METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

1933 APRIL Part 4

I.—PROPERTIES OF METALS

(Continued from pp. 113–120.)

On the Alleged Allotropy of Antimony. A. Schulze and L. Graf (*Metallwirtschaft*, 1933, **12**, 19–21).—Reversible electrical and dilatometric anomalies of antimony are apparently to be ascribed to internal mechanical deformations, *e.g.* elastic displacements of the crystallites against one another; they disappear on ageing at 600° C. and do not occur in single crystals. No transformation can be detected by X-ray examination at high temperatures.—v. G.

Absorption of Light in Cæsium Vapour. H. J. J. Braddick and R. W. Ditchburn (*Nature*, 1933, **131**, 132–133).—The absorption of light by cæsium vapour (at 270° C. and 0·15–0·6 mm. pressure) has been measured between 3184 A. and 1935 A. The absorption at a given wave-length is proportional to the pressure. Attention is directed to an increase in absorption in the far ultra-violet.—E. S. H.

Tensile Properties of Copper at Low Temperature. Masawo Kuroda (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, No. **393**, 1932, 163–167).—[In English.] Test-pieces were cut from copper plate 3 mm. thick and quenched after annealing at 800° C. Tensile tests were carried out at temperatures from + 16° to − 180° C. by means of an apparatus in which the specimen was immersed in petroleum ether cooled by the admission of liquid air. The stress-strain relations resemble those found by Pester (this *J.*, 1932, **50**, 431), and show no yield-point, in contrast to the results of Schoenmaker (this *J.*, 1931, **47**, 102). K. concludes that the well-defined yield-point in steels is due to the crystal boundary structure, and not to the resistance of slip within the crystal.—W. H.-R.

The Elastic Constants of Single Crystals of Copper. Ren'iti Kimura (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1933, **10**, (1), 35–45).—[In Japanese.] From the modulus of elasticity E and of torsion n in various directions, the Voight moduli were found for single-crystal copper at room temperature: $S_{11}\cdot 10^{12} = 1\cdot 291$; $S_{12}\cdot 10^{12} = -0\cdot 523$; $S_{44}\cdot 10^{12} = 1\cdot 636$; $E_{[111]} : E_{[100]} = 2\cdot 06$; $n_{[111]} : n_{[100]} = 1/1\cdot 81$. These values are all given in c.g.s. units.—S. G.

Comparative Properties of Oxygen-Free High-Conductivity Phosphorized and Tough-Pitch Coppers. W. R. Webster, J. L. Christie, and R. S. Pratt (*Amer. Inst. Min. Met. Eng. Preprint*, **1933**, Feb., 1–4).—A comparison of so-called "oxygen-free high-conductivity copper" and the samples reported on in an earlier paper (*Proc. Amer. Inst. Metals Div., Amer. Inst. Min. Met. Eng.*, **1927**, 233; see this *J.*, 1927, **37**, 382; 1928, **40**, 461). It is found that the oxygen-free copper resembles phosphorized electrolytic, rather than the tough-pitch electrolytic in the annealing temperature at which softening starts. The oxygen-free copper shows high values for reduction in area lying on a very flat curve. Phosphorized copper is better suited to the manufacture of small seamless tubes than is tough-pitch copper. The oxygen-free variety can also withstand more severe drawing operations in greater consecutive numbers than even the phosphorized copper. Annealing scale flakes off the latter, but not off the former.—W. A. C. N.

The Recovery of the Electrical Resistance of Copper, Silver and Gold, and of Platinum and Palladium from the Effects of Cold-Work. G. Tammann and K. L. Dreyer (*Ann. Physik*, 1933, [v], **16**, 111–119).—The changes in the hardness and electrical resistance of copper, silver and gold, and of the thermo-

electric power of platinum and palladium, has been determined during annealing of the cold-worked metals. In the case of the first three the decrease of hardness occurs within the same temperature range as the decrease in resistance; this range is lower for silver than for copper and gold. The resistance and thermo-electric properties of platinum and palladium decrease at temperatures much below those at which softening occurs. The softening temperatures of copper, silver, and gold are reduced by increased cold-work, whereas they remain constant for platinum and palladium with reductions between 15% and 40%. These differences are discussed with reference to the position of the metals in the Periodic Table.—v. G.

The Extraction of Germanium from Germanium-Bearing Spelter Retort Residues. Howard S. Gable (*Rec. trav. chim.*, 1933, **52**, 225–228).—[In English.] Germanium has been extracted from the retort residues from Missouri zinc ores. The residue is heated at about 1350° C. with a large excess of carbon; zinc distils off, whilst germanium is not markedly volatile at this temperature. The germanium in the residue is then treated with hot hydrochloric acid and separated by distillation as germanium tetrachloride. Spectroscopic examination showed that the germanium thus obtained was contaminated only by silicon and iron in appreciable quantities. Spelter retort residues are suggested as a commercial source of germanium. The germanium content varies from 0·1 to 0·5% of the original residue, the material is cheap, and the method of extraction simple.—E. S. H.

The Electrical Conductivity of Mercury at High Temperatures. Werner Braunbek (*Z. Physik*, 1933, **80**, 137–149).—The following relative values of the electrical conductivity of mercury under 300 atmospheres pressure have been determined at the respective temperatures (° C.) stated: 0°, 1·00; 100°, 0·91; 200°, 0·82; 300°, $0{\cdot}73_5$; 400°, 0·65; 500°, 0·57; 600°, 0·50; 700°, $0{\cdot}43_5$; 800°, 0·38; 900°, 0·33. The following values of the pressure coefficient $\times 10^5$ of change of resistance at pressures of between 300 and 600 atmospheres were also found at the respective temperatures: 0°, 3·2; 100°, 3·7; 200°, 4·3; 300°, 5·1; 400°, 5·9; 500°, 6·8; 600°, 7·9. The results are in good agreement with those of Birch [*Phys. Rev.*, 1932, **41**, 641].—J. S. G. T.

Deposits of Metallic Mercury by High-Frequency Discharge. D. Banerji and Radharaman Ganguli (*Phil. Mag.*, 1933, [vii], **15**, 676–681).—Coloured rings, due to deposition of mercury, are found to occur under certain conditions on the inside wall of a high-frequency electric discharge tube containing mercury vapour and fitted with external electrodes.—J. S. G. T.

The Effect of Mercury Vapour on Sliding Contacts. R. M. Baker (*Electric J.*, 1932, **29**, 64–65).—The voltage drop across a sliding contact between brass or copper rings and carbon brushes operating in a non-oxidizing atmosphere of hydrogen or nitrogen was reduced by as much as 90% when a small amount of mercury vapour (derived from a mercury seal) was present. The amount of mercury causing the effect is very small. No mercury was visible on the surface of the ring after running 2–3 weeks.—J. C. C.

The Electromotive Behaviour of Nickel and Cobalt. Erich Müller and J. Janitzki (*Z. physikal. Chem.*, 1932, [A], **162**, 385–397).—Nickel and cobalt resemble iron in their electromotive behaviour, which is exhibited only on damaged places, so that the compact metal shows only a limiting potential at which the rate of diffusion of the ions into solution is the same as the rate of diffusion of the discharged hydrogen atoms. It is doubtful whether in neutral salt solutions the reversible limiting potential of nickel is ever reached. For cobalt in normal cobalt chloride solution $\varepsilon_H = -0{\cdot}292$ v.—B. Bl.

X-Ray Studies on the Diffusion of Copper into Nickel. Chujiro Matano (*Mem. Coll. Sci. Kyōtō Imp. Univ.*, 1932, [A], **15**, 351–353).—[In English.] Cf. this *J.*, 1931, **47**, 71, 475; 1932, **50**, 291. From measurements of the changes in radii of the Debye rings, the coeffs. of diffusion of copper into

nickel have been determined as $3{\cdot}5 \times 10^{-7}$ cm.^{2}/day at 650° C. and $1{\cdot}9 \times 10^{-5}$ cm.^{2}/day at 890° C.—E. S. H.

A New Determination of the Atomic Weight of Osmium. Raleigh Gilchrist (*U.S. Bur. Stand. J. Research*, 1932, **9**, 279–290; and *U.S. Bur. Stand. Research Paper* No. **471**; also (short note) *Met. Ind.* (*Lond.*), 1933, **42**, 154).—A method is described for the preparation of pure osmium. The value of the atomic weight of osmium is calculated from the average percentage of osmium found in carefully prepared samples of ammonium chloro-osmate and of ammonium bromo-osmate. The value obtained from the ratio $(NH_4)_2OsCl_6$: Os is 191·53, and from the ratio $(NH_4)_2OsBr_6$: Os is 191·57, based on the values for nitrogen, hydrogen, chlorine, and bromine given in the International Table of Atomic Weights for 1932. The weighted average value is 191·55. The densities of ammonium chloro-osmate and of ammonium bromo-osmate at 25° C. were found to be 2·93 and 4·09 grm./cm.^{3}, respectively.—S. G.

The Production of Polonium from Radioactive Lead Salts. S. Meyer (*Anz. Akad. Wiss. Wien*, 1931, **68**, 84).—Two methods are described: (1) the polonium was separated as an isomorphous polonium lead tellurate. By separating the lead as sulphate and the tellurium as metal, the polonium alone remained in solution. (2) The polonium was attached to a platinum colloid as carrier, and after exposure to the quartz mercury vapour lamp the platinum was separated and the polonium distilled in a stream of hydrogen.—W. A. C. N.

The Optical Constants of Transparent Silver. Hans Murmann (*Z. Physik*, 1933, **80**, 161–177).—A method for determining the optical constants n, k of thin absorbing layers of known thickness deposited on a transparent plate is described and applied to the case of a deposit of silver. The dependence of n and k on the thickness of deposit is discussed. The density of a layer of silver of thickness 15 mμ is the same as that of massive silver.—J. S. G. T.

The Diffusion of Thorium in Tungsten. Gorton R. Fonda, Andrew H. Young, and Amy Walker (*Physics*, 1933, **4**, (1), 1–6).—Thoriated tungsten wires have been heat-treated in gas so as to develop variations in grain-size ranging in length from 4 μ to 3 cm. These variations produced marked changes in the thermionic emissive characteristics, *e.g.*, rates of de-activation and duration of emissive life at normal operating temperature. The heat of diffusion was unaffected. The intergranular diffusion of thorium through tungsten is too rapid to be measured. The conception that the observed phenomena depend entirely on such diffusion is in accord with the existence of a critical grain-size for the realization of a maximum emissive life. Experiments demonstrating the spreading of thorium atoms over the surface of a tungsten single-crystal, and showing the effect of slight strains in the crystal lattice on activation, are described.—J. S. G. T.

Experiments on the Contact Potential of Zinc Crystals. W. A. Zisman and H. G. Yamins (*Physics*, 1933, **4**, (1), 7–9).—Experiments showing that it is possible to obtain a reproducible contact p.d. on zinc in air at ordinary pressures by using the cleaved surface of a single crystal, are described. It is suggested that the lack of reproducibility of the Volta effect of turned or scraped surfaces of zinc is due to anisotropy of the crystals, and not to condensation phenomena associated with roughness of the surface. Confirmatory evidence is found in the reproducibility of the contact p.d. of turned and scraped surfaces of copper. Ende's suggestion that emery embedded in the metals gives rise to false p.d. is shown to be correct. Emery increases the p.d. between zinc and gold by about 0·4 v.; rouge decreases it by about 0·5 v.—J. S. G. T.

The Exact Determination of Specific Heats at Elevated Temperatures. III.—Systematic Study of the Causes of Experimental Error in the Use of the Metallic Calorimeter and in the Measurement of the Specific Heats of Worked Metals. F. M. Jaeger, E. Rosenbohm, and J. A. Bottema (*Rec. trav. chim.*, 1933, **52**, 61–84).—Attention is directed to the discordance of published

experimental data concerning the specific heats of metals and the variation of these values with temperature. The phenomena accompanying the exchange of heat between a metal calorimeter and its surroundings are considered, and it is shown that the apparent invalidity of Newton's law must be attributed to the properties of the Dewar flask employed. The necessary cooling corrections are discussed. The value obtained for the specific heat is influenced very strongly by the particular internal condition of polycrystalline metal, which is as a rule ill-defined, even when allotropic modifications are absent. This is regarded as the principal cause of lack of reproducibility. When the metals are subjected to a definite thermal treatment, the internal structure is stabilized, and reproducible results are obtained. These features are illustrated by measurements of the specific heats of platinum, silver, copper, and gold.

—E. S. H.

The Change in Thermo-Electric Power on Recovery of Metals from Cold-Work. G. Tammann and G. Bandel (*Ann. Physik*, 1933, [v], **16**, 120–128).—The thermo-electric power of metal wires drawn to various degrees of hardness has been measured against fully-annealed wires of the same metal and the effect of temperature on the e.m.f. has been determined. For wires drawn down to 95–98% reduction, silver gives 0·5, copper 0·10, gold 0·05, magnesium 0·14, iron −0·4, nickel 0·95, platinum 0·07, palladium 0·8 v./° C., and aluminium zero against the corresponding annealed wire. The e.m.f. in the case of silver rises linearly with the degree of reduction. The temperature interval during which the thermo-electric power of silver decreases coincides approximately with that in which the recovery of the electrical resistance occurs. The e.m.f. of the hard/soft silver couple decreases by about 20–30% during 2 weeks' storage at room temperature.—v. G.

Exploring the Conductivities of Molten Metals. Anon. (*Electric J.*, 1932, **29**, 193).—A note, illustrated by resistivity-temperature curves for tin, copper, and two copper–tin alloys containing 4% and 2% tin, respectively. These were obtained from measurements of the voltage drop between contacts at the ends of a porcelain rod which was mounted in a fused quartz tube and immersed in the molten metal through which a constant current was passed.—J. C. C.

A Theory of the Change of Electrical Resistance in Metals Caused by Hydrostatic Pressure. Kôtarô Honda, Tamotu Nishina, and Tokutarô Hirone (*Sci. Rep. Tôhoku Imp. Univ.*, 1932, [i], **21**, 851–868).—[In English.] See abstract from another source, this *J.*, 1932, **50**, 422.—E. S. H.

Change of Electrical Resistance Due to Magnetization. Walther Gerlach (*Physikal. Z.*, 1932, **33**, 953–957).—Read before the VIII Deutsche Physikertag, September, 1932. The following matters are discussed: (1) the relation between the temperature coeff. of electrical resistance of a ferromagnetic metal, *e.g.*, nickel, and its magnetic energy; (2) change of electrical resistance associated with magnetization in the neighbourhood of the Curie point; and (3) change of electrical resistance in intense fields below the Curie point.

—J. S. G. T.

Superconductivity in Metals. E. L. Hill (*Rev. Sci. Instruments*, 1933, [N.S.], **4**, (1), 3–6).—A very readable article, briefly summarizing knowledge of the phenomenon of superconductivity in metals, is presented.—J. S. G. T.

Theory of Superconduction.—II. R. de L. Kronig (*Z. Physik*, 1933, **80**, 203–216).—Cf. *J.*, this volume, p. 118. A theory of superconduction, explaining why only elements of small atomic volume and many outer electrons can function as superconductors, is developed.—J. S. G. T.

Transverse Magnetostriction Effect. Werner Fricke (*Z. Physik*, 1933, **80**, 324–341).—A method, employing high-frequency fields, for the investigation of the transverse magnetostriction effect in cylindrical rods is described and results obtained with iron, nickel, and cobalt are detailed.—J. S. G. T.

II.—PROPERTIES OF ALLOYS

(Continued from pp. 120–128.)

Thermal Expansivity of Aluminium Alloys. L. W. Kempf (*Amer. Inst. Min. Met. Eng. Preprint*, **1933**, Feb., 1–15).—Data have been gathered during the examination of a great number of alloys used in the development of an aluminium piston having relatively low thermal expansion. The apparatus was essentially of the (U.S.) Bureau of Standards type. Pure metals were used in the alloys. Generally by adding metals of lower thermal expansivity to aluminium an alloy is produced with a lower coeff. of expansion than that of pure aluminium. The latter decreases with increasing quantities of the alloying element when the coeff. of expansion of the latter is lower than that of pure aluminium. Copper, silicon, nickel, and iron are increasingly efficacious in this order in reducing the coeff. of expansion of aluminium. Some variation arises in the results for copper as compared with those of some previous workers. It is pointed out that structural changes attendant on the reheating during the determination of thermal expansion may, if disregarded, bring about relatively large errors in the determination. Approximate coefficients of thermal expansions for a number of commercial aluminium alloys have been estimated. Basic data available on the effect of various alloying elements on the thermal expansion of pure aluminium have been used.—W. A. C. N.

The Equilibrium Diagram of the Binary System Antimony–Manganese. Takejiro Murakami and Atsuyoshi Hatta (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1932, **9**, (11), 465–475).—[In Japanese.] The equilibrium diagram of the antimony–manganese system has been determined by means of thermal analysis, electrical resistance measurements, and microscopic examination. In this system there exist 3 intermetallic phases, η(MnSb), ϵ(Mn_3Sb_2), and δ(Mn_2Sb). The η-phase has practically no solubility range and forms a eutectic with antimony at 570° C., 9·5% manganese. The ϵ-phase is formed by the peritectic reaction melt $+ \delta \rightleftarrows \epsilon$ at 872° C., the existing range being 32–41% manganese. The δ-phase exists in the range 45–50% manganese at high temperature, and 47–48% manganese at room temperature. The δ-phase forms a eutectic with the β-phase (Mn) at 922° C., 55% manganese. The β-phase is produced by the peritectic reaction melt $+ \gamma \rightleftarrows \beta$ at 1202° C. On further cooling, the β-phase is resolved into the α-(Mn) and δ-phases at 677° C., 94·5% manganese by the eutectoid reaction $\beta(Mn) \rightleftarrows \alpha(Mn) + \delta$.
—S. G.

Resistance to Fatigue of some Aluminium Casting Alloys. R. Cazaud (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 485–486).—Results are cited for the following alloys: (1) aluminium 92, copper 8%, sand-cast; (2) aluminium 88, copper 12%, chill-cast; (3) aluminium with silicon 5, 12, and 18%, chill-cast.—W. N.

Beryllium Alloys. R. Straumann (*Uhrmacherkunst*, 1932, **57**, 655–656; and (abstract) *Z. Instrument.*, 1933, **53**, 93).—The hardening effect of beryllium on copper is described. Alloys of copper–beryllium, nickel–beryllium, iron–nickel–beryllium, and chromium–nickel–beryllium are useful in the manufacture of watches and clocks. A copper–beryllium alloy (2·5% beryllium) is particularly useful for springs and driving parts; it is non-magnetic, is less liable to break than steel, and does not rust. The nickel–beryllium alloy is suitable for springs that have to withstand high temperatures. All the alloys should be melted in a vacuum in order to avoid the formation of beryllium oxide.—E. S. H.

An Electrochemical Investigation of Cadmium–Silver Alloys. Arne Ölander (*Z. physikal. Chem.*, 1933, [A], **163**, 107–121).—The electrode potential of the cell cadmium (liquid) | lithium, rubidium, cadmium chloride | cadmium -

silver alloy (solid) and its temperature coeff. have been determined for 71 alloys between 330° and 555° C. The results agree, in the main, with the known equilibrium diagram, except that a δ-field has been separated from the γ-field. The δ-phase has a lattice structure which is identical with that of the γ-phase, and it is assumed that the γ-phase has an oriented and the δ-phase a random atomic distribution. The β′-phase bears a similar relation to the β-phase as the γ-phase to the δ. The heats of transformation of γ into δ and of β′ into β have been calculated and the deviation of the oriented atomic structure of the β′ and γ-phases from the perfect orientation has been estimated.—B. Bl.

Calcium Alloys [of Lead and Copper]. R. R. Syromiatnikov (*Metallurg* (*Metallurgist*), 1931, **6**, 466–485; *Chem. Zentr.*, 1932, **103**, II, 3615–3616).—[In Russian.] Calcium forms two compounds with lead, Pb_3Ca, melting point 670° C., and PbCa. Pb_3Ca forms a eutectic with lead (melting point 330° C.) and with PbCa (melting point 630° C.) containing 9·2% calcium. Alloys with more than 16% calcium cannot be prepared under a calcium chloride slag; on melting calcium with lead under slags containing chlorides of lithium, sodium, potassium, or barium, alloys are obtained which contain more or less of the metal in the slag. Iron crucibles are the only satisfactory containers for melting the alloys, the use of clay or porcelain crucibles resulting in contamination of the alloy with aluminium and silicon. Alloys with up to 10% calcium can be prepared by electrolysis of a mixture of calcium chloride and fluoride over molten lead which is kept stirred during the process; with current at 18 v. external heating of the crucible is unnecessary. Rapidly-cooled calcium–lead alloys are harder than slowly-cooled alloys, but lose their extra hardness after annealing at 175° C. Calcium–copper alloys with up to 16·8% calcium can be prepared by adding calcium to molten copper under a calcium chloride and fluoride flux using a copper rod; iron rods contaminate the alloys with iron. The 16% calcium alloy has a structure comprising copper crystals surrounded by the copper–Cu_3Ca eutectic and forms a suitable material for use in deoxidizing copper. With 0·5% calcium the conductivity of copper falls to 50% of that of pure copper, but the hardness and tensile strength are scarcely affected; addition of molybdenum does not overcome the effect of calcium on the conductivity of copper as stated by Regelsberger.—A. R. P.

