

# METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)



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## I.—PROPERTIES OF METALS

(Continued from pp. 609-616.)

**On the Problem of the Reducibility of Beryllium Chloride with Aluminium.** Walter Kangro (*Metall u. Erz*, 1933, 30, 389-390).—Theoretical. Deductions from Nernst's formula indicate that beryllium chloride should be quantitatively reduced to metal by aluminium at 200°-300° C., but that at 460° C. only 2.8% of the beryllium should be reduced.—A. R. P.

**Researches on the Reducibility of Beryllium Chloride with Metallic Aluminium.** Hellmut Fischer and Newton Peters (*Metall u. Erz*, 1933, 30, 390-391).—Kangro's theoretical deductions (cf. preceding abstract) have been confirmed experimentally. At 260° C. a mixture of beryllium chloride with a deficiency of powdered aluminium gives a yield of 12-17% of the theoretical amount of beryllium metal, and at 350° C. a yield of 30-40%, provided the reaction is carried out in an atmosphere of hydrogen. The aluminium chloride distils away during the reaction and the excess of beryllium chloride can be distilled away at 460° C. Complete absence of moisture is essential, but even then the beryllium produced is generally contaminated with oxide and frequently pyrophoric.—A. R. P.

**The Effect of Tension on the Electrical Resistance of the Trigonal Crystals, Bismuth and Antimony.** Mildred Allen (*Phys. Rev.*, 1933, [ii], 43, 502).—Abstract of a paper read before the American Physical Society. The compensated potentiometer method of measuring small changes in resistance developed by P. W. Bridgman has been used in the study of the effect of tension, applied parallel to the direction of current flow, on the resistance of the two trigonal crystals bismuth and antimony. The adiabatic tension coeff. of resistance at 30° C. of both has been found to depend on the orientations of the principal and secondary cleavage planes. For the limiting cases of the principal cleavage plane, perpendicular and parallel to the tension, the coeff. is found to be independent of the secondary orientation. The coeff. shows trigonal symmetry, as is to be expected. Bridgman has shown on the basis of symmetry considerations that 6 constants are sufficient entirely to define the change of resistance of trigonal crystals under deforming forces. These have been found for both bismuth and antimony; the constants for antimony are about one tenth those of bismuth. The changes in resistance resulting from the deformation due to tension have been computed and applied as corrections to the observed changes.—S. G.

**The Saturation Magnetization of Pure Cubic Cobalt.** F. W. Constant and R. J. Allen (*J. Elisha Mitchell Sci. Soc.*, 1933, 49, (1), 33-34).—Cf. *J.*, this volume, p. 609. Abstract of a paper read before the North Carolina Academy of Science. The magnetization at a given temperature of an ellipsoid of cobalt, so heat-treated as to be in the cubic state, was measured for increasing fields, and Weiss's formula was applied in calculating from this the magnetization for an infinite field. The influence of temperature was investigated, and the results were compared with those obtained with iron and nickel (cubic crystals) and with hexagonal cobalt and other non-cubic materials.—P. M. C. R.

**Copper Embrittlement.—III.** L. L. Wyman (*Amer. Inst. Min. Met. Eng. Tech. Publ.* No. 508, 1933, 1-11).—(a) Different qualities of copper were heated in air at varying temperatures and the depth of oxidation was estimated by subsequent heating in hydrogen, which reduced the oxide, and left

an open-grain boundary structure which could be recognized microscopically, and which causes embrittlement. The three types of material selected were: two kinds of pure oxygen-free copper; "tough-pitch" coppers containing up to 0.06% oxygen, and "double deoxidized" copper containing 0.026% residual silicon. (b) Oxygen-bearing samples of copper were heated in hydrogen for varying periods at temperatures from 200° to 1000° C., and the depth of penetration of hydrogen was estimated in the same way. Neither pure copper when oxidized or deoxidized, nor the "tough-pitch" coppers, are embrittled by exposure to hydrogen for 4 hrs. at 400° C. or below. The double deoxidized copper, in agreement with previous work (Wyman, this *J.*, 1932, 50, 722, and this volume, p. 65), is superior to the other varieties as regards resistance to the oxidation-reduction cycles. The embrittlement caused by hydrogen is of the same order as that produced by illuminating gas, and the rate of embrittlement due to hydrogen decreases with depth of penetration. The rate of oxygen penetration into "pure" copper decreases markedly below 800° C. and that of hydrogen penetration into oxygen-bearing copper decreases markedly below 700° C., so that up to 800° C. the oxygen-free coppers are more resistant to embrittlement than the "tough-pitch" coppers.—W. H.-R.

**Atomic Heats, Heats of Fusion, and Heats of Transformation of Gallium, Indium, and Thallium.** W. A. Roth, Ingrid Meyer, and Hans Zeumer (*Z. anorg. Chem.*, 1933, 214, 309-320).—The heats of fusion of gallium, and of very pure indium and thallium as determined by measurements of the specific heats in the solid and liquid state are:  $19.15 \pm 0.02$ ,  $6.80$ ,  $\pm 0.02$ , and  $5.041 \pm 0.011$  cal./gram., respectively. The heat of transformation of thallium is  $0.361 \pm 0.012$  cal./gram.—M. H.

