarten, Herstellung, Einbau und Betrieb.* 15 × 22 cm. Pp. viii + 140, with 140 illustrations. 1937. Berlin: R. C. Schmidt & Co. (Lw., M. 6.50.)

**Messkin, Weniamin Ssemenowitsch.** *Ferromagnetic Analysis.* [In Russian.] Pp. 791. 1937. Leningrad and Moscow: Onti. (Rbl. 15.50.)