Physical Properties and Structure of the Binary System Iron–Cobalt. A. Kussmann, B. Scharnow, and A. Schulze (*Z. tech. Physik*, 1932, **13**, 449–460).—The abnormally high conductivity at low temperatures of body-centred cubic iron–cobalt alloys in the middle of the system corresponds with a high saturation magnetization; the density, thermal expansion, and hardness do not show any peculiarities, and the alloys probably consist of an ordered solid solution phase of the β′-brass type. The transformation from random to regular orientation cannot be suppressed by quenching, and shows no (or only a very small) hysteresis. At the upper limit of the transformation range of the alloy with 52% cobalt, which should lie at about 800° C., no sharp transformation point has so far been found by electrical measurements. This probably lies at still higher temperatures just below the γ–α change point, and either consists of a change in the state of the valency electron system without rearrangement of the atoms or of a close proportionality between the lattice changes and the atomic grouping.—J. W.

Notes on the Copper-Rich Alloys. H. C. Anstey (*Metallurgia*, 1933, **7**, 117–118).—The development of copper alloys is briefly reviewed and the effect of small percentages of other elements such as zinc, tin, lead, silver, silicon, and phosphorus on the modulus of elasticity, coeff. of expansion, and electrical conductivity of copper is discussed. Special reference is made to the "aluminium–bronzes" and to their increasing application in engineering due to their high tensile strength, which is retained at elevated temperature, and which results from their modification with small percentages of nickel and

iron. It is also suggested that in the future development of alloys it may be possible to determine mathematically the subsequent conditions which will result when two or more systems combine.—J. W. D.

Investigation on the Influence of the Thermal Treatment on the Magnetic Properties of Geissler Alloys. W. W. Sholobow (*Metallurg* (*Metallurgist*), 1931, **6**, 856–868; *Chem. Zentr.*, 1932, **103**, II, 3615).—[In Russian.] The residual magnetism of the alloys decreases with increase in temperature and reaches zero between 150° and 350° C. except in the case of the alloy containing copper 57·3, manganese 26·2, and aluminium 16·5%, the magnetism of which increases with increase in temperature. In alloys in which the residual magnetism decreases on heating it increases during cold-rolling; and in alloys in which it increases on heating it decreases during cold-rolling. Hard-rolled alloys lose their magnetism at lower temperatures (150°–250° C.) than similar annealed alloys (250°–350° C.). The change in the magnetic properties caused by temperature changes appears to have no connection with the transformations revealed by thermal and micrographic analysis.—A. R. P.

Rate of Precipitation of Nickel Silicide and Cobalt Silicide in the Hardenable Copper–Nickel–Silicon and Copper–Cobalt–Silicon Alloys. Curtis L. Wilson, Horace F. Silliman, and Eugene C. Little (*Amer. Inst. Min. Met. Eng. Preprint*, 1933, Feb., 1–12).—The paper arises out of a paper by Corson (this *J.*, 1928, **40**, 505). It shows that although the rate of precipitation increases with the reheating temperature in a general way it does not do so continuously. The discontinuities are shown on curves which are supplementary to Corson's. Modifications in the solubility curves are suggested. The hardness of the heat-treated nickel silicide alloys was found to depend on the percentage of nickel silicide present, the quenching temperature, the temperature of reheating the quenched specimens, and the length of time the specimens were held at the reheating temperature.—W. A. C. N.

Investigations on the Equilibrium Relations of Heavily Alloyed Bronzes. I.—Studies on the Copper–Nickel–Tin System. II.—Studies on the Equilibrium Diagram of the Lead–Tin Bronzes. J. Veszelka (*Banyamérnöki es Erdömérnöki Főiskola bányászati es Kohászati osztályának Közleményeiből*, 1932, **4**, 1–24, 25–42; and *Mitt. berg. hütt. Abt. Kgl. Hochschule Berg.- u. Forstwesen zu Sopron, Ungarn*, 1932, **4**).—[In German.] (I.—) The ternary system nickel–copper–tin contains 5 quasi-binary systems, *viz.*, copper–Ni_3Sn, copper–Ni_3Sn_2, Cu_4Sn–Ni_3Sn_2, Cu_3Sn–Ni_3Sn_2 and Cu_6Sn_5–Ni_3Sn_2, from which it appears that nickel has a greater affinity than copper for tin. The equilibria in the ternary system have been investigated by thermal and micrographic analysis of alloys with constant nickel contents of 2, 4, 7, 10, and 15%, and of alloys with a constant tin content of 25%, as well as by determination of the isothermals for 750°, 700°, and 500° C. The characteristic solidification and transformation reactions in copper–tin alloys are suppressed by the presence of more than 4% nickel, and the peritectic horizontal α + liquid $\longrightarrow \beta$ becomes a surface with 7% nickel corresponding with no definite reaction other than the end of the solidification process. With increasing nickel the β-field becomes smaller, and finally disappears at 5% nickel, the γ-phase solidifies over a spherical surface, and, with more than 7% nickel, the α- and γ-phases form a eutectic mixture. The transformation temperature of β is increased by addition of nickel, and with 4% nickel it begins immediately after the alloy solidifies. The γ-phase is stabilized by addition of nickel as the Ni_3Sn_2 thereby formed remains in solid solution down to room temperature; no decomposition into (α + δ) occurs, therefore, except when the nickel content is low or the tin content very high. In the quasi-binary system copper–Ni_3Sn_2 the solubility of the compound in copper increases rapidly with rise of temperature, hence these alloys, especially those with 3–15% nickel, can be hardened by quenching and ageing. The paper contains

numerous sectional equilibrium diagrams and photomicrographs of characteristic structures. (II.—) Cf. *J.*, this volume, p. 12. Lead affects only slightly the solidification and transformation processes of tin–copper alloys; the only new reactions caused by lead are the formation of a lead-rich liquid by a monotectic reaction similar to that which occurs in lead–copper alloys, and the reaction α + liquid (copper) $\longrightarrow$ β + liquid (lead) which occurs over a wide concentration range at 772° C. The miscibility gap in the quasi-binary system Cu_3Sn–lead begins at 2% lead.—A. R. P.

Precipitation of Alpha from Beta Brass. Oscar T. Marzke (*Amer. Inst. Min. Met. Eng. Preprint*, **1933**, Feb., 1–10).—An attempt to determine the character of the needle-like α-phase precipitate in the copper–zinc system and also the orientation relationship between the matrix and the precipitate. A summary of recent work on this and cognate subjects is given. Alloys containing 62, 60, 58, and 56% copper, respectively, were used. They were prepared from very pure materials. Heat-treatment consisted in quenching at a controlled rate, rapid quenching followed by reheating, and rapid quenching after furnace cooling various amounts below the transformation temperatures. The quenching media were tap water, cold air blast, still air furnace, sand and oil at 200° C. Two types of precipitate were ultimately observed, depending on the temperature of precipitation. At high temperatures it occurred in needle form, and at low temperatures in plates. It was found that a (111) plane and [011] direction of the precipitate are parallel to a (011) plane and [111] direction of the matrix.—W. A. C. N.

Studies on Brasses. —— Moustacas and —— Merle (*Usine*, 1931, **40**, (23), 33).—Abstract of paper read before the 10e. Congrès de Fonderie. Many foundry troubles, especially with brass, are thought to be due to the metal, and would be avoided by closer co-operation between the refiner and the founder. Differences in properties of brasses having practically the same chemical composition are thought to be due to "brass disease," and a small amount of afflicted metal may contaminate a charge.—H. W. G. H.

The Precious Metal Alloys of Gold, Silver, and Nickel. F. Renaud (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 444–448).—The gold–nickel alloys are interesting metallurgically on account of their sensibility to heat-treatment at low temperatures which is accompanied by structural modifications. Silver–nickel alloys, on the other hand, offer problems with regard to the solubility of the metals in one another and to the homogeneity of the resulting materials. The equilibrium diagrams and physical properties of these alloys are discussed. —W. A. C. N.

Investigations on the Solid Solution System Gold–Silver and on Its Attackability by Nitric Acid. M. Le Blanc and W. Erler (*Ann. Physik*, 1933, [v], **16**, 321–336).—Tests on the solubility of gold–silver alloys in nitric acid of such a density that it will not dissolve pure gold show that there are no well-defined resistance limits at 49° C. Even alloys with less than 48 atomic-% silver lose some silver after prolonged exposure to the acid. The attackability rises at first slowly, then rapidly, and finally slowly again with increasing silver until a solubility equal to that of pure silver is reached. The steep rise in the solubility lies between 57 and 62 atomic-% silver, but depends to some extent on the time, density of the acid, and degree of working, cold-working increasing the rate of dissolution of the silver. Determinations of the lattice constants agreed well with those of Sachs and Weerts; the minimum of the constants, however, was found at about 50 atomic-% silver.—v. G.

White Metal Bearing Alloys: Mechanical Properties at Different Temperatures and Service Tests. Harry K. Herschman and John L. Basil (*U.S. Bur. Stand. J. Research*, 1933, **10**, 1–5; and *U.S. Bur. Stand. Research Paper* No. **512**).—A more complete discussion of the details and results of this investigation was presented in a paper read before the American Society for

Testing Materials (see this *J.*, 1932, **50**, 429). Some additional work has since been completed; this included (1) a metallographic study of the alloys tested, and (2) the determination of the mechanical properties of hardened lead B (lead 98, sodium 0·65, potassium 0·3, calcium 0·75, lithium 0·4%).—S. G.

Thermal and Electrical Conductivities of a Number of Magnesium Alloys and Their Relation to the Wiedemann–Franz Law. Rimpei Kikuchi (*Sci. Rep. Tôhoku Imp. Univ.*, 1932, [i], **21**, 585–593).—[In German.] Cf. this *J.*, 1932, **50**, 732. The thermal and electrical conductivities of pure magnesium and of binary alloys of magnesium containing up to about 6% of other metals have been determined. The alloying metals decrease both conductivities progressively, the magnitude of the effect produced increasing in the order copper, nickel, silver, zinc, tin, aluminium. The Wiedemann–Franz law holds only approximately.—E. S. H.

Tensile Properties of Cast Nickel–Chromium–Iron Alloys and of Some Alloy Steels at Elevated Temperatures. William Kahlbaum and Louis Jordan (*U.S. Bur. Stand. J. Research*, 1932, **9**, 327–332; and *U.S. Bur. Stand. Research Paper* No. **474**).—The tensile properties as measured in "short-time" tests were determined for a medium–manganese steel at 900° F. (482° C.); for a series of cast nickel–chromium–iron alloys containing carbon 0·5, chromium 35, and nickel 10–45%, at a temperature of 1550° F. (843° C.); and for 3 tungsten–chromium–vanadium steels and 4 molybdenum–chromium–vanadium steels at temperatures of 850° and 1000° F. (454° and 538° C.). The nickel–chromium alloys showed no marked change in proportional limit at 1550° F. (843° C.) over the range of composition studied. With nickel contents above 30%, the tensile strengths of the alloys decreased noticeably and the ductility increased.—S. G.

Special Cupro–Nickel Alloys. M. Ballay (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 203–208).—Cf. this *J.*, 1932, **50**, 541. Initially the equilibrium diagram of the copper–nickel series and the physical properties of the most important commercial alloys in that series are discussed. The effect of impurities in modifying those physical properties is enlarged upon. Especial attention is given to Monel metal. Separate sections are devoted to the consideration of copper–nickel alloys containing varying amounts of silicon and tin, both separately and together. Alloys containing aluminium are employed in the cast state, and are said to have good mechanical resistance, and to be reasonably resistant to corrosion, particularly by sea-water. Manganese in small quantities increases the hot-working properties.—W. A. C. N.

Copper–Nickel Alloys Containing Silicon. M. Ballay and A. Le Thomas (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 598–611).—Cf. this *J.*, 1932, **50**, 541, 661. The resistance to oxidation, erosion, and shock, and the satisfactory physical properties of copper–nickel–tin alloys are first discussed and illustrated by curves and results. While the influence of manganese, antimony, zinc, and lead in these alloys is negligible, that of silicon is important. The effect of silicon on various standard copper–nickel–tin alloys, up to a content of 5% silicon, has been studied. Photomicrographs are given to indicate the various structural changes.—W. A. C. N.

On the Equilibrium Diagram of the Binary System Nickel–Zinc. Kanzi Tamaru (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1932, **9**, (12), 511–626).—[In Japanese.] See abstract from the English copy of this paper, *J.*, this volume, p. 15.—S. G.

Factors Determining the Properties of White Bearing Metals. J. Neill Greenwood and G. B. O'Malley (*Proc. Australian Inst. Min. Met.*, 1932, (**87**), 207–215).—A brief resumé of the properties of tin- and lead-base bearing metals and the effect of casting conditions on the structure and behaviour during use.—A. R. P.

Magnolia Metal. Anon. (*Technique moderne*, 1931, **23**, 27).—An outline of the properties of this alloy.—H. W. G. H.

[Report on] Inorganic Chemistry. H. Bassett (*Ann. Rep. Prog. Chem.*, 1932, **29**, 74–95).—A review of recent work on the chemistry of non-ferrous metals. References are given to work on the following systems: silver–copper–manganese, iron–nickel–phosphorus, iron–zirconium, iron–cobalt–tungsten, iron–cobalt–molybdenum; silver–copper–zinc, aluminium–magnesium–silicon, aluminium–magnesium–copper, aluminium–copper–silicon, aluminium–copper–iron, iron–cobalt–carbon, and iron–cobalt–chromium.
—E. S. H.

On the Existence of Resistance Limits in Solid Solutions with Random Atomic Distribution.—II. U. Dehlinger and R. Glocker (*Ann. Physik*, 1933, [v], **16**, 100–110).—In continuation of earlier work (see this *J.*, 1932, **50**, 607) it has been calculated that the frequency of chains consisting of two of the less noble atoms in a solid solution lattice decreases rapidly at 29 atomic-%, and those consisting of three such atoms at 21 atomic-%. However, all these calculations give a very close approximation to zero solubility, but not complete insolubility, as has been observed experimentally at Tammann's suggested "resistance limits". It is therefore assumed, and this is supported by the researches of Graf (see this *J.*, 1932, **50**, 355), that the atoms of the noble metal go into solution from the surface layer attacked by the solvent, and then are again precipitated in the voids in the second layer, and thus, if their concentration therein is sufficient, further attack is hindered.—v. G.

Contribution to the Investigation of the Cathodic Disintegration of Metallic Alloys.—III.–IV. L. Belladen (*Gazz. chim. ital.*, 1932, **62**, 493–496, and 497–502).—Cf. this *J.*, 1932, **50**, 354. (III.—) The cathodic disintegration of bismuth–antimony and copper–tin alloys is shown graphically as a function of the composition. (IV.—) The results obtained in the whole series are discussed with reference to the crystal symmetry and lattice structure of the various alloys investigated. The composition of the dusts obtained from solid solutions, intermetallic compounds and eutectics, and the influence of cold-working and annealing on the pulverization of copper are discussed, and a definite relation between pulverization and lattice parameters has been established.
—G. G.

The Exact Determination of Specific Heats at Elevated Temperatures. IV.—The Law of Neumann–Joule–Kopp–Regnault Concerning the Additivity of Atomic Heats of the Elements in Their Chemical Compounds. F. M. Jaeger and J. A. Bottema (*Rec. trav. chim.*, 1933, **52**, 89–111).—See this *J.*, 1932, **50**, 478.—E. S. H.

The Magnetic Susceptibility of Several Systems of Binary Alloys [Au–Ag; Au–Cu; Sb–Bi; Pt–Pd; Sn–Bi; Bi–Pb; Cd–Sn; Sb–Pb; Bi–Te; Al–Sn]. Yosomatsu Shimizu (*Sci. Rep. Tôhoku Imp. Univ.*, 1932, [i], **21**, 826–850).—[In English.] The relation between magnetic susceptibility and concentration has been examined in the systems gold–silver, gold–copper, antimony–bismuth, and platinum–palladium (which form continuous solid solutions), and also in the systems tin–bismuth, bismuth–lead, cadmium–tin, antimony–lead, bismuth–tellurium, and aluminium–tin. All the specimens were prepared by melting and annealing in a vacuum. The great effect of absorbed gases is emphasized, and the curious results obtained by previous investigators of these systems are attributed to the neglect to melt and anneal in a vacuum. In the case of alloys which form continuous solid solutions the maximum deviation of susceptibility from the values calculated from the additive law is small, whilst the deviation of density is less than 1%. In the case of eutectic alloys with solubility on both sides, the susceptibility–concentration curve is linear in the range of eutectic composition and slightly curved in the range of solid solution. The apparent decrease of magnetic susceptibility of bismuth or antimony on

adding small quantities of tin, tellurium, lead, &c., which has been attributed to the formation of a solid solution, is shown to be due to the presence of absorbed gases.—E. S. H.

Hall E.M.F. and Intensity of Magnetization. E. M. Pugh and T. W. Lippert (*Phys. Rev.*, 1932, [ii], **42**, 709–713).—Further experiments confirm P. and L.'s previous conclusion (*ibid.*, 1930, [ii], **36**, 1503), that the Hall e.m.f. is a linear, single-valued function of the intensity of magnetization $B-H$, but is neither a linear nor a single-valued function of either the induction B, or the applied field H alone. The materials investigated included electrolytic iron, various steels, an iron–cobalt alloy (50% cobalt), and an iron–nickel alloy (30% nickel). In each material the ratio $E/(B-H)$ remained constant, dependent on temperature and previous heat-treatment only, for all of the magnetic changes to which it was subjected.—W. H.-R.

Mono-Crystal Barkhausen Effects in Rotating Fields. Fred J. Beck, Jr., and L. W. McKeehan (*Phys. Rev.*, 1932, [ii], **42**, 714–720).—The experiments described refer to silicon–steel, but the results are of general interest. A single crystal disk of silicon–steel was held stationary in a magnetic field, which was rotated slowly in the plane of the disk. Two search coils mounted at right angles were used to measure the longitudinal and transverse components of the change in magnetization arising from the same Barkhausen discontinuity. For low values of magnetization ($I = 190$ and 100, respectively) the effects were mainly transversal with respect to the applied field H, and were more nearly transversal for the greater value of magnetization. The direction and frequency of the effects were unaffected by changing the direction of H in the plane of the disk so that no dependence on the crystallographic directions of I, H, or dH/dt has been established.—W. H.-R.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 128–130.)

A Micrographic Study of the Decomposition of the β-Phase in the Copper–Aluminium System. Cyril Stanley Smith and W. Earl Lindlief (*Amer. Inst. Min. Met. Eng. Tech. Publ.* No. **493**, 1933, 1–39).—Micrographic examination of specimens of an aluminium–copper alloy containing 11·87% aluminium after annealing at temperatures between 566° and 573° C. has shown that the eutectoid temperature is 570° ± 1° C.; electrical conductivity measurements have confirmed this. Numerous samples of the alloy were quenched from the homogeneous β-field in a salt bath maintained at constant temperatures between 375° and 565° C. and their microstructure was examined after varying periods in the bath. At 565° C. the transformation started after 1 hr. and was completed in 10 hrs., whereas at 535° C. it was complete after 7 minutes; at still lower temperatures the rate of transformation rapidly decreased, until at 400° C. it occupied 5 days. The high rate of transformation at 535° C. was accompanied by the appearance of a new transitional phase β′, from which the α-needles or plates grew very rapidly; the amount of α formed was greater the lower the temperature, and below 400° C. practically the whole of the alloy was converted into α, although the saturated α-phase normally contains only 9·8% aluminium. A theory is advanced to account for the formation of β′ and supersaturated α based on the assumption that β′ is more stable than β at temperatures below 535° C. and contains a higher aluminium content. The β′ phase appears as clusters of rosettes in specimens etched with ammoniacal hydrogen peroxide or with a solution of chromic acid in 1 : 1 nitric acid; ferric chloride, ammonium persulphate, and potassium dichromate etching reagents fail to reveal its presence. Addition of large amounts of tin to the alloy stabilizes the β′-phase, but small amounts tend to delay its formation on cooling.

The hardness of β′ is approximately the same as that of β, and it is suggested that the so-called β′ of Obinata (this *J.*, 1930, **43**, 456) was really a fine (α + δ) complex. The final hardness of eutectoidal specimens increases with decreasing temperature of formation from 565° to 525° C., then decreases at lower temperatures owing to the appearance of α before the eutectoid.—A. R. P.

The Distinction Between Rolled Gold and Electroplated Gold. E. Raub (*Mitt. Forschungsinst. Edelmetalle*, 1932, **6**, 57–63).—Edges of the articles which have been cut, sawn, or punched when examined under the microscope show the absence of gold on the cut side when the article is made of rolled gold, whereas in plated articles all portions have the same thickness of gold. Soldered places in rolled-gold articles are also free from gold on the surface, but are covered in plated articles. The thickness of gold in pressed parts is the same on the prominences and in the recesses in the case of rolled gold, but is thinner in the recesses in the case of plated gold. In the links of chains gold fails to plate at the places where 2 links touch, but in rolled gold chains there is an equal thickness of gold all round the link. To prepare the specimens for examination they should first be plated with copper from a cyanide bath, then from an acid bath until a heavy coating is obtained; the article is then sectioned, polished, and etched in concentrated nitric acid for 1–2 seconds.
—A. R. P.

Segregate Structures of the Widmanstätten Type Developed from Solid Solutions of Copper in Zinc. M. L. Fuller and J. L. Rodda (*Amer. Inst. Min. Met. Eng. Preprint*, **1933**, Feb., 1–13).—Presents an analysis of the crystallographic relationship between the segregate and the solid solution matrix in the Widmanstätten structures observed when a secondary phase ε is precipitated from the η solid solution of copper in zinc. The plane of segregation in the matrix contains the direction of closest atomic packing of the lattice. Both segregate and matrix are hexagonal close-packed. It is suggested that a (10·4) plane of the segregate is parallel to a (10·4) plane of the solid solution matrix, that the closest-packed directions in the two planes, which are at the same time directions of closest possible atomic packing in this type of lattice, are coincident, and that the principal axes of the segregate crystals are at 4° to the principal axis of the parent mixed crystal. A theoretical explanation of the mechanism of the segregation phenomenon has been put forward.—W. N.

Preparation of Lead and Lead Alloy Cable Sheath for Microexamination. Earle E. Schumacher and G. M. Bouton (*Met. Ind.* (*Lond.*), 1933, **42**, 101–103).—Abstract of the discussion of a paper by W. H. Bassett, Jr., and C. J. Snyder, read before the American Society for Testing Materials (see this *J.*, 1932, **50**, 485).—J. H. W.

The Measurement of Grain-Size. R. G. Johnston (*Met. Ind.* (*Lond.*), 1933, **42**, 145–146).—Gulliver's theory of grain measurement (this *J.*, 1918, **19**, 145) depends on 2 assumptions, *viz.*, that the average or mean grain-size as usually obtained has a real meaning, and that the number of grains in a given field can be counted. It is claimed that neither of these postulates can be granted, and that the only possible method of measuring grain-size is by comparison with an arbitrarily accepted standard grain pattern.—J. H. W.

Grain-Size Measurement. J. D. Jevons (*Met. Ind.* (*Lond.*), 1933, **42**, 194).—A letter supporting the conclusions given in an article by R. G. Johnston (see preceding abstract).—J. H. W.

Recrystallization Power and Shear Hardening in Aluminium Single-Crystals. W. G. Burgers (*Nature*, 1933, **131**, 326–327).—Experiments on the recrystallization of stretched single-crystals of aluminium indicate that, for the same amount of shear, the number of crystallites formed under identical conditions of heat-treatment decreases as the number of slip planes involved in the distortion increases. An explanation, based on G. I. Taylor's view of curvature on slip planes, is given, and the possibility of the simultaneous occurrence of lower recrystallization power and greater hardening is considered.—E. S. H.

New Additions to the Theory of Recrystallization. U. Dehlinger (*Metallwirtschaft*, 1933, **12**, 48–50).—D. assumes that the recrystallization of a deformed metal starts in the places of smallest stress. The greater stresses are so far relieved during the primary working recrystallization that the atoms can attach themselves by a kind of slip mechanism to the places of low stress which act as recrystallization nuclei. These small stresses remain almost constant, and provide a motive power for secondary recrystallization after prolonged annealing. The differences in the surface energies of different crystal surfaces, which have previously been assumed to be the cause of growth, are of too small an order of magnitude to effect this.—v. G.

On Recrystallization. A. E. van Arkel (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (2–3), 84–90).—See this *J.*, 1930, **44**, 556.—D. N. S.

On the Structure of the Surface of Cut Metal Crystals. W. Boas and E. Schmid (*Mitt. Material., Sonderheft* **21**, 1933, 39–42).—See this *J.*, 1932, **50**, 552.—J. W.

The Crystal Structure of Borides of the Composition MeB_6. M. von Stackelberg and F. Neumann (*Z. physikal. Chem.*, 1932, [B], **19**, 314–320).—CaB_6 has a cubic cæsium chloride structure composed of calcium atoms and B_6 groups, the six boron atoms of the latter occupying the corners of an octahedron. SrB_6, BaB_6, LaB_6, CeB_6, PrB_6, NdB_6, ErB_6, and ThB_6 all have a similar structure, and all have a metallic character.—v. G.

Magnetochemical Researches. VII.—On the Magnetism of the Borides of the Rare Earths. W. Klemm, W. Schüth, and M. von Stackelberg (*Z. physikal. Chem.*, 1932, [B], **19**, 321–327).—Since the metallic character of borides of the formula MeB_6 has been established by their electrical conductivity, it follows from magnetic measurements that, in the borides LaB_6, CeB_6, PrB_6, NdB_6, and SmB_6, the rare-earth metals are embedded in the form of tervalent ions in the electronic gas which produces the metallic character of the compounds.—v. G.

X-Ray Study of Copper–Cadmium Alloys. E. A. Owen and Llewelyn Pickup (*Proc. Roy. Soc.*, 1933, [A], **139**, 526–541).—The whole range of the copper–cadmium system has been examined by X-ray powder methods. The phase regions of the diagram given by Jenkins and Hanson have been confirmed. The β-, γ-, and ε-phase structures were too complex to be solved from the photographs taken, but the δ-phase structure was confirmed to be similar to that of γ-brass. The close analogy, suggested by some workers, between the corresponding phases of the copper–cadmium system and the copper–zinc, silver–zinc, and silver–cadmium, is not supported by the present results. Special attention is given to annealing treatments. While lattice distortion in filings is completely eliminated by simple annealing, such annealing may not, and does not with these alloys, bring about true thermal equilibrium. Alloys were therefore annealed in lump form for long periods, which, when followed by comparatively short annealing of the filings, produced equilibrium. The solid solubility of cadmium in the copper lattice decreases with decreasing temperature. The limits of solubility are: 97·8% copper at 500° C., 99·0% at 400° C., and 99·5% at 300° C. A modification is therefore suggested in the $(\alpha) - (\alpha + \beta)$ boundary of the equilibrium diagram given by Jenkins and Hanson. This change is considered to be of importance in the working of the industrial alloys of the system.—J. S. G. T.

The Lattice Constants of the Copper–Palladium Solid Solutions. J. O. Linde (*Ann. Physik*, 1932, [v], **15**, 249–251).—The lattice constants of copper–palladium alloys have been determined in a Seemann–Bohlin camera with an accuracy of $\pm$ 0·05%. The values for the solid solution are consistently greater than corresponds with the mixture rule, the difference reaching a maximum of 0·35% at 50 atomic-% palladium. The regularly oriented phase Cu_3Pd has the same lattice constants as the solid solution of the same

composition, but there is a volume contraction of 0·5% when the solid solution corresponding with CuPd is converted into the body-centred cubic lattice of this compound.—v. G.

Crystal Structure of Electrolytically-Deposited Iron–Nickel Alloys. Keizô Iwasé and Nobuyuki Nasu (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1933, **10**, (1), 26–34).—[In Japanese.] Iron and nickel were co-deposited in various proportions electrolytically from their mixed sulphate solutions, and X-ray diffraction patterns were photographed by the Debye–Scherrer and Seemann–Bohlin methods. The results obtained were as follow: Iron and nickel co-deposited from a solid solution. The homogeneity of the solid solution thus formed appears to be not so good as that of the alloy solidified from the melt. (2) The co-existence of α- and γ-solid solutions is also observed in deposits the nickel concentration of which ranged from 15 to 58%. In the melted alloys this range is between 25 and 33% nickel. (3) The lattice constant of the α- (or γ-)solid solution increases slightly at first, reaches a maximum and then decreases as the nickel (or iron) content increases. It is concluded, from these results, that when the total or local concentration of the one metal in the deposit is small, two cases may arise: either (i) the metal is forced to deposit among the crystals of the other metal without forming its proper crystal lattice, forming a pseudo-solid solution as a result, or (ii) the unit mass of the deposited crystals of that metal is small and consequently it easily diffuses into the other after deposition. When the concentration of the metal is fairly large, the unit mass of that crystal also becomes large, and its diffusion into the surrounding crystal of the other takes place less easily than before, leaving some of that crystal undiffused. This tendency becomes greater as the concentration of that metal in the deposit increases. The existence of the maximum on the above-mentioned curve and the co-existence of α- and γ-solid solutions in a wider range of the composition of the deposited melted alloy are sufficiently explained by the process of deposition suggested above.—S. G.

Changes in the Lattice Constants and the Conductivity of Palladium by Electrolytic Charging with Hydrogen. F. Krüger and G. Gehm (*Ann. Physik*, 1933, [v], **16**, 174–189).—Palladium rods were charged electrolytically with hydrogen for varying periods at 20° C. and the absorbed hydrogen was determined by measuring the quantity of gas evolved and deducting it from the theoretical amount based on the current used. X-ray photographs showed the presence of two face-centred cubic phases, one apparently corresponding with palladium containing only a small amount of hydrogen in solid solution as its parameter increased with the hydrogen content from 3·884 to 3·886 A. ($\pm$ 0·001), and with 10% hydrogen the lines of the second phase appeared. The latter has a lattice parameter of 4·020 A. with less than 44 atomic-% hydrogen, and this increases linearly to 4·045 A. with 47·4 atomic-% hydrogen. The electrical resistance increases linearly from $11{\cdot}6 \times 10^{-4}$ for pure palladium to $19{\cdot}6 \times 10^{-4}$ for alloys containing the second phase. At 44 atomic-% hydrogen the curves of concentration/electrical resistance and concentration/lattice parameter show sharp deviations, indicating that this is the boundary of the homogeneous second phase. Its upper limit is not known, as no alloys could be prepared with more than about 47–48 atomic-% hydrogen.—v. G.

Lattice Constants and Electrical Conductivity of Electrolytically Charged Palladium–Silver Alloys as a Function of the Hydrogen Content. F. Krüger and G. Gehm (*Ann. Physik*, 1933, [v], **16**, 190–202).—The lattice parameter of the equiatomic silver–palladium solid solution is about 0·01 A. less than that required by the mixture rule. Alloys with 10, 30, and 40% silver were charged with hydrogen in the same way as pure palladium (cf. preceding abstract). In all cases a small expansion in the lattice parameter occurs corresponding with a solubility of hydrogen, which, however, in no case exceeds

10 atomic-%. With higher hydrogen content a second lattice appears. The field of homogeneity of this phase begins at 41 atomic-% hydrogen for the 10% silver alloy (a = 3·999 A.), at 44 atomic-% hydrogen for the 30% silver alloy (a = 3·974 A.), and at 32 atomic-% hydrogen for the 40% silver alloy (a = 3·972 A.). From these figures it is concluded that at about 45% silver the miscibility gap between the hydrogen-rich and the hydrogen-poor phase is closed. The rate at which equilibrium with hydrogen is reached decreases with increasing silver content, so that determinations must be made with thin wires. Maximum absorption of hydrogen occurs with the 30% silver alloy, which absorbs more hydrogen than pure palladium.—v. G.

On the Structure of Technical Zinc Dust. G. Wassermann (*Metallwirtschaft*, 1933, 12, 1–2).—X-ray examination of zinc dust reveals zinc crystallites of about the same size as the particles recognizable under the microscope, so that each particle consists of only one or a few crystals. Weak lines of zinc oxide can also be detected in the röntgenographs, and these lines are just as strong in the coarser part of the material as in the finer, hence it appears that the oxide forms a thin surface film on the zinc particles. The particles of zinc dust cannot be melted together even at 500° C. in a vacuum; on addition of zinc chloride and heating until the latter begins to volatilize, the dust can be melted into a button. If the zinc chloride cannot be distilled, the zinc particles will not fuse together, but remain suspended in the flux.—v. G.

On the Crystallographic Treatment of Wire- or Rod-Shaped Single Crystals. J. Leonhardt (*Metallwirtschaft*, 1932, 11, 659–662).—For the mathematical treatment of röntgenographic and crystallographic problems in rod- and wire-shaped single crystals the use of a projection net, obtained by central projection on a cylindrical surface and unrolling of this surface to produce a plane, is recommended.—v. G.

Does the Change in Lattice Constants in the Formation of Solid Solutions Depend on the Grain-Size? E. Schmid and G. Siebel (*Metallwirtschaft*, 1932, 11, 685).—Experiments on silver–copper, aluminium–magnesium, zinc–magnesium, magnesium–aluminium, and copper–aluminium alloys have failed to confirm Wiest's observation on silver–copper alloys (cf. this *J.*, 1932, 50, 308) that the change in lattice constants produced by a metal entering into solid solution is dependent on the grain-size. The lattice constants were the same in single crystals as in polycrystalline aggregates having a grain-size down to 0·05 mm.—v. G.

Does the Change in Lattice Constants in the Formation of Solid Solutions Depend on the Grain-Size? U. Dehlinger and P. Wiest (*Metallwirtschaft*, 1933, 12, 2–3).—A reply to Schmid and Siebel (cf. preceding abstract). D. and W. have repeatedly confirmed their results with silver–copper alloys, and have found similar results with silver–gold alloys. In the latter case the cast and recrystallized alloys have different lattice constants.—v. G.

On a Relation between the Mechanism of Precipitation in Single Crystals and Polycrystalline Aggregates. P. Wiest (*Metallwirtschaft*, 1933, 12, 47–48).—Before complete precipitation of the silver the Debye lines of copper saturated with silver and of copper from which all the silver has been precipitated, but of no intermediate stage, can be seen in juxtaposition in X-ray photographs of rotating wires of the quenched and tempered alloy of copper with 10% silver. In photographs of stationary wires, however, single points can be detected in the lines of both constituents which can be attributed only to a gradual transition between the phases. These facts are explained as follows: owing to the relatively rapid rate of transformation, in a definite time-interval during the precipitation many grains have not changed at all, and others have completely decomposed, whereas only a relatively small number of grains can be observed in the process of precipitation.—v. G.

Heat of Disintegration (Auflockerungswärme) of the Lead [Crystal] Lattice. G. v. Hevesy, W. Seith, and A. Keil (*Z. Physik*, 1932, **79**, 197–202).—The heat of disintegration of the crystal lattice of lead is derived from data relating to the temperature coeff. of the velocity of diffusion of a radioactive lead isotope in lead, and found to be 27,830 cal. per mol.—J. S. G. T.

Sodium–Lead Alloys. The Structure of the Compound Known as Na_4Pb. Charles W. Stillwell and Walter K. Robinson (*J. Amer. Chem. Soc.*, 1933, **55**, 127–129; and (abstract) *Met. Ind.* (*Lond.*), 1933, **42**, 257).—The type structure of a compound appears to depend on the ratio between the number of atoms and the number of valence electrons in the molecule rather than on the empirical formula. X-ray analysis of the phase known as Na_4Pb showed it to possess a face-centred cubic structure, with $a_0 = 13{\cdot}27 \pm 0{\cdot}035$ A., and to be apparently analogous to the γ-phase of copper, silver, and gold alloys. Its more exact formula is $Na_{31}Pb_8$.—R. G.

New Phenomena Relating to the Change of [Electrical] Resistance of Bismuth Single-Crystals in Magnetic Fields. I.—An Electrical Method of Analysis of Crystal Structure. O. Stierstadt (*Z. Physik*, 1933, **80**, 636–669).—A method for the determination of the change of electrical resistance of a bismuth crystal, oriented as desired, in a magnetic field, is described. The change of resistance perpendicular to the principal axis for different orientations of the crystal exhibits features characteristic of the crystal structure, and effects associated with planes not related in any direct simple manner to the primary crystal structure, and with the presence of impurities are observed. The phenomena are suggested as an auxiliary means of crystal structure analysis.—J. S. G. T.

Precision Determinations of Lattice Constants by the Powder Method. G. Menzer (*Fortschritte Min., Krist., u. Pet.*, 1932, **16**, (2), 162–207).—The principles of the method, the calculations and corrections necessary, and the various old and new precision methods are described at length and critically discussed. —J. W.

The Effect of Lattice Distortion and Fine Grain on the X-Ray Spectra of Metals. W. A. Wood (*Phil. Mag.*, 1933, [vii], **15**, 553–562).—The effects of fine grain and of lattice distortion on the X-ray spectrum of a metal are differentiated by reference to results obtained with electrodeposited and cold-rolled nickel, and a method is suggested for calculating the proportionate contribution of each factor to the broadening of the X-ray diffraction lines. —J. S. G. T.

On the Corrections for Debye–Scherrer X-Ray Photographs. Zenji Nishiyama (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1932, **9**, (11), 476–489).—[In Japanese.] See abstract from the English copy of this paper, *J.*, this volume, p. 17.—S. G.

The Tropism of Crystals. F. Bitter (*Phys. Rev.*, 1932, [ii], **42**, 731–732).—A theoretical note. The anisotropy of a crystal is not confined to that of the crystallographic planes, in which the atoms are regarded as points or spherically symmetrical centres of force. Directional effects may also be caused by electronic spins, atoms which are not spherically symmetrical, &c. The effect of spin coupling on ferromagnetism is discussed. If the spins are coupled so that the energy is least when neighbouring spins are parallel, the crystal will exhibit spontaneous magnetization, but if the coupling is such that the energy is least when the spins cancel each other in pairs, the orientation will be unaffected by a magnetic field, although the "spintropism" may show other effects, and B. suggests that peculiarities such as elastic hysteresis, unexplained critical temperatures, &c., may be due to a "tropism" of this kind.—W. H.-R.

Industrial Applications of X-Ray Crystallography. Robert Schmidt (*Technique moderne*, 1932, **24**, 710–713).—The construction and handling of the

"Metalix" apparatus are explained. Full details of simple examples of lattice measurement are given and profitable uses in industry, such as quantitative analysis, detection of lattice distortion, and grain-size estimation, are suggested.—H. W. G. H.

IV.—CORROSION

(Continued from pp. 131–133.)

On the Velocity of Dissolution of Aluminium in Aqueous Solutions of Ferric Salts. Witali Heller (*J. Chim. physique*, 1932, **29**, 488–506).—The velocity of dissolution of aluminium in ferric salt solutions has been followed by (*a*) gravimetric determination of the dissolved metal; (*b*) volumetric analysis of the solution; and (*c*) measurement of the volume of hydrogen evolved. It is shown that about 90% of the total hydrogen liberated in the reaction goes to reduce the ferric salt, the remainder being evolved in the free state. The velocity coeff. in ferric chloride solution is independent of concentration between 0·15 and 0·43 grm.-mol. per litre, but falls when the concentration is less than 0·15 grm.-mol. per litre. The low temperature coeff. (1·27 for an increase of 10° C.) and the considerable influence of stirring indicate that the velocity is controlled by a diffusion process. The velocity of dissolution of aluminium in ferric nitrate is about 9 times less than in ferric chloride. Aluminium scarcely dissolves in ferric sulphate, but the addition of chloride ions accelerates the reaction considerably. The velocity of dissolution of magnesium in aqueous solutions of weak acids, or salts of weak bases and strong acids, is proportional to the H-ion concentration.—E. S. H.

Corrosion and Protection against Corrosion of Aluminium Rolling Alloys in the Construction of Airplanes. Paul Brenner (*Jahrb. deut. Versuchsanst. Luftfahrt*, **1931**, 505–520).—See *Z. Metallkunde*, 1930, **22**, 348–356; cf. this *J.*, 1931, **47**, 19; and *Z. Metallkunde*, 1930, **22**, 420–422; cf. this *J.*, 1931, **47**, 83.—B. Bl.

Influence of Common Salt Solutions of Varying Concentrations on the Course of the Corrosive Attack in Alternating Immersion Tests [Lautal]. Erich K. O. Schmidt (*Jahrb. deut. Versuchsanst. Luftfahrt*, **1931**, 521–524).—See *Korrosion u. Metallschutz*, 1930, **6**, 250–255; cf. this *J.*, 1931, **47**, 341.—B. Bl.

On the Question of Corrosion. III.—Aluminium, Lead, Copper. L. W. Haase (*Gas- u. Wasserfach*, 1932, **75**, 372–374).—The behaviour of aluminium, copper, and lead under corrosive conditions is discussed and the utility of these metals under various conditions described.—B. Bl.

Corrosion Phenomena in Gas-Heated Geysers: Causes and Prevention. Prof. Junkers Forschungsanstalt, Abteilung Wärmetechnik, Dessau (*Gas- u. Wasserfach*, 1932, **75**, 753–758).—Two cases of corrosion of the copper covers of hot-water geysers are described; in one case the cause of the trouble was traced to the high carbon dioxide content of the water and to stray electric currents, and in the other case no explanation could be found.—B. Bl.

On the Use of Lead and Copper Tubes for Drinking-Water Pipes. G. Nachtigall (*Gas- u. Wasserfach*, 1932, **75**, 941–949).—Systematic tests on the rate of dissolution of lead and copper from new pipes of these metals filled with water show that after 9 hrs.' standing the first half-litre of water taken from the lead pipe in the first month contained 2·1 mg., in the fifth month 0·5 mg., and in the seventh month 0·3 mg./litre of lead, whereas under the same conditions water taken from the copper pipe contained 3 mg./litre of copper in all cases. No effect on the health of users of the water was observed in either case.

—B. Bl.

Contribution to the Knowledge of the Destruction of Lead Cables. W. Zwieg (*Elektrotech. Z.*, 1933, **54**, 154–155).—The cause of a failure of an underground lead cable was traced to the mechanical vibrations set up by street cars

running near it. Chemical and electrochemical corrosion took place only after the formation of fatigue cracks. The cable sheath consisted of very pure lead; alloyed lead has a greater resistance to fatigue and corrosion, and should therefore be used for cable sheaths.—B. Bl.

[Corrosion of Buried Cables.] Anon. (*Telephone Eng.*, 1931, **35**, (1), 42).—The existence of a.c. power distribution systems is not likely to cause corrosion of buried sheathed cable. Certain soils, and moisture in ducts may give rise to corrosion.—H. F. G.

Modern Theories of Corrosion of Metals and Methods for Testing their Resistance to Chemicals. N. A. Isgarichev (*Zvetnye Metally* (*The Non-Ferrous Metals*), **1930**, 328–347; *C. Abs.*, 1933, **27**, 485).—[In Russian.] See this *J.*, 1932, **50**, 231.—S. G.

V.—PROTECTION

(Other than Electrodeposition.)

(Continued from pp. 134–136.)

Researches on the Anodic Film of Aluminium. I.—Effect of the Concentration of the Electrolyte on the Formation of Anodic Film. Shoji Setoh and Akira Miyata (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, No. **396**, 1932, 189–236).—[In English.] The effect of the concentration of the electrolyte on the formation of an anodic film on commercially pure aluminium in aqueous solutions of oxalic acid has been investigated. D.c., a.c., and a.c. superposed on d.c. were used, and the temperature, current density, and terminal voltage were varied. The resistance of the films to corrosion was studied by immersing the specimens in 1*N*-hydrochloric acid, and measuring the volume of gas evolved in a given time. The deterioration of the electrolyte during electrolysis was also examined. The most suitable concentration of the electrolyte is from 2 to 6% oxalic acid (weighed as $(COOH)_2 2H_2O$). The essential chemical change occurring is the oxidation of aluminium to Al_2O_3, but roughly one-quarter of the film dissolves in the electrolyte. This solution produces a skeleton sponge-like structure, so that whilst the film has a density only $\frac{2}{3}$ that of pure Al_2O_3, the film thickness is almost that expected from an ideal case where the whole of the electrical energy produces Al_2O_3 and no secondary reactions occur. In a.c. electrolysis the energy efficiency of film formation is less, and the solution of film, and secondary decomposition of oxalic acid are greater than in d.c. electrolysis. Generally speaking, corrosion-resisting films are produced by electrolysis (*a*) in concentrated or in hot solutions; (*b*) at low current densities; or (*c*) by superposing a.c. on d.c. or by a.c. alone.—W. H.-R.

Researches on the Anodic Film of Aluminium. II.—Anodic Behaviour of Aluminium in Aqueous Solutions of Oxalic Acid. Shoji Setoh and Akira Miyata (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, No. **397**, 1932, 237–291).—[In English.] Cf. preceding abstract. The anodic film on aluminium consists of two layers, the comparatively thick visible film of porous structure, below which is a much thinner "active layer," which is also more or less porous. Using oxalic acid solutions studies have been made of the current-time and voltage-time variations in constant-current and constant-voltage electrolysis, respectively, and from these the state of the active layer has been estimated. A rotating switch enabled observations to be made down to $2{\cdot}5 \times 10^{-4}$ seconds after switching off the current. The speed and mechanism of formation of the active layer, its dielectric capacity and thickness, and the counter electromotive force were measured. S. and M. conclude that the older theories that the active layer is produced by the precipitation of colloidal aluminium hydroxide, and its subsequent hardening or burning by electric sparks must be rejected. The active layer is probably formed by direct attack of the metal by oxygen, which penetrates the pores of the existing film. In this way the visible film is

continually formed from the active layer from which it derives its porous structure, whilst the active layer is re-created. The presence of oxygen in the pores gives characteristic phenomena when the voltage is suddenly changed and is an important factor in the anodic behaviour.—W. H.-R.

The Eloxal Process. Hans Schmitt (*Metallwirtschaft*, 1932, **11**, 689–690).—The production and sphere of utility of protective oxide coatings on aluminium, Silumin, and Lautal are discussed.—v. G.

Practising Economy in Carrier Operation. [Corrosion and Protection of Lead Cable Sheath.] F. J. Dommerque (*Telephone Eng.*, 1931, **35**, (2), 33–35).—Ten years after laying, the lead sheath of the Berlin–Cologne underground toll cable had deteriorated in many places, principally where the soil or ground-water contained lime; in other cases electrolytic corrosion had arisen from contact of the lead with the iron casings of the loading coils, and total destruction of the cable was prevented only by attaching large zinc plates to the sheath. Fibre conduit is used with satisfactory results in the U.S.A.—H. F. G.

Corrosion of Magnesium Alloys. I.—Protection of Magnesium Alloys by Oxide Films. W. O. Kroenig and G. A. Kostylev (*Transactions of the Central Aero-Hydrodynamical Institute* (*U.S.S.R.*), No. **128**, 1932, 1–40).—[In Russian, with English summary.] Owing to the growing importance of Elektron in aircraft engineering, the problem of increasing its resistance to corrosion, especially in sea-water, requires immediate solution. This is the first of a series of three papers describing the results of an investigation on the mechanism of corrosion of magnesium, and methods for its protection. The other parts of the work will deal with the corrosion of (*a*) cast and (*b*) rolled alloys. Parallel to the research on oxide films, work is being carried out on the preparation of suitable protective lacquers. The production of corrosion-resisting films on various Elektron alloys has been investigated in solutions of the following reagents: (1) potassium dichromate and nitric acid in concentrated solutions; (2) the same in dilute solutions; (3) phosphoric acid and potassium permanganate; (4) boric acid and potassium permanganate; (5) 10% sodium fluoride; (6) potassium permanganate (saturated); (7) the same with a few drops of nitric acid; (8) sodium fluoride and potassium permanganate; (9) boric acid (saturated); (10) phosphoric acid and potassium dichromate. The specimens were immersed at various temperatures for from 45 sec. to 4 minutes, washed, dried, the corrosion rate determined in sea-water, tap-water, and a moist atmosphere and compared with those of a similar untreated alloy as standard. The most suitable solutions for cast Elektron (aluminium 6·22, manganese 0·20, silicon 0·03, iron 0·10, and copper 0·23%) were No. 2 for 45–60 sec. at 80° C.; No. 2 with a little chromium nitrate (for 1–1½ minutes at 80° C.), and No. 2 with aluminium nitrate (8–10 minutes at 15°–20° C.). For rolled Elektron (aluminium 6·34, manganese 0·25, zinc 0·43, and iron 0·10%), the best solution was No. 2 (very dilute) for 45 sec. at 80° C. The passive films thus obtained increase the stability of Elektron towards sea-water 100–250 times, but still do not give complete protection. With tap-water, no protection whatsoever is obtained, so that if Elektron is to be used in a water-cooled system, it must be protected by some form of lacquer or its composition must be changed. The protection against a moist atmosphere is satisfactory, although not so good as against sea-water. For storing Elektron, therefore, the films may be suitable, although if conditions are adverse the use of a lacquer such as "Dural" is recommended (cf. *Korrosion u. Metallschutz*, 1932, **8**, 147–151; this *J.*, 1932, **50**, 742).—M. Z.

Nickel-Clad Steel. Anon. (*Mech. World*, 1932, **92**, 560–562).—Cf. this *J.*, 1932, **50**, 85, 551. The composite product consisting of nickel rolled on steel is described and vessels made therefrom are illustrated and described. The bond between the two metals, of which a photomicrograph is given, is made at a temperature lower than the melting points of the metals concerned and is

effected by diffusion. A commonly-used example is ¼-in. thick plate with 10% of the total thickness as nickel covering.—F. J.

The Biological Factor in the Protection of Metals in Sea-Water. Anon. (*Peinture, Pigments, Vernis*, 1932, 9, 180–187; *Rev. Assoc. Brit. Paint Manuf. Rev.*, 1932, (30), 343).—Mainly a review of American, British, and German investigations up to the year 1930, full reference being made in the appropriate places to the original literature from which the information is derived.—S. G.

Spraying Molten Metal to Combat Corrosion. Anon. (*Petrol. Eng.*, 1932, 3, (12), 38; *J. Inst. Petrol. Tech.*, 1932, 18, 392A).—Corrosion of oil equipment is being checked by the use of the metal spraying process, which is described. In spraying metals to combat corrosion, care must be taken that the coating is not porous, particularly when applying metals that are electro-positive to iron. An under-coating of zinc is useful where it is not economical to apply several coatings of the protective metal. Agitators and condenser boxes can be successfully sprayed with lead. A gas-transmission company is applying a 0·006 in. thick coating of aluminium on exhaust ells of gas-driven compressors. These reach temperatures of 1105° F. (596° C.), and have been in service for 10 weeks without any effect on the adhesion of the aluminium coating. The cost of spraying is stated to be 3·5–6 cents per ft.² per coat for softer metals (excluding the cost of sand-blasting). Hard metals cost more because of their slower speed of application. Details are given of the operation of the spray pistol, the method of preparation of the surface, and the conditions of application of the coating.—S. G.

The Battle to Preserve Material. Julius Klein (*Telephone Eng.*, 1930, 34, (5), 25, 46–47).—The use of electroplating, galvanizing, and of "stainless" alloys to prevent wastage of material by corrosion, is noted.—H. F. G.

Metal Protecting Medium "Pantexol." Walther Roething (*Metallwaren-Ind. u. Galvano-Tech.*, 1932, 30, 389).—The material is a colourless lacquer suitable for protecting the surface of highly-polished metal articles from atmospheric influences; the film is said to remain elastic up to 100° C. and can be washed with warm water without damage.—A. R. P.

Painting Sheet Copper—Copper and Other Metallic Powders in Paints—Copper Stains on White Paint. H. A. Gardner and L. P. Hart (*Amer. Paint Varnish Manuf. Cong.* No. 416, 251–262; *Rev. Assoc. Brit. Paint Manuf. Rev.*, 1932, (30), 347).—It has been found that ordinary oil and varnish paints may be used satisfactorily on copper surfaces provided that care is taken to clean grease from the surface before the application of paint. Stains on painted surfaces due to oxidation of adjacent materials may often be removed by a 10% solution of oxalic acid in water, whilst dilute hydrochloric acid appears to be suitable for cleaning copper stains.—S. G.

Some Recent Advances in Protective Coatings on Metals. H. Sutton (*J. Electrodepositors' Tech. Soc.*, 1931–32, 7, 91–102; discussion, 177–182; and (summary) *Met. Ind. (Lond.)*, 1932, 40, 227–230; discussion, 355–357, 451–452).—A general review. Special reference is made to the relative protection from corrosion afforded to steel by electrodeposited zinc and cadmium coatings, the protection from atmospheric corrosion of light metals and alloys by electrodeposition of zinc, cadmium, or nickel or by anodic oxidation, and of Duralumin by a rolled-on coating of pure aluminium. Recent work on the formation of protective deposits by chemical treatment without current on steel and on aluminium and its alloys, and the protection of iron and steel from oxidation at high temperatures by thick nickel plating, calorizing, aluminium spraying, or dipping is also described.—S. W.

The Testing of Metallic Coatings. C. W. Bergman (*Electrodepositors' Tech. Soc. Abstracts app.*, 2882; and *Met. Ind. (Lond.)*, 1933, 42, 107–109).—Workshop inspection tests of metallic coatings should be simple, non-destructive,

and positive. Development research tests should be designed to test specific properties such as thickness, distribution, porosity, hardness, stress, and adherence. Broad outlines of suitable tests are given. The mutual effect of the coating and the basis metal under corrosive conditions or by alloying or diffusion must be taken into account.—S. W.

VI.—ELECTRODEPOSITION

(See also "Protection," p. 194.)

(Continued from pp. 136-137.)

Cadmium and Its Application in Electroplating Practice. Paul Gerhardt (*Metallwaren-Ind. u. Galvano-Tech.*, 1932, **30**, 377–378, 396–397, 417–418, 459–461, 478–481, 498–499, 516–517).—A review of the metallurgy of cadmium and of the development and uses of cadmium plating.—A. R. P.

Untarnishable Cadmium Plating Process. Anon. (*Mech. World*, 1932, **92**, 540).—Notice of a modification of electro-cadmium plating known as "Epalex" whereby the coating is rendered bright and "commercially stainless."—F. J.

The Structure of the Chromic Acid Plating Bath; the Theory of Chromium Deposition. Charles Kasper (*U.S. Bur. Stand. J. Research*, 1932, **9**, 353–375; and *U.S. Bur. Stand. Research Paper* No. **476**; also (short note) *Met. Ind.* (*Lond.*), 1933, **42**, 262).—The structure of solutions that are of importance to the theory of chromium deposition from the chromic acid bath was investigated by cryoscopic and conductivity measurements, and absorption spectra. It was shown that the first step in the reduction of chromic acid is the formation of chromium dichromate, $Cr_2(Cr_2O_7)_2$, a strong electrolyte which forms negative molecular ions. This compound is found not to exist in the "green" form. The next product of reduction is the basic chromium chromate, $Cr(OH)_3 \cdot Cr(OH)CrO_4$. This compound is a colloid, which may exist in relatively acid solutions. If sulphate is present, it forms chromic sulphate, only the green form of which exists in chromic acid solutions. If the basic colloid does not have its electrophoretic velocity reduced, it coats the cathode and prevents further reduction of chromic acid. The beneficial action of the sulphate is due to the fact that it lowers that velocity by adsorption. The sulphate reaches the cathode film by being transported as a non-reactive positive molecular ion, $[Cr_4O(SO_4)_4H_2On]^{++}$. The above theory was confirmed by employing it to correlate facts and principles of chromium plating. A bibliography of 34 references is appended.—S. G.

The Adhesion of Electrodeposited Nickel to Brass. A. W. Hothersall (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 115–141; discussion, 188–191; and (summary) *Met. Ind.* (*Lond.*), 1932, **41**, 13–15, 111–113; discussion, 159–160).—Methods of examining the adhesion of electrodeposits of nickel to brass are reviewed and satisfactory qualitative and quantitative tests described. Electrodeposits of nickel applied to a chemically clean but unetched brass surface, which has been prepared by filing or machining, are strongly adherent. Where the brass has been emeried or polished, the adhesion is poor owing to the embrittlement of the inherently weak surface layer by hydrogen, co-deposited with the nickel. The hydrogen embrittlement is removed and the adhesion somewhat improved by heat-treatment, *e.g.*, at 250° C. for 2 hrs. To obtain good adhesion of nickel deposits on such surfaces it is necessary to remove the weak surface layer by etching. Chemical etching with nitric acid mixtures, whilst giving satisfactory adhesion, destroys the polish. A method of controlled etching by electrolytic action, *e.g.*, at 10 amp./ft.^{2} for 30 seconds in either 5% potassium cyanide or 50 grm./litre citric acid neutralized with ammonia plus a further 20 grm./litre citric acid, has been developed which permits strongly adherent deposits to be obtained without appreciable effect on the polished surface. The citric acid solution is preferred.—S. W.

Stopping-Off Materials for Articles to be Nickel-Plated. Anon. (*Oberflächentechnik*, 1932, **9**, 229–230).—The value of various waxes, lacquers, and plastics containing tarry matter or rubber is discussed.—A. R. P.

Problems of Modern Nickel Plating. Anon. (*Oberflächentechnik*, 1932, **9**, 255–257).—Practical hints for obtaining good nickel plating.—A. R. P.

The Electrodeposition of Tin from Alkaline Solutions. L. Wright and F. Taylor (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 103–114, discussion, 183–187; and (summary) *Met. Ind.* (*Lond.*), 1932, **40**, 449–451, discussion, 544–547, **41**, 64–65; also (abstract) *Brass World*, 1932, **28**, 199–201).—Solutions recommended for the electrodeposition of tin coatings are reviewed. A method of analysis is given. A solution of stannous chloride 68, potassium chloride 101, peptone 0·7 grm./litre operated at 60°–70° C. and 4–6 amp./ft.^{2} is found satisfactory for the electrodeposition of thin deposits of tin, although the cathode efficiency is low. Equivalent amounts of sodium hydroxide and glucose may be substituted for potassium hydroxide and peptone without detriment. The stannite is rapidly converted to stannate on electrolysis. A low free alkali content, a high temperature, a large anode–cathode area ratio, and pure tin anodes are advised to assist anode corrosion; frequent replenishment with stannous chloride is also necessary. In the discussion it is stated that smooth tin deposits of any thickness may be prepared from solutions from which stannite ions are rigorously excluded. The accuracy of the analytical methods given is also questioned.—S. W.

The Surface Improvement of Aluminium. Oskar Krämer (*Metallwaren-Ind. u. Galvano-Tech.*, 1932, **30**, 435–436).—Plating with nickel or with nickel and chromium does not afford prolonged protection of aluminium, as it is impossible to avoid imperfections in the plate, and these set up local corrosion which the plating metals accelerate. It is claimed that it is possible to deposit chromium directly on aluminium as a completely protective coating using a special electrolyte of which no details are given.—A. R. P.

The Galvanic Treatment of Aluminium. Anon. (*Metallwaren-Ind. u. Galvano-Tech.*, 1932, **30**, 438–439).—A review of recent journal and patent literature on the plating of aluminium.—A. R. P.

Surface Improvement of Aluminium. Anon. (*Metallwaren-Ind. u. Galvano-Tech.*, 1932, **30**, 457).—By a recently developed method, of which no details are given, it is claimed to be possible to deposit firmly adherent electrolytic coatings of nickel on aluminium, such that the metal may be bent and hammered without the coating flaking. New methods of anodic oxidation are also briefly described.—A. R. P.

Practical Experiences on the Importance of Hydrogen Adsorption in the Surface Improvement of Metals [by Electroplating]. Richard Justh (*Metallwaren-Ind. u. Galvano-Tech.*, 1932, **30**, 335–339; and *Oberflächentechnik*, 1932, **9**, 161–164).—A review of recent work on the effect of hydrogen adsorption on the nature and hardness of various electroplates and on the behaviour of metals after pickling in acid liquors.—A. R. P.

Some Aspects of Throwing Power. Its Quantitative Expression. Samuel Field (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 83–90; discussion, 175–176; and *Met. Ind.* (*Lond.*), 1932, **40**, 403–406; discussion, 501, 549).—The present method for the quantitative expression of throwing power is unsatisfactory because (1) the accepted primary current distribution ratio of 5 : 1 is inconsistent with plating practice, and (2) the numerical expression for ideal throwing power is dependant on the primary current distribution ratio. Throwing efficiency, the ratio of measured throwing power to ideal throwing power is not constant in the same solution operated under different conditions. A new method, more directly applicable to commercial practice, of measuring and numerically expressing throwing power is therefore proposed. The primary current distribution ratio is maintained at 2 : 1 and the throwing power is

defined as the percentage deviation of the metal ratio from this. A variation is necessary for negative values. A simple method of measuring throwing power using ammeter readings only, is also described.—S. W.

Notes on the Control of Plating Solutions. H. Riley (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 166–169).—Workshop methods for the preparation and efficient control of cadmium, tin, copper, silver, gold, nickel, chromium, and brass electroplating baths are given.—S. W.

Electrolytic Deposition of Metals on Cathodes Covered by Insulating Films. Ch. Marie and N. Thon (*J. Chim. phys.*, 1932, **29**, 569–576).—Experiments are described on obtaining electrodeposits of copper on a cathode coated with a thin film of insulating organic material. The mechanism of deposition is related to the phenomenon of electrostenolysis. The degree of adherence of the deposit is low.—E. S. H.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition and Electro-Refining.)

(Continued from pp. 137–138.)

The Metallurgy of Magnesium. Rudolf Hoffmann (*Metallbörse*, 1932, **22**, 1421–1422, 1453–1454, 1485–1486, 1517–1518, 1551, 1615).—A review of modern practice with especial reference to recent developments in the electrolytic baths. More than 100 references are appended.—A. R. P.

Electrolysis of Rare Metals. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 168).—A description is given of a new continuous method of electrolysis for the production of uranium, thallium, tantalum, and other rare metals. For the production of thorium, a cathode is inserted in a bath of sodium and potassium chlorides containing some potassium thorium fluoride, and replaced by a new one when powdered thorium about 1 in. thick has been deposited.—J. H. W.

The Stick Antimony Electrode for the Measurement of Hydrogen-Ion Concentration. Taku Uemura and Hideo Sueda (*Bull. Chem. Soc. Japan*, 1933, **8**, 1–10).—[In English.] The antimony electrode in an unstirred solution in contact with air at equilibrium gives trustworthy data when the p_H lies between 1 and 9. The polished surface becomes covered with a film, apparently of oxide, the colour of which depends on the H-ion concentration; it is black when the p_H is between 1 and 8, but in alkaline solutions it is whitish. The time required for equilibrium to be attained also depends on H-ion concentration, being longer as the solution is more acidic. The influence of stirring is to increase the e.m.f. obtained.—E. S. H.

VIII.—REFINING

(Including Electro-Refining.)

(Continued from p. 139.)

Discussion of C. W. Clark and A. A. Heimrod's Paper on "Recovery of Precious Metals from Electrolytic Copper Refining at the Canadian Copper Refiners Plant, Montreal East, Quebec." F. F. Colcord. T. D. Jones (*Trans. Electrochem. Soc.*, 1932, **61**, 90).—Cf. this *J.*, 1932, **50**, 372, 684. F. F. C. suggests that concentrations greater than 30 grm. per litre of silver and 20 grm. per litre of copper give the most satisfactory conductivity. T. D. J. confirms this and adds that with 38–40 grm. of copper per litre the silver produced is 999·85 fine.—W. A. C. N.

IX.—ANALYSIS

(Continued from pp. 140–141.)

Rapid Industrial Methods for Metallurgical Analysis. R. Arzens (*Bull. Assoc. Tech. Fonderie,* 1931, 5, 33–38).—A discussion of laboratory routine from the points of view of efficiency, economy of time and materials, and an accuracy sufficient for industrial purposes. It includes sections on standard alloys for comparative purposes, the use of analoids or tabloid reagents, the choice of the magnitude in the initial weighings and improvements in technique. Examples are taken from the analysis of steels.—W. A. C. N.

New British Chemical Standard [Copper–Nickel]. Anon. (*Met. Ind.* (*Lond.*), 1932, 41, 473).—It is announced from the headquarters of British Chemical Standards that a new non-ferrous standard of Cu–Ni to serve as a standard for the analysis of Cu–Ni sheet and strip referred to in British Standard Specification No. 374, 1930, has been prepared. Its analysis is as follows: Cu, 68·85, Ni 30·1, Si 0·12, Mn 0·89, Fe 0·05, Mg 0·027, C 0·02, S 0·01, Pb and Co each not more than 0·01%.—J. H. W.

Quantitative Optical Spectral Analysis of Lead Alloys. A. Guenther (*Z. anorg. Chem.*, 1931, 200, 409–418; *Brit. Chem. Abs.*, 1931, [A], 1385).—The systems examined were Li, Cu, Zn, Au, Tl, and Bi in Pb, and Ag in Sn. Tables are giving showing pairs of lines in the emission spectra of the alloys suitable for the characterization of alloys containing up to 10% of the other metal.

—S. G.

Some Analytical Applications of Sodium Hydrosulphite. II.—Separation of Tin from Copper, Zinc, Lead, &c., and from Oxalic Acid Solutions. Determination of Tin in Steel. B. S. Evans (*Analyst,* 1932, 57, 362–368).—The solution containing Sn, Cu, Zn, and Pb is treated with 10 c.c. of citric acid (100 grm./200 c.c.), NH_4OH until slightly alkaline, 10 c.c. of saturated KCN solution, 25 c.c. of saturated NH_4Cl solution, 10 c.c. of $(NH_4)_2S$, and 7 grm. of $Na_2S_2O_4$, boiled for 1 minute, cooled slightly, treated with a further 2 grm. of $Na_2S_2O_4$, and again boiled. The SnS precipitate is filtered hot and washed with a solution containing small amounts of all the reagents added above; it contains, in addition to Sn, all the Pb, Bi, and most of the Sb present. It is dissolved in NaOH and H_2O_2, the solution acidified with HCl, and the analysis finished as previously described (this *J.*, 1931, 47, 440). In the analysis of bronze, sufficient KCN must be added to discharge the blue Cu colour and dissolve any ZnS; in the analysis of brass, at least 20 grm. of NH_4Cl must be added. In the absence of NH_4Cl, Pb may be precipitated free from Sn, using NaOH instead of NH_4OH to neutralize the solution; the filtrate from the PbS precipitate is then boiled with a large excess of NH_4Cl and the Sn precipitated as described above. When $H_2C_2O_4$ is used to separate Sb from Sn, precipitation of the latter from the oxalate solution by $Na_2S_2O_4$ is not quite complete.

—A. R. P.

On the Method for the Determination of Aluminium in the Presence of Iron. Saburo Ishimaru (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1932, 9, (12), 527–529).—[In Japanese.] The present methods for the separation and determination of Al in the presence of various amounts of Fe leave much to be desired from the points of view of accuracy, ease of manipulation, and speed. The four known methods are reviewed and discussed. I. proposes the following procedure: treat the slightly acidic solution first with $Na_2S_2O_3$ (Chancel's method), cool quickly to room temperature, add alcoholic solution of $C_6H_5{\cdot}NH{\cdot}NH_2$ (1 : 1) (Hess and Campbell's method), filter, wash with boiling water, and ignite (above 950° C.) to Al_2O_3. The results (only a single separation) indicate that this procedure is an excellent one.—S. G.

The Determination of Indium and Gallium with 8-Hydroxyquinoline. W. Geilmann and Fr. W. Wrigge (*Z. anorg. Chem.*, 1932, **209**, 129–138).—In is precipitated quantitatively by 8-hydroxyquinoline from a solution containing 1% $CH_3{\cdot}COONa$ and 1% $CH_3{\cdot}COOH$ at 70°–80° C.; after keeping for 2–3 hrs. in a cool place the $In(C_9H_6NO)_3$ is collected in a filter crucible, washed with warm water, dried at 120° C., and weighed; it contains 20·99% In. The compound is volatile above 150° C., so the In must be recovered by destruction of the organic matter with H_2SO_4 and HNO_3, followed by treatment of the solution with NH_4OH. Ga may be determined in a similar way in exactly neutral or feebly ammoniacal solutions even in the presence of tartrate. $Ga(C_9H_6NO)_3$ contains 13·89% Ga. The sensitivity of the method in both cases far exceeds that of the hydroxide precipitation.—M. H.

The Use of α-Benzoinoxime in the Determination of Molybdenum. H. B. Knowles (*U.S. Bur. Stand. J. Research*, 1932, **9**, 1–7; and *U.S. Bur. Stand. Research Paper* No. **453**).—Present methods for the determination of Mo in any considerable amount require a number of tedious and time-consuming operations prior to the actual determination of that element. α-Benzoinoxime, advocated as being specific for Cu, has been found to precipitate Mo quantitatively and to isolate it from most of the more commonly encountered elements. As a result of the present study, a procedure has been developed by which Mo can be determined in ores, steels and other products in much less time than by present methods and with all the accuracy of the best methods now in use. —S. G.

The Use of Potentiometric Analysis in Steelworks Laboratories.—V. P. Dickens and R. Brennecke (*Mitt. K.-W.-Inst. Eisenforschung*, 1932, **14**, 249–259).—Mo may be determined potentiometrically in pure solutions of alkali molybdates by precipitation with $HgClO_4$ or $Pb(ClO_3)_2$ using a Mo sheet as indicator electrode. The use of these methods and reduction potentiometric methods in steel analyses is described.—J. W.

Determination of Nickel and Chromium in Alloys and in Cast-Iron. V. Pestelli (*Usine*, 1931, **40**, (43), 29).—Abstract of paper presented to the 6e. Congrès International de Fonderie. See this *J.*, 1932, **50**, 554.—H. W. G. H.

Quantitative Determination of Nickel in Nickel Steels by an Electrographic Method. A. Glazunov and J. Křivohlavy (*Z. physikal. Chem.*, 1932, [A], **161**, 373–388).—The alloy to be tested is separated from a plate of indifferent metal by a filter-paper soaked in dimethylglyoxime solution, and a current is passed from the alloy (anode) to the plate (cathode). The red colour produced on the paper by the formation of Ni dimethylglyoxime is compared with that produced under similar conditions by similar alloys of known Ni content. By this method all types of alloys can be analyzed in a few minutes without destroying the alloy or even making a polished section.—B. Bl.

Molecular Spectra and Spectrographic Analysis. IV.—Determination of Scandium. G. Piccardi (*Atti R. Accad. Nazion. Lincei. Rendiconti Classe Scienze Fisiche*, 1932, **15**, 577–579).—The method is based on the persistence of molecular spectra; it gives good quantitative results.—G. G.

Determination of Sodium in Aluminium. K. Steinhäuser and J. Stadler (*Z. anal. Chem.*, 1932, **89**, 268–270).—The metal (100 grm.) is dissolved in HCl and the Al removed as $AlCl_3,6H_2O$ by saturating the solution with HCl. The filtrate is evaporated and again saturated with HCl, this process being repeated continually until no more Al is present. The final filtrate is evaporated with H_2SO_4, the SiO_2 removed, the heavy metals precipitated with H_2S and Mn and the Fe group with Br and NH_4OH, and the filtrate then evaporated to dryness. The residue is heated to expel NH_4 salts and treated in the usual way to remove Ca. The residual Na_2SO_4 is weighed, any Mg and Zn removed as phosphates, and the corresponding correction made.—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

(See also "Testing" and "Pyrometry.")

(Continued from pp. 142–143.)

The New Universal Vertical Illuminator of the Emil Busch A.-G. H. Pfeiffer (*Z. wiss. Mikroskopie*, 1932, **49**, 103–107).—The vertical illuminator serves for light- and dark-field illumination of the object.—B. Bl.

The Ultropak. H. Heine (*Z. wiss. Mikroskopie*, 1931, **48**, 450–465).—In contradistinction to the vertical illuminator in which the light passes through the objective in both directions and produces a light field image in the eye-piece, in the Leitz Ultropak the light is reflected on to the object from all sides by a lens system surrounding the objective, so that a dark field image is produced when the reflecting surface is a plane polished surface, and a light-dark field image when the surface is uneven and reflects diffusely.—B. Bl.

Apparatus for Introducing and Removing Photographic Plates, into and out of, a High Vacuum. E. G. Andresen (*Physikal. Z.*, 1932, **33**, 771–772).—A simple form of apparatus for moving a photographic plate, into and out of, an evacuated vessel is described.—J. S. G. T.

The Measurement of Elongation on Bending Tests. C. v. Roessler (*Schmelzschweissung*, 1932, **11**, 242).—An apparatus for measuring the radius of curvature of bent sheet metal is described.—B. Bl.

On the Viscosity of Molten Metals and Alloys.—V. Outflow Viscometer with a Constant Pressure Height for Substances with High Surface Tension. F. Sauerwald (*Z. anorg. Chem.*, 1932, **209**, 277–280).—M. H.

Two Types of Laboratory Pumps for Pumping Mercury. P. B. Zhivotinsky (*Ukrainskii Khemichnii Zhurnal* (*J. Chim. Ukraine*), 1931, **6**, (5/6), 241–244).—[In Ukrainian, with Russian summary.] Two simple pumps, constructed of glass and rubber tubing, for pumping mercury are described and illustrated. The throughput is about 100 c.c./minute and the height raised is 35 cm.—M. Z.

XI.—PHYSICAL AND MECHANICAL TESTING AND RADIOLOGY

(Continued from pp. 143–145.)

The First Congress of the New International Association for Testing Metals. Anon. (*Technique moderne*, 1932, **24**, 316–318).—A brief review of the discussions at Zürich.—H. W. G. H.

Contribution to the Study of Methods for Controlling Foundry Products. P. Nicolau (*Bull. Assoc. Tech. Fonderie*, 1931, **5**, 233–250).—Cf. this *J.*, 1932, **50**, 750. A discussion of general methods of foundry control including: (1) old systems; (2) tensile, compressive, and bending tests; (3) tests as to homogeneity; (4) newer methods, such as microscopic analysis, torsion tests, static and dynamic hardness. A useful bibliography is appended.—W. A. C. N.

Inspection of Surfaces for Minute Defects. F. A. Firestone and H. B. Vincent (*Mech. Eng.*, 1932, **54**, 647; also *Automotive Ind.*, 1932, **67**, 556; and *Mech. World*, 1932, **92**, 431).—Illustrates and describes an apparatus for the surface inspection of any kind of metal for defects which change the light reflectivity or transmissivity. Light reflected from the surface under inspection controls the current passing through a photo-electric cell. The current is transmitted to a hot-cathode ionization tube which provides sufficient current to actuate a rejection device if the surface is not up to the standard for which the device is set.—F. J.

The Dependence of Material Damping on the Magnitude and Rate of Deformation. Ernst Bankwitz (*Metallwirtschaft*, 1933, **12**, 33–35).—The depen-

dence of the resonance vibration frequency on the magnitude of the torsion angle has been measured in a torsion vibration machine; the frequency is constant for small twists, but decreases linearly above a definite limiting value which must be considered as the beginning of the damping action, and is about half as great as the twist value at which heating of the material becomes measurable. This procedure therefore provides a sensitive method for determining the beginning of damping. The behaviour is the same for vibration frequencies between 200 and 2500 (varied by altering the oscillating mass), and is thus independent of the rate of deformation. The static yield-point rises appreciably after some millions of alternations under torsion vibration loading; this effect is particularly marked with aluminium and an aluminium alloy (Cu 4, Si 1, Mn 0·5%), the rise being 40–50% compared with 15–30% for other metals.—v. G.

Repeated Impact Tests: Dependence of the Impact Number on the Falling Weight and Height. Martin Beilhack (*Forschungheft*, **354**, 1932, 1–22).—The apparatus and procedure for repeated impact tests are described. These tests have a somewhat more limited application than other mechanical tests. The impact number depends largely on the weight of the striker and the distance through which it falls. With decreasing weight and increasing height of fall so that the momentum is constant, the impact number (the number of blows to fracture) increases, and may reach infinity in the case of very small weights at high speed. Calculations show that with a 4-kg. weight dropping through 10 mm., 48% of the energy is lost, which is explained by the deformation-effect being produced not by a single blow, but by the series of continued impulses. This hypothesis was confirmed by measuring the incidence and period of the blow and the deflection of the test-piece by means of an oscillograph. Equations are derived for perfectly elastic material and for partly elastic material for which the energy loss can be approximately calculated. In these tests, not only must the kinetic energy of the falling weight and the impact number be given, but also the size of the falling weight and the height through which it falls, and the deflection of the test-piece to enable the mechanical strength of the material to be approximately calculated.
—J. H. W.

The Interference Method of Measuring Thermal Expansion. George E. Merritt (*U.S. Bur. Stand. J. Research*, 1933, **10**, 59–76; and *U.S. Bur. Stand. Research Paper* No. **515**).—This paper is published in response to numerous enquiries for details of the method developed at the (U.S.) Bureau of Standards and described in *U.S. Bur. Stand. Sci. Papers* Nos. **393** and **485**, and several articles in other publications. It is intended as a manual for the use of those who wish to measure thermal expansions by the interferometric method. As such, a more complete description of the apparatus and methods developed can be included than would be in order in a paper dealing primarily with the results of a particular set of measurements. The apparatus, method of making the specimens, forms for taking data, and computation of data are each the subject of a careful exposition. Tables and special calculations are included in an appendix.—S. G.

Notched Bar Impact Testing. P. Field Foster (*Machinery* (*Lond.*), 1932, **40**, 105–107).—An account is given of the method of carrying out notched bar tests; the Izod, Charpy, Mesnager, and Frémont test-specimens are compared, and the Amsler impact testing machine is described and illustrated.
—J. C. C.

Adapting Light Rays in Hardness Testing. J. R. C. (*Machinery* (*Lond.*), 1932, **40**, 761).—A simple device for routine hardness testing is described. A mirror system is employed to indicate the depth of penetration of a 1-mm. ball under a load of 500 lb.—J. C. C.

XII.—PYROMETRY

(Continued from pp. 145–146.)

On Micropyrometry. G. Lewin (*Z. tech. Physik*, 1932, **13**, 497–499).—The principles of construction of micropyrometers (see *J.*, this volume, p. 145), the degree of magnification possible and the possibility of increasing the magnification at very high temperatures are discussed.—J. W.

New Thermocouples of Noble Metals for Very High Temperatures. Otto Feussner (*Elektrotech. Z.*, 1933, **54**, 155–156).—Iridium/60 : 40 rhodium–iridium alloy thermocouples can be used up to 2000° C. The brittleness of the pure iridium wire can be appreciably reduced by suitable treatment, and the constituents are relatively only slightly volatile at high temperatures, so that frequent standardization of the couples is unnecessary. The e.m.f. is 1·1 mv. at 200° C., 5·5 mv. at 1000° C., and 10·85 mv. at 2000° C.—B. Bl.

Reference Tables for Platinum to Platinum–Rhodium Thermocouples. Wm. F. Roeser and H. T. Wensel (*U.S. Bur. Stand. J. Research*, 1933, **10**, 275–287; and *U.S. Bur. Stand. Research Paper* No. **350**).—Reference tables for use with platinum/platinum–10% rhodium and platinum/platinum–13% rhodium thermocouples have been prepared. When these tables are used, the deviation curves obtained for individual couples have no points of inflection and are, with few exceptions, linear. These tables are based on the International Temperature Scale, so that the indications of a thermocouple whose calibration is obtained by extrapolation of a deviation curve above the gold point will agree in this region with those of an optical pyrometer.—S. G.

An Optical Method for Measuring Temperature Distribution and Convective Heat Transfer. R. B. Kennard (*U.S. Bur. Stand. J. Research*, 1932, **8**, 787–805; and *U.S. Bur. Stand. Research Paper* No. **452**).—In order to avoid the errors inherent in material thermometers, a method has been devised whereby the temperatures in the region of heated air near a hot surface may be determined from the displacement of the fringes in an interferometer. Photographs were taken of the interference fringes near a hot vertical plate and near horizontal heated cylinders. The temperature distribution and the convective heat transfer were determined from measurements made on enlargements of these photographs. It is shown that the temperature distribution does not correspond with that called for by the film theory.—S. G.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 146–153.)

Metallography and the Foundry. Introduction to the Scientific Study of Casting. Albert Portevin (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 19–25; and (abstract) *Usine*, 1931, **40**, (51), 31).—A very interesting study of foundry problems from new angles, in which the necessity of metallographic investigations is emphasized. Physico-chemical principles are applied in arriving at a knowledge of what is required both by the founder and by the metallurgist. Of especial interest are the sections which are concerned with the conditions necessary for soundness of castings, exactness of form, and the control of contraction.—W. A. C. N.

Foundry Working on Railways. N. L. Baillie (*J. Inst. Locomotive Eng.*, 1932, **22**, 676–736; discussion, 737–750).—An account of the equipment and operation of a railway foundry, particularly adapted to conditions in the Argentine. Among items of non-ferrous interest are included notes on crucible furnaces, details of non-ferrous mixtures used in railway practice, accounts of moulding and centrifugal casting machines, and a discussion of the characteristics desired in moulding sands and their control.—J. C. C.

Excrescences and Eruptions in Foundry Work. L. Gasquard (*Bull. Assoc. Tech. Fonderie*, 1931, **5**, 137–139).—The remedies suggested for these defects include the following: use of a sand of specific composition and of regular grain; it should be free from all material which might be harmful to the castings; the size of grain should be adapted more or less to the size of the casting to be produced; the maximum moisture content should be 8%; casting must be carried out regularly so as to give as uniform cooling as possible; gates and risers should be placed judiciously.—W. A. C. N.

Security in Using Castings. R. de Fleury (*Bull. Assoc. Tech. Fonderie*, 1931, **5**, 127–131; and (short abstract) *Usine*, 1931, **40**, (23), 29).—A study of the factors which enter into foundry work causing instability or variation in the quality of the castings produced. It includes sections on the falling off in quality during the course of time, or, in other words, the number of remeltings; indirect factors such as the nature of the primary material, and the physical properties of the alloys during solidification; phenomena occurring during casting such as solidification interval, viscosity, and prevalence of gas. It is pointed out that while any of these factors alone may be of comparatively small significance, the possibility of more than one coming into operation at the same time is definitely liable to react on the quality of the finished work. —W. A. C. N.

On the Measurement of the Shrinkage of Castings by Means of an Extensometer. Kôtarô Honda and Rimpei Kikuchi (*Sci. Rep. Tôhoku Imp. Univ.*, 1932, [i], **21**, 575–584).—[In English.] The linear contraction of castings of aluminium, tin, zinc, lead, bismuth, antimony, and the whole series of aluminium–zinc alloys has been determined with an improved extensometer of the Turner type. The total shrinkage consists of contraction (*a*) in the liquid phase, (*b*) during solidification, and (*c*) in the solid phase. Of these the extensometer indicates merely the approximate contraction in the solid phase, and gives no indication of the change of volume during solidification. The values of total shrinkage of castings of various metals and alloys usually adopted are too small, being roughly half the correct values.—E. S. H.

Some Considerations on the Cooling of Castings. E.-V. Ronceray (*Bull. Assoc. Tech. Fonderie*, 1931, **5**, 78–88).—Cf. this *J.*, 1930, **44**, 702. A very full and clear explanation of the course of cooling, and the theoretical principles which underlie the phenomena. Different types of apparatus are described for obtaining the best casting conditions, for obtaining sound castings, and for ensuring that slag and scoria are retained so that they do not enter the moulds.—W. A. C. N.

Some Practical Foundry Methods for Preventing Unsoundness in Aluminium Alloy Castings. H. J. Rowe and E. M. Gingerich (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 343–352).—The first part deals generally with the causes of porosity, and is followed by a discussion of the factors which affect the soundness of the alloys. Among these are the temperatures during casting, the nature of the melting furnace and the fuel used, the foundry technique, the composition of the alloy and of the materials used, and the condition of the metal as determined by its prior history. Succeeding sections are concerned with experimental investigations of the influence of factors incidental to the foundry and of methods which have been adopted for suppressing porosity. Generally it is found that the following principles should be borne in mind: use of low casting temperatures, control of all melting conditions and speed of solidification, correct moulding practice, intermediate solidification of the metal, the use of certain chlorides, and a strict supervision of the ingredients of the alloy.—W. A. C. N.

Some Causes of Defects in Aluminium Alloys. D. Hanson (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 431–444).—A resumé of work, most of which has already been published by the Institute of Metals. It deals with gas absorp-

tion and the methods which may be adopted to counteract it; with the type of furnace to be employed in melting; and with the experimental investigation of the various factors which are incidental to this problem.—W. A. C. N.

Use of Graphite and Cast-Iron Crucibles in the Aluminium Foundry. P. Girod (*Usine*, 1931, **40**, (23), 33).—Abstract of a paper read before the 10e. Congrès de Fonderie. Graphite crucibles are said to cause the formation of hard spots in castings, and crucibles of grey cast-iron are proposed, to substitute them.—H. W. G. H.

The Deoxidation of Copper with Various Metals. Earle E. Schumacher and W. C. Ellis (*Bell Telephone System Tech. Publ., Monograph* **B 707**, 1932, 1–8). —Reprint of a paper on "The Deoxidation of Copper with Metallic Deoxidizers, Calcium, Zinc, Beryllium, Barium, Strontium, and Lithium," read before the Electrochemical Society. See this *J.*, 1932, **50**, 580.—S. G.

Bronze Founding Industry in 1932. E. G. Cox (*Met. Ind.* (*Lond.*), 1933, **42**, 218).—Another letter on this subject, in favour of the use of crucible furnaces for bronze casting (see Rowe, *J.*, this volume, p. 147).—J. H. W.

Some Remarks on Casting Heads in the Bronze Foundry. M. De Brock (*Bull. Assoc. Tech. Fonderie*, 1932, **5**, 21–29).—The effect of contraction due to liberation of gas and to solidification is considered. The use of heads to take superfluous metal and to feed the shrinkage is discussed. The various factors which affect the size of head to be used and its form are reviewed very thoroughly. Special instances are cited wherein casting by these methods has been successful.—W. A. C. N.

Notes on Brass Casting. F. A. Livermore (*Met. Ind.* (*Lond.*), 1932, **41**, 439–440).—Notes on the use of crucibles for melting, the need for pyrometric control, and defects in castings and their eradication.—J. H. W.

On the Preparation of Manganese-Brass. Edmund T. Richards (*Metallbörse*, 1932, **22**, 1357–1358, 1389–1390).—The composition, preparation, and properties of numerous manganese-brasses are briefly discussed with especial reference to the influence of impurities.—A. R. P.

Die-Castings and Stampings. Anon. (*Iron Age*, 1933, **131**, 48).—A brief review of the trend in die-castings and stampings of brass and alloys containing brass, aluminium, and nickel, as indicated by the practice of large modern firms.—J. H. W.

The Design of Die-Castings. F. A. W. Livermore (*Met. Ind.* (*Lond.*), 1933, **42**, 217–218).—A brief description of the die-casting process is given, and considerations governing design, precautions in venting, and the casting of lettering and threads are discussed.—J. H. W.

Moulds for the Casting of Ingots of Non-Ferrous Metals and Alloys. I. E. Gorshkov (*Metallurg* (*The Metallurgist*), 1932, **7**, (1), 67–83).—[In Russian.] Cf. this *J.*, 1932, **49**, 203, 232. The merits of horizontal, vertical and inclined chill-moulds for casting non-ferrous ingots are discussed, and the characteristics of each method of casting are critically summarized with reference to numerous diagrams.—M. Z.

Some Special Cores. H. Fabre (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 226–235).—Descriptions of special types which have been made in particular circumstances.—W. A. C. N.

Agglomerated Sand Cores. J. Doskocil (*Bull. Assoc. Tech. Fonderie*, 1932, **6**, 475–484).—The problem of the choice of a convenient sand mixture is bound up with the following considerations: the quality and general characteristics of the siliceous part of the mixture; the nature of the binder; a proper understanding of the kind of core required for the particular purposes in view; and the heat-resistant qualities. The manufacture of the cores entails a review of the nature of the surface of the core, its permeability, and the rapidity and facility with which it can be disengaged from the casting. These various factors are all discussed fully from the practical point of view.—W. A. C. N.

Application of Sand Testing in the Foundry with the Object of Ensuring Control. H. W. Dietert (*Bull. Assoc. Tech. Fonderie*, 1931, **5**, 281–282).—Tests for moisture, permeability, drying properties, grain-size, and clay content are described.—W. A. C. N.

Methods of Testing and Control for Moulding Sands. A. Deleuse (*Bull. Assoc. Tech. Fonderie*, 1931, **5**, 282–284).—Cf. this *J.*, 1931, **47**, 240.—W. N.

XIV.—SECONDARY METALS: SCRAP, RESIDUES, &c.

(Continued from p. 153.)

Method of Calculating the Yield of Non-Ferrous Metals from Scrap in the U.S.S.R. I. Valk and S. V. Ivanov (*Zvetnye Metally* (*The Non-Ferrous Metals*), **1930**, 725–742; *C. Abs.*, 1933, **27**, 483).—[In Russian.] Statistical data are given for the non-ferrous scrap industry of the U.S.S.R., covering the period 1901–1933 (data for 1930–1933 are obtained by extrapolation).—S. G.

XV.—FURNACES AND FUELS

(Continued from pp. 154–157.)

FURNACES

Developments in Gas-Fired Furnaces. F. Johnstone Taylor (*Machinery* (*Lond.*), 1932, **40**, 613–619).—The principles governing the design of town's gas and producer-gas fired heating furnaces are outlined and some typical examples described and illustrated. The Wellman–Chantraine "multi-flame" system of combustion (to prevent local overheating), the efficiency of recuperation systems, the use of pressure burners, and the advantages of suspended roofs are among the points discussed.—J. C. C.

Procedure in the Industrial Use of Gas. Otto Wolff (*Gas- u. Wasserfach*, 1932, **75**, 617–623).—An illustrated article on the various types of gas-heated industrial furnaces, with special reference to the steel industry, with data on the gas consumption, the efficiency, and the cost of operation.—B. Bl.

Oil Heating Furnaces. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 193–194).—A brief description of a modern type of oil-fired heating furnace.—J. H. W.

The Melting of Aluminium and Its Alloys. Electric or Fuel-Fired Furnace? C. Sonnino (*Bull. Assoc. Tech. Fonderie*, 1932, **16**, (Suppt.), 12–17).—A comparison is drawn between the relative economic advantages and disadvantages of the electric furnace on the one hand and fuel furnaces on the other for the fusion of aluminium alloys. A number of technical points in favour of the electric furnace—exact regulation of temperature atmosphere, and ease of removal of gases—are examined. It is concluded that the rather insignificant advantages of coke or gas firing are more than outweighed by the greater advantages of the electric furnace.—W. A. C. N.

Electric Heat. Victor Paschkis (*Elektrotech. Z.*, 1932, **53**, 1169–1171).—A review of recent literature on welding machines, arc furnaces, induction furnaces, and resistance furnaces.—B. Bl.

Resistance Furnaces for Heat-Treating Aluminium. Anon. (*Machinery* (*Lond.*), 1932, **39**, 631–632).—An illustrated description of an installation of three electric resistance furnaces each equipped for automatic charging, provided with automatic temperature control, fitted with two centrifugal fans in the roof, and designed for heat-treating aluminium. Two of the furnaces have chambers 14 ft. long, 7 ft. wide, and 5 ft. high, and are the largest so far installed in this country.—J. C. C.

XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 158–159.)

Electrical Resistivity of Specialized Refractories. Harold E. White (*J. Amer. Ceram. Soc.*, 1932, 15, 598–610).—Tests were carried out on the electrical resistivity of 12 commercially-used special refractory bricks at temperatures up to 1300° C. Standard 9-in. bricks were tested using apparatus which is standard equipment and readily obtainable. Temperature lag was eliminated by constant heating over a prolonged period of time at given temperatures. The results obtained indicate a decrease in resistivity with prolonged heating for some classes of refractories. Those refractories composed of minerals of the same petrographic classification appear to undergo the least change. A *bibliography* of 41 references is appended.—S. G.

Researches on the Thermal Conductivity of Refractory Materials. Anton Kanz (*Mitt. Forsch.-Inst. Ver. Stahlwerke A.-G., Dortmund*, 1932, 2, 223–234; *Ceram. Abs.*, 1932, 11, 457).—A new method for determining the thermal conductivity of refractory materials is described. Because of the smaller size of the sample and its cylindrical form, it was possible to save much time and to obtain a more uniform heating of the surfaces. The bricks investigated were: 4 silica, 2 grog, 2 bauxite, 1 corundum, 2 sillimanite, and 1 chromite. The figures of thermal conductivity of these bricks agree well with those obtained by other methods, with the exception of those for chromite brick. Silica bricks which have already been fired once are capable of conducting heat which increases with increased temperatures, more below 400° C. than above it. Thermal treatment influences the formation of tridymite in silica brick. It considerably increases the capability of conducting heat, and makes the figure of thermal conductivity dependent on the linear temperature. Irregularities were determined under 300° C. in alumina blocks, *e.g.*, grog, bauxite, corundum, and sillimanite brick, which are probably influenced by the modification changes occurring in the brick. Well-fired bricks did not show these phenomena. In these bricks also, the influence of the dependence of temperature of the figure of thermal conductivity on the firing temperature, in consequence of the formation of crystalline modifications, was determined. The researches showed that the determination of the capability of conducting heat of refractories in the temperature range between 100° and 600° C. may produce important results because of a greater knowledge of the interior structure of refractories. The great differences in the results obtained by different investigators are due to the inexact methods used.—S. G.

Expansion of Refractories. Anon. (*Rev. mat. constr. trav. publ.*, No. 269, 1932, 75–76; *Ceram. Abs.*, 1932, 11, 371).—The continuous expansion of different refractories from room temperature up to the highest reached, is shown by means of curves. A quartz-marl brick showed a weak expansion under 300° C., a partial transformation of quartz at 500°–600° C., and a large expansion at 1400° C. Bricks in which quartz was completely transformed have the highest expansion under 400° C. Their volume remains constant at higher temperatures. The expansion of other kinds of refractories: magnesite grog, dynamidon, electrically-fused silica, and artificial sillimanite are discussed. —S. G.

Reversible Thermal Expansion of Refractories. W. J. Rees (*Brit. Clayworker*, 1932, 40, (480), 7; *Ceram. Abs.*, 1932, 11, 414).—There is no real difference between "thermal expansion" and "reversible thermal expansion" except in rare cases when the expansion which takes place on heating is of a permanent character and is consequently described as an "after-expansion" and not as "thermal expansion." An increase in the porosity of a fire-brick causes a decrease in the reversible thermal expansion up to a porosity of 50%, but does not produce irregularities in the expansion curve.—S. G.

Influence of Size of Load on the Deformation of Refractories at High Temperatures. V. Zegzhda (*Trans. Ceram. Research. Inst.* (*U.S.S.R.*), No. 34, 1932, 63–77; *Ceram. Abs.*, 1933, 12, 19).—[In Russian.] Experiments on the deformation under load (from 1 to 5 kg./cm.^{2}) of refractory products at high temperatures are described. It was found that the influence of the load depends on the chemico-mineralogical and granulometric composition of the samples, and that the load of 2 kg./cm.^{2} is the most suitable.—S. G.

Temperature of Incipient Fusion of Refractory Products. M. Lépingle (*Ind. chim. belge*, 1931, 2, 475–483; *Ceram. Abs.*, 1933, 12, 19).—L. studied the modifications in height as functions of time and temperatures of cylinders 500 mm. high and 35·7 mm. in diameter, under a constant load of 2 kg./cm.^{2}. The curves obtained showed 3 interesting points: (1) the temperature at which expansion ceases; (2) the temperature at which it begins to collapse; and (3) the temperature at which the rate of collapse tends to infinity. The last two points constitute usual constants, but no consideration is usually given to the first, which, however, must correspond with a modification in the structure of the sample, a transformation which is due to the incipient fusion of the fluxes contained in, and unevenly distributed throughout, the refractory. In aluminous refractories there is a slow and continuous collapse of the sample constituting a true viscous fusion.—S. G.

An Investigation of the Action of Coal-Ash Slags on Firebrick by Microscopic Methods. Harold E. Simpson (*J. Amer. Ceram. Soc.*, 1932, 15, 520–535).—The action of coal-ash slags on firebrick refractories was studied by microscopic examination of thin sections prepared from quenched samples of ash and refractory heated together. The 8 refractories used varied as to clays, method of fabrication, grind, and firing treatment. Six different coal ashes varied from highly corrosive to non-corrosive ashes. Samples were quenched at intervals in the range of 2200°–2800° F. (1205°–1538° C.) and the critical temperature or maximum safe operating temperature of all combinations of slag and refractory was determined. These values are presented, together with a discussion of the various minerals formed.—S. G.

A Classified Review of Refractory Slag Tests. Harold E. Simpson (*J. Amer. Ceram. Soc.*, 1932, 15, 536–544).—The literature on refractory slag tests is reviewed. The various methods are divided into 8 different classifications, and references are given to the literature.—S. G.

Protection of Refractory Materials with Colloidal Graphite. Anon. (*Industrie chimique*, 1931, 18, 838; *Ceram. Abs.*, 1932, 11, 414).—Researches carried out in the laboratory of the Verein zur Überwachung der Kraftwirtschaft des Ruhrzechen, Germany, did not confirm the hypothesis that a coat of colloidal graphite (Hydrokollag) can protect refractory materials against the action of furnace gases. The tests were made in a blast-furnace with reduced atmosphere in the presence of corrosive cinders. Both diluted and undiluted Hydrokollag were used. In both cases graphite burned up almost completely, and consequently refractories treated with Hydrokollag did not behave better than others.—S. G.

Refractoriness and Standard Methods for Its Determination in Germany, U.S.A., and U.S.S.R. S. I. Perkal (*Ukrainsky Silikaty*, 1931, (8/9), 251–264). —[In Russian.]—S. G.

Ceramic Shops at Metallurgical Plants. I. I. Kuzmenko (*Ukrainsky Silikaty*, 1931, (11/12), 362–366).—[In Russian.]—S. G.

Research Work on Refractories in the U.S.S.R. During the Past Five Years. S. I. Perkal (*Ukrainsky Silikaty*, 1931, (6), 165–178).—[In Russian.]—S. G.

A Useful Range of Plastic Cements [Drykos; Purimachos]. Anon. (*Eng. Rev.*, 1932, 46, 346).—Some grades of Drykos and Purimachos plastic fire cements are described.—P. M. C. R.

On Graphite Crucibles. Edmund Richard Thews (*Tonind. Zeit.*, 1932, **56**, 60–62).—A correlated abstract.—B. Bl.

Some Experiments with Zircon and Zirconia Refractories. George F. Comstock (*J. Amer. Ceram. Soc.*, 1933, **16**, 12–35).—A record of the results of 5 years' research on refractory uses for a chemically purified grade of zircon and electrically-fused zirconia of high purity. The products investigated included semi-permanent foundry moulds, refractory bricks and cements, ladle nozzles, and crucibles. Electric firing and a small oil-fired tunnel kiln are described. The effects of various binders are discussed. Sintered zircon grog was found to be superior to electrically fused grog. Zircon bricks made with 50% grog, using 20% milled zircon for the permanent bond, and fired at 1600° C. for 1 hr., showed no firing shrinkage, very slight volume change, and high compressive strength at 1600° C. They were extremely resistant to spalling, but did not resist basic slags or metallic oxides very well at high temperatures. Zircon-bonded magnesite bricks were more refractory than ordinary magnesite, more resistant to spalling, and had about the same slag-resistance as magnesite. Zirconia was more refractory than zircon and had better slag-resistance. Lime-bonded zirconia crucibles of good spalling-resistance were made, but the cost was higher than that of zircon.—S. G.

Alundum, Refractory Aluminous Product. V. Charrin (*Céram. Verrerie*, 1932, (**843**), 477; *Ceram. Abs.*, 1933, **12**, 20).—The preparation of alundum in an electric furnace is described, and the uses for the finished product are discussed.—S. G.

[Siemensit] A Refractory of High Service Value. Justus Schmauser (*Tonind. Zeit.*, 1932, **56**, 1123–1124).—A short account is given of the properties of Siemensit, a refractory material made by fusing a mixture of chromic oxide, magnesia, and alumina in the electric furnace.—B. Bl.

Magnesite. Anon. (*Brit. Clayworker*, 1932, **40**, 391–392; *Ceram. Abs.*, 1932, **11**, 312).—The varying conduct of the refractory is due to differences both in the chemical composition and physical structure of the raw materials. Trouble with the finished brick is also due to the method of grinding, tempering, and bonding and the system of conducting the drying and final firing. A brief discussion on crucibles prepared from magnesite, and the increased use of magnesite for basic-lined converters in the refining of copper and nickel and in the metallurgy of silver, is included.—S. G.

Researches on the Capability of Conduction of Heat of Magnesite Blocks. Martin Boetticher (*Mitt. Forsch.-Inst. Ver. Stahlwerk A.-G., Dortmund*, 1932, **2**, 235–248; *Ceram. Abs.*, 1932, **11**, 458).—Different magnesite blocks were investigated for their thermal conductivity, characteristics, and structure by X-rays. (1) The sp. gr. and the grain-size of the block change with a subsequent heating to redness at a temperature which lies considerably above the firing temperature. The time of heating to redness has no effect. (2) The thermal conductivity of magnesite depends directly on the sp. gr. and grain-size because with their increase produced by subsequent calcining the thermal conductivity increases. The change of the thermal conductivity is small. (3) No relationships between the thermal conductivity, gas permeability, and porosity were found in the blocks investigated. (4) The lattice parameter of periclase, contained by magnesite, does not change with a subsequent heating to redness. Its value corresponds with that of pure magnesium oxide within the limits of error. An index of literature on the subject is given.—S. G.

Determining the Effects of the Rate of Firing and Rapid and Slow Cooling on the Physical Properties of Fireclay Refractories. R. C. Hutchison (*J. Amer. Ceram. Soc.*, 1932, **15**, 517–519).—This investigation determined that the rate of firing, as specified in the standard test for the firing behaviour of fireclay refractories, could be reduced without materially affecting the accuracy of the

data obtained. The rate of cooling was found to be the cause of variations between test results and laboratory and factory results.—S. G.

A Study of Heating and Cooling Rates of Checker Brick. Gilbert Soler and R. M. King (*J. Amer. Ceram. Soc.*, 1932, **15**, 545–549).—A test simulating the heat absorption and emission of checker brick was developed. The results of such tests on firebricks of 2 sizes, made by 3 different processes and procured from 4 fireclay districts, are given and correlated with the bulk, sp. gr., and porosity of the bricks.—S. G.

Magnesite Bricks Insensitive to Temperature Changes. K. Endell (*Stahl u. Eisen*, 1932, **52**, 759–763).—Norton's formula, according to which the sensitivity to temperature change is, *ceteris paribus*, inversely proportional to the change of shape at high temperature, is shown to be applicable to five types of magnesite brick having different sensitivities to quenching. From micrographic examination it has been found that change of shape in the torsion test at elevated temperatures is rendered possible by crystallographic cleavage (and perhaps also by slip and twinning) in the periclase crystallites. A high periclase content of the bricks is therefore a criterion of good temperature stability. —J. W.

Magnesium Orthosilicate as a Refractory. F. Reinhart (*Tonind. Zeit.*, 1932, **56**, 323–324).—The material is prepared by burning at 1500° C. hydrated magnesium silicates such as talc, serpentine, olivine, peridote, or dunite, with a binder and 2% of an alkali silicate and chloride. Stable bricks may be prepared by taking advantage of the property of a certain coarse-grained olivine of expanding during burning and the property of a finely-ground mixture of serpentine and magnesia of contracting under the same conditions.—B. Bl.

Relation of Crushing Strength of Silica Brick at Various Temperatures to other Physical Properties. Sandford S. Cole (*J. Amer. Ceram. Soc.*, 1932, **15**, 611–621).—The failure at elevated temperatures under constant load of silica bricks is reported, using the Dupuy load test apparatus. The crushing strengths at 1500°, 1800°, 2100°, and 2400° F. (815°, 982°, 1149°, and 1316° C.) are recorded, as well as the crushing strength at room temperature. The size of the test-piece normally used was 1 × 1 × 2½ in. A definite relationship is shown to exist between the strength at room temperature and that at elevated temperatures. The effect of variation in lime content, bats content, and fluxes is also given. Data were obtained on bricks made from 3 different quartzites. Additional physical data are reported to give information concerning the properties of the bricks tested.—S. G.

The Evaluation of Silica Bricks by Their Appearance. Robert Selzer (*Tonind. Zeit.*, 1932, **56**, 361–362).—The quality of silica bricks cannot be judged by their appearance as their colour and the presence of spots depend on numerous factors, such as the nature of the raw material, its iron content, and the method of burning, which do not necessarily have a direct influence on the quality of the brick.—B. Bl.

The Bernitz Carbofrax Furnace Blocks. Anon. (*Eng. Rev.*, 1932, **46**, 332).—The properties of Carbofrax (over 88% silicon carbide) are enumerated and its applications described.—P. M. C. R.

A Recently Introduced Plastic Refractory. Anon. (*Eng. Rev.*, 1932, **46**, 310).—Durosil and Peaksil are among the products of silica deposits occurring in the Peak District of Derbyshire. Durosil is especially suitable for the construction of monolithic walls.—P. M. C. R.

Rapid Methods for the Determination of Silica [in Refractories]. Anon. (*Tonind. Zeit.*, 1932, **56**, 597–598).—Evaporation of the solution with perchloric instead of with sulphuric acid for the dehydration of the silica has the advantage that the alkaline earths pass readily into solution on diluting with water. References to the literature are given.—B. Bl.

XVII.—HEAT-TREATMENT

(Continued from pp. 160–161.)

A Study on the Electrochemical Potential in Relation to the Heat-Treatment and Ageing of Duralumin. Hiroshi Imai and Masami Hagiya (*Kinzoku no Kenkyu* (*Journal for the Study of Metals*), 1932, **9**, (12), 530–538).—[In Japanese.] Experiments were carried out to examine the influence of heat-treatment and ageing on the electrochemical potential of Duralumin. The potential existing between Duralumin and a *N* solution of potassium chloride was measured against a normal calomel electrode at 20° C. The results show that by quenching at 510° C. Duralumin becomes distinctly electro-negative, and that the potential for the quenched alloy remains unaltered throughout the 10 days of ageing, whilst by tempering at 100° C. it becomes slightly electro-positive; by finally tempering at 200° C. its normal value is restored. Some of the copper–aluminium and magnesium–silicon–aluminium alloys were also examined to confirm the behaviour of the compounds $CuAl_2$ and Mg_2Si. No signs of precipitation of the compounds nor change in the supersaturated solid solution were deserved during the time of ageing.—S. G.

Heating of Sheets of "Elektron AZM" to Remove Internal Stress. M. Abraham (*Jahrb. deut. Versuchsanst. Luftfahrt*, **1932**, 13).—Internal stress in spring-hard Elektron sheets is removed in 1 minute at 250° C. but 1 hr. is necessary at 200° C.—B. Bl.

Retarding the Ageing of High-Resistance Light Alloys. —— Coquelin (*Arts et Métiers*, 1932, **85**, 353–356).—A series of aluminium alloys of the Duralumin-type was subjected to heat-treatment and then placed in a refrigerator and maintained at a constant low temperature for various periods of time, after which the breaking stress and Brinell hardness were determined. From the results of these experiments it is concluded that: (1) when ageing has begun, it cannot be stopped even at a temperature of — 10° C.; (2) the temperature at which the metal must be kept (to prevent ageing) is about — 5° C.; (3) after removal from the refrigerator the metal ages normally and resumes its normal mechanical properties; (4) the metal retains its soft state as long as the low temperature is maintained. Experiments with stamping test-pieces after a similar treatment confirmed these results.—J. H. W.

XVIII.—WORKING

(Continued from pp. 161–164.)

Fabrication and Properties of Seamless Phosphorized Arsenical Copper Tubing. G. L. Craig and O. Z. Klopsch (*Amer. Inst. Min. Met. Eng. Preprint*, **1933**, Feb., 1–9).—The effect of arsenic up to 0·2% on the basic properties of tough-pitch and of phosphorized copper has been critically studied and laboratory experiments have been supplemented by mill scale tests. It is shown that the basic properties of copper are not greatly affected by small amounts of arsenic. An increasing strength with an increase in the arsenic content has been noted, whilst at the same time there is no corresponding loss of ductility. It is concluded that, within the range of the reductions with which the paper deals, arsenic has no appreciable effect on the fabricating characteristics of copper.—W. A. C. N.

Developments and Future Trends of the Non-Ferrous Tube Trade. Gilbert Evans (*Metallurgia*, 1933, **7**, 111–113).—The position of the non-ferrous tube trade is reviewed and the methods adopted by British tube manufacturers to meet prevailing conditions are considered. Reference is made to modern plant and methods, such as the development of the rotary piercing machine as applied to copper tube production, and the various types of extrusion

machines. The relative methods of rotary piercing and extrusion, and the comparative merits of hydraulic and chain benches are discussed, and consideration is given to the merits of a fixed drawing bar and die as applied to draw- or push-benches of the hydraulic type, as compared with a free bar or die. Various methods of annealing are also considered, and the future possibilities for economical production and application of tube in various forms referred to.—J. W. D.

Use of Small Diameter Rolls and Improvements in Multiple Rolling-Mills. W. Rohn (*Stahl u. Eisen*, 1932, **52**, 821–825).—Very small diameter rolls have recently been used in 12-high rolling-mills in which they are supported against 2 loose intermediate rolls which themselves are supported against 3 external rolls. This arrangement renders possible a more economical production of very thin sheets in relatively few steps with increased precision. The technical and constructional principles for such rolling-mills are discussed with examples, an apparatus for the continuous testing of the accuracy of the rolling is described, and information on the economies of the mills is given.—J. W.

Lubricating a 48-in., 3-High, Universal Mill. Louis H. Hein (*Blast Fur. and Steel Plant*, 1933, **21**, 99–102).—Refers primarily to steel mill plant, but the system and principles involved are applicable to rolling-mills in general. 196 bearings were included in the scheme, in which the control equipment is entirely mechanical.—R. Gr.

Care of Large Electrical Apparatus. J. S. Murray (*Blast Fur. and Steel Plant*, 1933, **21**, (2), 114–115, 117, 118).—Outlines the necessary tests to be applied before starting up an electrical plant which has been idle for considerable periods. Testing of the insulation for breakdown due to moisture is essential.—R. Gr.

Dies for Wire Manufacture. Richard Saxton (*Mech. World*, 1932, **92**, 479–480).—Steel for wire-drawing dies is used chiefly because when the bearing shows signs of wear, it can be quickly re-set and used again. The setting by hand is superior to drilling methods. A die for drawing copper and brass is illustrated. It is of shorter bearing length than that for drawing mild steel, the reduction possible being over 3 times as great as that possible in drawing high-carbon steel. The longer the bearing the smaller is the reduction possible. The length of bearing for copper and brass is about the same as the diameter of the wire when drawn. "Stone metal" dies should oust the steel die when they have been improved by research.—F. J.

Structural Change in Drawn Wire. R. Saxton (*Mech. World*, 1932, **92**, 117–118).—The change which takes place in wire or wire rod while undergoing the drawing process is little understood even by many in the trade. Steel wire only is discussed and attention is directed to the improvement which occurs—in the torsion test—when drawn wire is allowed 2 or 3 months' rest.—F. J.

Lime in Wire-Drawing. D. E. Washburn (*Wire and Wire Products*, 1932, **7**, 385–386).—The essential factors necessary for a lime giving the most successful and effective results in wire-drawing are described. Although the limits of chemical composition are difficult to prescribe, the calcium oxide content should probably not be less than 94%, magnesia and silica each less than 2%, and other impurities less than 1%, with carbon dioxide between 1·5 and 0·6%.—J. H. W.

Fourdrinier Wires and Cloths.—II. Kurt Jahn (*Wire and Wire Products*, 1932, **7**, 221–223).—The testing of wires, choice of warp and filler wires, winding on to warp spools, and the spooling of the filler wires are described. (See this *J.*, 1932, **50**, 455.)—J. H. W.

The Deep-Drawing Qualities of Thin Sheets. J. Cunningham (*Mech. World*, 1932, **92**, 53–54).—The deep-drawing expansion test devised by Siebel and Pomp (cf. this *J.*, 1930, **43**, 579, and 1930, **44**, 600), in which annular test-pieces, having a central hole, are drawn into a cup while the outer rim of the

cup is firmly clamped in a circular flat-faced die, is favourably compared with the Erichsen test in indicating the ability of the material to undergo deep-drawing. The test is useful in connecting deep-drawing properties with micro-structure, cold-working, and heat-treatment. Another method of testing devised by F. Eisenkolb (*Stahl u. Eisen*, 1932, **52**, 357–364) is described, in which the Erichsen test is used on material, after cold-working it by drawing the test-discs into closed cylinders through a number of dies.
—F. J.

Effect of Machine Rigidity on Metal Flow. E. R. Frost (*Canad. Mach.*, 1932, **43**, (15), 17–28, 40; and *Iron Steel Canada*, 1932, **15**, 137–139).—Read before the Ontario Chapter of the American Society for Steel Treating. Very accurate forging and stamping, a stronger product and economy of material are rendered possible by the improved strength and stiffness of modern machinery; these qualities appear to influence the mechanical properties of the product more than does the design of the die, if this be used. It is found that when metal flow is once induced, it should be allowed to continue uninterrupted to completion of the operation otherwise greatly increased pressure is needed for re-starting. Methods of machining based on these observations are outlined, with their effects on quality and cost.
—P. M. C. R.

Investigations on Stamping Tools. Bruno Deja (*Werkzeug* (Suppt. to *Maschinenkonstrukteur*), 1933, **9**, 7–8).—The form and the sudden application of some common types of die cause excessive wear of the tool and much distortion and marginal tearing in the stamped piece. An alteration in the form of the tool is proposed; specimen micro-sections show clean-cut edges and an even distribution of stress as against the severe local stresses and torn edges found in work produced by the earlier methods.—P. M. C. R.

Tapered Shell Dies. S. A. McDonald (*Mech. World*, 1932, **92**, 337).—In the production of sheet-metal cones from flat stock, absence of folds or wrinkles cannot be ensured in work produced from dies which might make conical shells directly, and it is necessary to develop a stepped shell with parallel sides to each step, and then convert this into a cone. The secret of success in this conversion lies in closing-in the metal of the stepped cone instead of stretching it. The various operations are described and illustrated. Brass, being a ductile material, lends itself to this kind of work, but by making enough steps to the step-cone and annealing carefully, steel also gives good results.—F. J.

The Production of [Modified] Cylindrical Pieces in Brass. A. Wiedenhoff (*Werkzeug* (Suppt. to *Maschinenkonstrukteur*), 1932, **8**, 107–108).—A combined drawing and pressing process is described, effecting considerable economy of material as compared with machining the cast material. Scale diagrams of the various stages of the process are given.—P. M. C. R.

Hot-Pressing or Machining? Otto Lich (*Werkzeug* (Suppt. to *Maschinenkonstrukteur*), 1932, **8**, 132–133).—Cutting processes decrease strength by interrupting the grain of the material concerned, while hot-pressing produces a deflection of the unbroken grain, together with a structure of increased density. Speed and economy are further advantages of hot-pressing processes, of which several modifications are briefly described and illustrated.
—P. M. C. R.

Forging and Stamping of Light and Ultra-Light Alloys. I.—Observations on the Pouring of the Metal (Continued). E. Decherf (*Aciers spéciaux*, 1932, **7**, 329–344).—Cf. this *J.*, 1931, **47**, 600; 1932, **50**, 192. Further examples of forgings and stampings in light alloys are given as follows: (4) rough-shaping a prismatic disc of square or rectangular section; (5) as (4), but where bending over a form or preliminary stamping is required; (6) hammering one end of a billet to a circular section, the other end being unforged; (7) as (6), using dies for forging; (8) as (6), using dies for trimming; (9) hammering the middle

part only of the billet; (10) and (11) hammering the ends only; (12) hammering the whole billet, but stamping with one pair of dies only.—J. H. W.

Filling Head for Vertical Lead Cable Presses. A Device for Eliminating Oxides. Anon. (*Met. Ind.* (*Lond.*), 1932, **41**, 401, 403).—A description of a device for eliminating oxides in extruded cable sheaths, designed by the Siemens-Schuckert A.-G., Berlin-Siemensstadt, Germany. It consists essentially of a spill-head or annular trough fitted to the top of the container and into which lead overflows after the container is full, carrying oxides and other impurities with it.—J. H. W.

[Moulding from Metal Powder.] Anon. (*Canad. Mach.*, 1932, **43**, (16), 57).—A brief description of the moulding process, now applied to tungsten, chromium, nickel, copper, and various alloys, as well as to iron.—P. M. C. R.

Machinery for the Manufacture of Metal Foil Caps. Anon. (*Werkzeug* (Suppt. to *Maschinenkonstrukteur*), 1932, **8**, 62).—A continuous process is described for the making of screw caps from foil consisting of lead or a lead alloy, coated on both sides with tin.—P. M. C. R.

Modern Ideas in Silversmiths' Work. Anon. (*Met. Ind.* (*Lond.*), 1932, **41**, 389–390).—A discussion of the use of pure and standard silver in decorative work.—J. H. W.

Machinability of Free-Cutting Brass Rod. Alan Morris (*Trans. Amer. Inst. Min. Met. Eng.*, 1932, **99**, (Inst. Metals Div.), 323–330; discussion, 331–344).—For abstract of the paper, see this *J.*, 1932, **50**, 260. In the discussion, in which the following took part: *F. V. Hartman, O. W. Boston, J. L. Kimberley, O. W. Ellis, W. B. Price, D. K. Crampton,* and *A. Morris*, the relative machinability of 5 leaded brasses with 59·15–63·25% copper after (1) furnace cooling, (2) air cooling, and (3) quenching from temperatures between 850° and 500° C. are shown graphically; the figures have been determined by Kessner's method (*Carnegie Schol. Mem., Iron Steel Inst.*, 1913, **5**, 10) and are referred to an alloy of copper 62–63, lead 2·5–3%, and the remainder zinc (machinability 100%). In series (1) the alloys with less than 62% copper showed a flat curve throughout the temperature range irrespective of the amount of β, but alloys with 62–64% copper showed much better machinability after slow cooling from above 800° C.; similar results were obtained in series (2) except that improvement in the 62–64% copper alloys started at 550° C. The values in series (3) showed that water-quenched alloys have poor machinability irrespective of the quenching temperature or amount of retained β. Cold-working increases the energy required to cut free-turning brass rod, but soft metal cannot be cut efficiently without perfect support. In the Kessner drill tests, the machining time falls to a minimum at 57% copper, rises again to a maximum at 58% copper, and falls to a second but lower minimum at 60% copper, after which it rises sharply to a maximum at 63·5% copper. Satisfactory high-speed rods can be prepared from brass containing copper 59–61, lead 3–4, nickel 0·5, and tin or iron not more than 0·2%. Tests in a standard high-speed screw-cutting machine have shown that the tool life is 30% greater when cutting a 4% lead–brass containing 62·27% copper than when cutting a similar brass with 60% copper. With a copper content of 62·27%, about 15% longer life of the tool is obtained with 4% lead than with 3·4%. Cutting tests on samples of free-cutting rod show that (1) hard-drawn rod exhibits distinct directional properties which diminish, but do not disappear on annealing; (2) a completely homogenized rod has a slightly higher unit cutting energy than one which still contains a small amount of β; (3) the directional properties do not depend on the presence of β; (4) transverse and cross-sectional cuts are more easily made on hard-drawn than on annealed rod.—A. R. P.

Machinability of Free Cutting Brass.—II. Alan Morris (*Amer. Inst. Min. Met. Eng. Preprint*, **1933**, Feb., 1–5).—A continuation of an earlier paper (cf.

this *J.*, 1932, **50**, 260, and preceding abstract). It is a record of the results of tests on samples of free cutting brass containing varying proportions of tin, iron, and copper. The apparatus used was the same as in the earlier instance. The cast bars were annealed at 500° C. for 7 hrs., cold-rolled to 0·7 in., annealed at 500° C. for 8 hrs., cold-rolled to 0·562 in., annealed at 500° C. for 2 hrs., and air-cooled. The addition of tin up to 0·75% has little effect on the hardness or resistance to the cutting action of a tool. Iron up to 0·5% improves the cutting properties only slightly, but hardens the material considerably. A variation in copper content from 58% to 63% has little effect on resistance to cutting, but a further increase to 65% results in a moderate increase in unit cutting energy.—W. A. C. N.

A New and Original Process for the Production of Irregularly-Shaped Pieces. —— Schlippe (*Werkzeug* (Suppt. to *Maschinenkonstrukteur*), 1932, **8**, (1/2), 1–4).—A movable arm follows on an enlarged drawing the outlines of the required piece. The movements of the arm are observed through a travelling microscope, the motions of which are made after reduction to regulate the depth of cut of the shaping apparatus. It is claimed that the device eliminates, by its accuracy, much tedious and expensive hand-finishing, and that output is greatly increased.—P. M. C. R.

Useful Hints on Drilling Metals. H. Bentley (*Met. Ind.* (*Lond.*), 1932, **41**, 642).—When a large number of holes have to be drilled in brass, bronze, phosphor-bronze, gun-metal, or similar material, it is preferable to use a high-speed twist drill having a slow spiral, a small cutting angle, and wide flutes.—J. H. W.

Hot-Sawing Machines. Anon. (*Mech. World*, 1932, **92**, 179).—Machines for hot-sawing of metals are briefly described and illustrated.—F. J.

XIX.—CLEANING AND FINISHING

(Continued from pp. 164–166.)

Flexibility in the Metal-Finishing Department. E. E. H. (*Machinery* (*Lond.*), 1932, **40**, 402–403).—In planning a metal-finishing department it is important to make provision for giving special treatment and applying special finishing coats where these are specified. Acid dipping and cleaning vats, the thickness of coatings, washing equipment, and lacquering methods are briefly discussed from this point of view.—J. C. C.

Modern Practice in Metal Cleaning. A. D. Weill (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 157–160).—Aqueous solutions for the degreasing of metals are composed of milder alkalis than formerly, frequently containing phosphates and/or cyanides. Electrolytic cathodic cleaners may contain copper salts; incomplete deposition of a film of copper indicates greasy patches. Typical formulæ are given. Methods for the removal of oxide are described. Suitable methods are given for cleaning stampings or castings of brass and similar metals, die-castings of zinc, aluminium and tin alloys, lead and pewter prior to electroplating.—S. W.

The Theory of Metal Cleaning. E. J. Dobbs (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 161–162).—Wetting power, emulsification, and peptizing action are shown to be necessary functions of a complex aqueous metal-cleaning solution. The constituents contributing each property are discussed. The use of organic solvents, particularly in the vapour phase for removing grease, is reviewed. Etching processes for cleaning steel and brass prior to electroplating are described.—S. W.

The Cleaning of Iron and Steel. S. Wernick (*J. Electrodepositors' Tech. Soc.*, 1931–32, **7**, 163–165).—Methods of degreasing, descaling, and electrocleaning steel prior to electroplating or other finishing processes are described. The

functions of soaps deliberately added or formed by saponification of vegetable oils on the emulsification of grease, together with their rinsing properties, methods of providing visual evidence of complete grease removal and the use of inhibitors in acid solutions to prevent over-pickling are also discussed.
—S. W.

Symposium on "Metal Cleaning." A. Dudley Weill. E. J. Dobbs. S. Wernick (*Met. Ind.* (*Lond.*), 1932, **40**, 589–591, 621–623, 625).—Abstract of addresses delivered to the Electroplaters' and Depositors' Technical Society. See preceding abstracts.—J. H. W.

Equipment for the Cleaning of Metal.—XIII. R. W. Mitchell (*Metal Cleaning and Finishing*, 1932, **4**, 15–19; *Ceram. Abs.*, 1932, **11**, 229).—Cf. this *J.*, 1931, **47**, 603; 1932, **50**, 192, 707. The question of cleaning solution agitation is further discussed. Descriptions of operation and data on both centrifugal and rotary pumps are presented.—S. G.

Cleaning Castings by Means of Water-Sand Mixtures. Friedrich Huth (*Emailletech. Monats-Blätter*, 1932, **8**, (8), 60–61; *Ceram. Abs.*, 1933, **12**, 9).—In cleaning castings by means of silica sand driven by water under pressure there was formerly a loss of silica sand due to the mixing in of the finer moulding sand that had adhered to the castings. A method for recovering the silica sand by washing through a series of screens is outlined.—S. G.

Pickling Practice. O. L. Thomas (*Metal Cleaning and Finishing*, 1932, **4**, 167–170; *Ceram. Abs.*, 1932, **11**, 349).—A general discussion is given of pickling technique and equipment.—S. G.

Control of the Pickling Bath. Anon. (*Emaillewaren-Ind.*, 1932, **9**, 152–153; *Ceram. Abs.*, 1932, **11**, 443).—Discusses the arrangements, manner of working, and the pickling pills or capsules used for the control of the pickling bath according to the method of Karl Türck.—S. G.

A New Pickling Machine for Sheets, Tubes, Wire, &c. —— (*Anz. Berg.-, Hütten.- u. Masch.*, 1933, **55**, (8), 6).—The machine rotates the goods in the pickling solution.—B. Bl.

Finishes for Zinc. Anon. (*Paint Manuf.*, 1932, **2**, 267; *Res. Assoc. Brit. Paint Manuf. Rev.*, 1932, (**30**), 346).—Cellulose and oleoresinous types of finish both exhibit signs of decomposition in contact with zinc, losing flexibility and adhesion, apparently due to chemical interactions. The decomposition of nitrocellulose can be demonstrated by incorporating a little alizarin, which, on zinc, changes from brown to red; it can be retarded by adding a small amount of an organic salt. Etching the zinc surface enhances the initial adhesion only, and it is necessary to resort to deposition of a dissimilar metal or a metal compound to secure permanent adhesion.—S. G.

XX.—JOINING

(Continued from pp. 166–168.)

Pressures Required for Heading Duralumin Rivets. George A. Fries (*Machinery* (*N.Y.*), 1932, **39**, 11).—The results of tests on the pressures required to head standard Duralumin rivets are tabulated.—J. C. C.

Practical Notes on Electric Furnace Brazing. H. M. Webber (*Machinist* (*Eur. Edn.*), 1932, **76**, 1153–1155).—The objects to be brazed are passed through an electric furnace with controlled atmosphere; the copper, which has been applied near the joints, melts and is drawn into the joints by capillary attraction and forms an alloy bond which is exceptionally strong, light, and clean. The controlled atmosphere consists of hydrogen or some less expensive reducing gas and takes the place of the flux normally used, although in some cases a flux, such as borax, is applied as well. Typical applications of the process are described.—J. H. W.

Oxy-Welding [of Aluminium] in the Interests of Science. Anon. (*Mech. and Welding Eng.*, 1931, **5**, 314–316; and (short note) *Welding J.*, 1931, **28**, 315).—An abstract from articles in *Rev. Soudure autogène*, 1931, **23**, 2284, and *Soudeur-Coupeur*, 1931, **10**, (7), 10, describing the construction of the balloon in which Professor Piccard and M. Kipfer made their ascent of 10 miles. The sphere was made of oxy-acetylene welded aluminium sheet, 3·5 mm. thick, the internal load being carried by vertical tie rods welded in. The welds were all hammered and annealed.—H. W. G. H.

Use of Aluminium. The Welding of Tanks in Aluminium. W. M. Dunlap (*Usine*, 1931, **40**, (28), 41).—Abstract of paper read before the International Acetylene Association. See this *J.*, 1932, **50**, 500.—H. W. G. H.

Arc Welding of High-Conductivity Joints in Copper. T. C. Stuart (*Engineering J.*, 1931, **14**, 600–601).—An account is given of methods investigated for attaching an equilateral triangular section copper bar of about 0·5 in. cross-sectional area along almost the whole length of a copper bus-bar 3 in. × 13·5 in. × 18–19 ft. Sweating the two together by means of silver solder was not satisfactory. In the method ultimately adopted, beads were deposited on the strip to form a current-carrying fillet, and pure copper, or later, on account of its faster flowing qualities, phosphor–copper, was used as filler material. The electric arc method gave entirely satisfactory results.—H. F. G.

The Autogenous Welding of Monel Metal. [R. Meslier] (*Welding News*, 1931, **2**, 21).—Translated from *Soudure et Oxy-Coupage*, 1931, **8**, 99. The original paper was published in *Rev. Soudure autogène*, 1929, **21**, 1756–1757. Emphasizes the danger of cracking due to expansion and contraction.—H. H.

Welding Die-Cast Zinc Alloys. Anon. (*Mech. and Welding Eng.*, 1931, **5**, 130–131).—Translated in abstract from *Soudeur-Coupeur*, 1931, **10**, (1), 8–10. Describes a method for welding zinc-base die-casting alloys. The envelope of the oxy-acetylene flame is used and the metal is puddled by means of a steel rod.—H. W. G. H.

Ductility: What is Its Significance? How Test for It? H. F. Moore (*J. Amer. Weld. Soc.*, 1932, **11**, (4), 35–36; discussion, (5), 26).—Contribution to a symposium on "Ductility." Ordinary ductility is explained as insurance against fracture under occasional overloads, and is thus distinct from "crackless plasticity"—insurance against the formation of a spreading crack by repetitions of normal loads. Cold bend, elongation, notched-bar impact, and notched-bar fatigue tests do not give correlation with the latter property, but the "damping" characteristics, as measured by Föppl and von Heydekamp, may give useful results. In the written discussion, *W. B. Miller* agrees with M. that extreme ductility is not advantageous if it sacrifices tensile strength and crackless plasticity.—H. W. G. H.

Ductility in Arc Welds with Some Reference to Strength Values. Chas. H. Jennings (*J. Amer. Weld. Soc.*, 1932, **11**, (4), 37–42; discussion, (7), 28–29).—The ductility of weld metal can be obtained by machining out of it, standard circular test-pieces and measuring the elongation and reduction of area. The same procedure, however, is not suitable for a butt-weld, since the latter is not a homogeneous structure and, the deposited metal usually having a higher yield-point and ultimate stress than the parent metal, fracture takes place outside the weld. This can be avoided by using a specimen, the section of which is restricted at the weld. It can be designed so as to give elongation values which are comparable with those obtained on homogeneous material using standard test-pieces. The ductility of a butt-weld is also measured by the elongation of the outer surface after "free" bending. The values obtained in this way have no apparent relation to the values given by the elongation of tensile specimens, but are comparable in themselves. *J. C. Lincoln*, in a contribution to the discussion, considers that the elongation over a particular gauge-length is not an accurate indication of the ductility of the sample, which

is more correctly given by the elongation of holes drilled through the centre of the weld so that fracture takes place there.—H. W. G. H.

Ductility in Metal Structures. C. A. Adams (*J. Amer. Weld. Soc.*, 1932, **11**, (4), 46–47; and *Welding J.*, 1932, **29**, 148).—Contribution to a symposium on "Ductility." Where the welds are sound and the metal between them is ductile, the ductility of the welds need not be high for many types of structure. Further research is required to find the exact amount of ductility which is necessary.—H. W. G. H.

Ductility and Penetration—Two Fallacies. C. J. Holslag (*J. Amer. Weld. Soc.*, 1932, **11**, (4), 47–48; and (abstract) *Welding News*, 1932, **3**, 20).—Contribution to a symposium on "Ductility." Excessive ductility in welds is harmful, since they are cast material and, therefore, inherently unsound. The weld should be regarded in its true light—as a joint. Penetration should not be deep enough to form a zone of weakness at the edge of the weld.—H. H.

Why Ductility of Welds is Important in Welded Pressure Vessels. E. R. Fish (*J. Amer. Weld. Soc.*, 1932, **11**, (4), 32–33; discussion, (5), 25–26; and *Welding News*, 1932, **3**, 26–27).—Contribution to a symposium on "Ductility." Presents the insurance companies' point of view, from which high ductility is regarded as extremely important, and emphasizes the need for co-ordinated research on the part of manufacturers. In the written discussion, *H. E. Rockefeller* states that high ductility is not the most important factor, and does not necessarily mean high resistance to shock and fatigue. Freedom from imperfections is of greater moment. *A. D. Risteen* emphasizes the need for control of material and technique.—H. W. G. H.

The Effect of Ductility on Security in Welded Connections—Methods of Its Measurement. D. Rosenthal (*J. Amer. Weld. Soc.*, 1932, **11**, (5), 5–9).—Contribution to a symposium on "Ductility." Both the parent metal and the weld must be ductile to allow for overstressing which may take place during shrinkage as well as under applied loads in service. The effect of localized stresses, the ductility, appears to be best measured by the notched-bar impact test. Experimental results of the author and other workers are quoted.—H. H.

Ductility : A Measure of Cleanliness. E. Chapman (*J. Amer. Weld. Soc.*, 1932, **11**, (5), 29–32).—Contribution to a symposium on "Ductility." Cases of uneven stress distribution in service are illustrated by photo-elastic analysis, and the way in which ductility allows plastic deformation, readjusts the stresses, and prevents fracture, is described. It is pointed out, however, that this plastic deformation is often not permissible, and ductility is most important as a measure of quality.—H. W. G. H.

Discussion of the Symposium on Ductility of Weld Metal. G. Doan. J. H. Critchett (*J. Amer. Weld. Soc.*, 1932, **11**, (5), 26–29).—G. D. states that in service, where stresses are usually below the elastic limit, ductility plays no part. During cooling, the stress concentration is higher in the weld, due to flaws in it and shrinkage. Ductility is then necessary, being a measure of deformability, or extent of deformation possible before fracture begins. If deformation has occurred, the residual stresses, which can only be a little below the yield stress, should be removed by annealing. J. H. C. reviews the trend of opinion on weld ductility and considers that extreme ductility is much less important than sound design, high-grade materials, careful fabrication, and thorough proof-testing.—H. W. G. H.

Autogenous Welding Practice in France and Abroad. A. Boutté (*Usine*, 1931, **40**, (14), 33).—Abstract of a paper read before the Société des Ingénieurs Soudeurs, February 26, 1931. Deals particularly with the practice of Sulzer Frères, Switzerland.—H. W. G. H.

Multi-Flame Welding Blowpipe. Anon. (*Usine*, 1931, **40**, (15), 33).—Abstract from *Journal de la Soudure*, 1931, Feb. See this *J.*, 1932, **50**, 115.
—H. W. G. H.

XXII.—MISCELLANEOUS

(Continued from p. 108.)

The Trend of Metallurgical Research. R. T. Rolfe (*Met. Ind.* (*Lond.*), 1933, **42**, 65–67, 70).—An indication is given of the trend of metallurgical research in the way of lightness and strength of alloys, corrosion, cathodic and anodic coating metals, stainless steel coatings, protective coatings on light alloys, condenser tube corrosion, improved lead alloys, and other recent researches.—J. H. W.

Research and Development. —— (*Met. Ind.* (*Lond.*), 1933, **42**, 68–70).—An editorial on the applications and functions of theoretical and practical research and development in industry.—J. H. W.

Enquiry [Definitions of Technical Terms]. Anon. (*Metallurg* (*The Metallurgist*), 1932, **7**, (1), 2).—[In Russian.] Editorial. Owing to differences in interpretation of the following terms: (1) dendrite; (2) single crystal; (3) metal grain; (4) mechanism of grain growth, the editor requests contributors to describe what the above terms mean to them under various conditions.—M. Z.

[Report on] Inorganic Chemistry. H. Bassett (*Ann. Rep. Prog. Chem.*, 1931, **28**, 49–65).—Developments during the year 1931 are reviewed. The following systems have been examined: cobalt–chromium, lithium–copper, bismuth–selenium, aluminium–manganese, copper–manganese, iron–manganese, lithium–silver, cadmium–silver, tungsten–rhenium, copper–tin, calcium–sodium, aluminium–silver, chromium–carbon, aluminium–silicon, calcium–bismuth, iron–carbon–tungsten, chromium–iron, iron–tin, aluminium–chromium, silver–bismuth, silver–antimony, silver–arsenic, gold–antimony, silver–tin, copper–magnesium, and silver–cuprous oxide. Considerable activity is noted in the work on rhenium and its compounds.—E. S. H.

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XXIV.—BOOK REVIEWS

(Continued from p. 176.)

Bericht über die I. Korrosionstagung am 20 Oktober 1931 in Berlin. Veranstaltet vom Verein deutscher Eisenhüttenleute, Verein deutscher Ingenieure, Verein deutscher Chemiker und der Deutschen Gesellschaft für Metallkunde. Demy 8vo. Pp. 136, with 88 illustrations. 1932. Berlin, N.W.7: VDI.-Verlag G.m.b.H. (Price R.M. 7.50.)

This little book contains 12 papers with discussions on various aspects of the corrosion problem read and discussed at a conference on corrosion of metals held jointly by the four German societies dealing with metallurgical subjects. Most of the papers deal with ferrous metals and with the general principles of corrosion, but the papers on corrosion-testing from the point of view of the constructor and on measurements of the rate of corrosion of copper–tin and copper–zinc alloys are definitely of non-ferrous interest only; the last three papers are devoted to means of protection from corrosion and the development of corrosion-resisting alloys. Whilst none of the papers contains much new work, the book taken as a whole provides a good survey of the phenomena of corrosion, and a broad outline of the methods adopted for testing the corrodibility of metals and in protecting them from attack in corrosive media. The illustrations are well chosen and beautifully reproduced, and many of the papers are accompanied by useful graphs and diagrams. Abstracts of the papers of general or non-ferrous interest have been published in this *Journal*.—A. R. POWELL.

A Textbook of Metallurgical Problems. By Allison Butts. Med. 8vo. Pp. xiv + 425, with 13 illustrations. 1932. New York: McGraw Hill Book Co., Inc. ($4.00); London: McGraw Hill Publishing Co., Ltd. (24*s*. net.)

This book will be welcomed in many metallurgical departments, especially as it is dedicated to the memory of Professor Joseph William Richards, the pioneer in metallurgical calculations. The last edition of the well-known book on "Metallurgical Calculations" by Professor Richards was published as long ago as 1918, and there has been in recent years a demand for a similar work. The book under review has been produced on somewhat similar lines to the above-mentioned treatise, although advantage has been taken of the advances made in metallurgical knowledge and practice in recent years, and corrected figures have been used in the case of many of the constants introduced.

The author is an Associate Professor of Metallurgy at Lehigh University, where metallurgical problem courses have been a special feature for many years. The book has been written with the primary object of providing a text-book for metallurgical students and it thus differs from "Metallurgical Calculations," which was written with the needs of the practising metallurgist in mind. There is little doubt that an extended use of a study of metallurgical problems from the mathematical point of view would be helpful in presenting and illustrating the practical applications of metallurgical practice in our colleges and schools. An attempt has been made to grade the work, and in the first chapters the problems are relatively simple, explanation has been given in detail, and illustrative examples have been fully worked out, whereas in the latter part of the book the matter is more advanced and explanatory details are curtailed. The subject-matter covers a large field, including necessary introductory matters, fuels and combustion, production of draught and blast, drying, calcining, and roasting. The calculation of charges for smelting and in connection with the products obtained in the case of the metallurgy of iron and steel, copper, and lead receives attention.

Special chapters are devoted to hydrometallurgy, electrolytic processes, distillation processes, transmission of heat, and volatilization of metals during smelting. Thermochemistry and thermophysics, the heat balance, vapour-pressure and temperature pressure in chemical reactions, and also the thermodynamics of chemical reactions are dealt with. A chapter on alloys is included in which the calculation of metallographical constitution, &c., is explained in the case of binary alloys, and calculations for iron and steel are specially included.

Useful tables of data necessary for the solution of metallurgical problems are given, and the book can be recommended not only to students, but also to many practising metallurgists.

—C. O. BANNISTER.

Sächsische Zinnbergwerke. Von G. Enderlein (Schriftenreihe "Deutsches Museum, Abhandlungen und Berichte," 3. Jahrg. Heft 4). Demy 8vo. Pp. 127–152, illustrated. 1931. Berlin: VDI-Verlag G.m.b.H. (R.M. 1.)

This little book gives a very interesting, if somewhat discursive, history of the rise and fall of the tin-mining industry in Saxony over a period of about 700 years. The development of the industry is described from the time of the first discovery of tin in Saxony in the year 1240 up to the present day, when it is almost extinct. The decline began with the influx of tin from the East Indies in 1870. The booklet has some good photographic illustrations.

—E. S HEDGES.

Principles of Patent Law for the Chemical and Metallurgical Industries. By Anthony William Deller. Med. 8vo. Pp. 483, with 19 illustrations. 1931. New York: Chemical Catalog Co. Inc. ($6.00.)

In writing this book the author's aim has been to explain to chemical and metallurgical inventors in simple language the intricacies of American patent law. The subject matter is divided into twelve chapters dealing with the history, theory and nature of patents, the various classes of patentable inventions, persons entitled to letters patent, principles of patentability, acquisition and termination of letters patent, remedy of defective patents, form and construction of patents, infringement of patents, suits for infringement, incidents of ownership of patents, commercial phases of patents, and foreign patents; there is also an appendix containing statistics of foreign countries and of mineral raw materials, information regarding foreign patents, figures of the production of minerals and metals in the principal countries of the world, and memoranda on developed and potential water power of the world. To illustrate the classes of patentable inventions the author has chosen to quote one claim from several patents in all the numerous classes in which chemical and metallurgical inventions are divided; this catalogue of claims extends over more than 50 pages and is given with practically no comment. Later on in the book a further 20 pages are devoted to illustrating the formulation of claims in an exactly similar manner. The book is liberally besprinkled with long excerpts of judgments given in the Circuit Courts and in the Supreme Court; while these, in general, are interesting to read, the busy commercial or scientific man who desires to get a broad idea of patent procedure would no doubt prefer to have a critical summary of these Court decisions rather than to plough through pages of text in the search for points which cover inventions in which he himself is concerned. Nevertheless the book as a whole makes very interesting reading in spite of the author's prolixity, and the reviewer must admit that he has acquired a great deal of valuable information from a close study of the subject matter which is presented, when the author uses his own words, in a clear and readily understandable manner.—A. R. Powell.

Chemical Engineering and Chemical Catalogue. A Catalogue of Heavy and Fine Chemicals, Raw Materials, Machinery, Plant and Equipment Applicable to Production Industries, Standardized, Condensed, and Cross-Indexed. Edited by D. M. Newitt. Compiled with the co-operation of leading British manufacturers. Eighth edition. Demy 4to. Pp. 107 + 53 + 27 + 9 + 76 + lxxiii. 1932. London: Leonard Hill, Ltd., 231–232 Strand, W.C.2. (10*s*. net.)

Many changes have been made in this edition of the annual catalogue of British chemical manufacturers. In the first place the bulk of the book has been reduced 50% by using a thinner paper; this is a considerable advantage to those who are constantly using the book for reference and is further enhanced by the provision of thumb indentations to permit of rapidly finding the desired section. The pages in every section are separately numbered and blank pages for memoranda are interspersed between the sections. The Tables and Data section has been still further enlarged (although it occupies no more pages than in the seventh edition) and at last the table of atomic weights has been printed in full with the latest available values. The Main Index and the Book Bibliography sections have been completely revised and brought up-to-date. It is disappointing to find that the number of firms taking space is still shrinking; in the seventh edition there were 101, but in this edition there are only 88, of which 5 are foreign firms with no factory in Great Britain and 8 are publishers of technical books. That only 75 British firms take the trouble to use this method of publicity is a poor tribute to the enterprise of British chemical industry; the corresponding American publication is much more liberally patronized.—A. R. Powell.

The Directory of Shipowners, Shipbuilders, and Marine Engineers, 1933. Thirty-first year of publication. Demy 8vo. Pp. 824 + 71. 1933. London: The Directory Publishing Co., Ltd., 33, Tothill Street, S.W.1. (20*s*. net.)

This directory forms a handy desk companion, and furnishes particulars of all the leading steamship companies, shipbuilders, ship-repairers, and marine engineering works throughout the world. It also gives the names of the directors and principal officials of the companies and, in the case of shipping concerns, details of the fleets. A supplementary section includes a list of societies, institutions, trade and labour federations, and a directory of consulting marine engineers and naval architects. At the end of the volume are exhaustive indexes covering some 25,000 entries. Important changes in the present edition include alterations to deadweight capacity and draught of tankers occasioned by the new load line regulations.