**Diffusion of Mercury into Tin Foil.** W. Gerlach [with E. Schweitzer] (*Sitzungsber. bayer. Akad. Wiss.*, 1930, 223-224; *Chem. Zentr.*, 1931, 102, II, 826; *Brit. Chem. Abs.*, 1932, [B], 265).—The spectroscopic detection of mercury is facilitated by electrodeposition on a small electrode; the form and distribution of mercury in tin were studied. Mercury does not diffuse equally readily in all directions into rolled tin foil; diffusion ellipses were obtained owing to the effect of rolling on orientation. Similar ellipses were obtained with rolled lead.—S. G.

**Rate of Vaporization of Molybdenum in Vacuo.** Lawrence Norris and A. G. Worthing (*Phys. Rev.*, 1933, [ii], 44, 323).—Abstract of a paper read before the American Physical Society. The changes in weight of various long filaments of molybdenum electrically heated *in vacuo* to various incandescent temperatures have been the basis of this study. In all cases two nearly identical filaments were mounted in a single bulb. Both filaments were heated to 2150° K. by the same current during a 20-minute ageing period. Thereafter only one of the two filaments was operated at the desired temperature until completion of the vaporizing period. To avoid the cooling effects of the supports only central portions of the filaments were used in determining weight losses. Contrary to what might normally be expected, but in agreement with what one of the authors had found for tungsten, operation at constant current resulted very closely in constant temperature. When plotted the results are represented very closely for the temperature range  $1600^\circ \text{K.} < T < 2400^\circ \text{K.}$ , by an empirical equation of the form  $\log m = A + B/T + C/T^2$ . When  $m$ , the rate of vaporization, is expressed in  $\text{gm./cm.}^2 \text{ sec.}$ , and  $T$  in °K.,  $A$ ,  $B$ , and  $C$  have values 7.57,  $-33.25 \times 10^3$ , and  $5.50 \times 10^6$ . The values reported here for  $m$  are greater than those reported by Jones, Langmuir, and Mackay by a factor of about 2.5 at 2400° K. and of about 11.5 at 1600° K.—S. G.

**A New Method for Determining the Thermionic Work-Functions of Metals and Its Application to Nickel.** Gerald W. Fox and Robert M. Bowie (*Phys. Rev.*, 1933, [ii], 44, 345-348).—A method is described for determining the



thermionic work-functions of metals which are too hard or too volatile for the ordinary methods. The specimen in the form of an approximate sphere is heated by electron bombardment from an auxiliary filament which is disconnected when the measurements are made. The electron emission from the cooling sample is made to charge a condenser which is discharged at intervals through a ballistic galvanometer. Application of the Richardson equation shows that the thermionic constants are given by the relation  $\log_{10}(T^2/SQ) = \log_{10}(2.3/aA) + \Phi/(1.988 \times 10^{-4}T)$ , where  $Q$  is the quantity of charge yet to flow on cooling the sample from temperature  $T$  to the absolute zero,  $-S$  is the slope of the  $\log Q$  versus time curve, and  $a$  is the area of the emitter. For outgassed nickel the values found are  $\Phi = 5.03 \pm 0.05$  v., and  $A = 1.38 \times 10^3$  amp./cm.<sup>2</sup> deg.<sup>2</sup>.—W. H. R.

**Revision of the Atomic Weight of Tellurium. II.—Synthesis of Silver Telluride.** O. Hönigschmid (*Z. anorg. Chem.*, 1933, 214, 281-288).—Silver telluride  $\text{Ag}_2\text{Te}$  has been synthesized by heating a weighed quantity of silver in tellurium vapour. The ratio  $\text{Ag}_2\text{Te} : 2\text{Ag}$  leads to an atomic weight for tellurium of 127.61.—M. H.

**Superconductivity of Tin at Radio Frequencies.** F. B. Silsbee, R. B. Scott, F. G. Brickwedde, and J. W. Cook (*Phys. Rev.*, 1933, [ii], 43, 1050).—Abstract of a paper read before the American Physical Society. Calorimetric experiments on extruded tin wire carrying radio-frequency currents showed that the effective resistance at temperatures slightly below the transition temperature (3-7° K.) was less than 1% of that at temperatures slightly above. The transition temperatures corresponding with various definite values of current and of frequency were observed for (a) direct current; (b) for alternating currents of frequencies ranging from 200 to 1200 kilocycles/second; and (c) for combinations of d.c. and a.c. Changes in resistance were indicated (a) by the deflection of a galvanometer connected across the terminals of the specimen; (b) by the changes in the readings of a thermo-ammeter in series with the specimen, and (c) by the simultaneous use of both. For large currents the transition temperature decreased by substantially the same amount for equal increments of the crest value of the resultant current (d.c., a.c., or combined d.c. and a.c.). At low currents there appeared to be a small difference (about 0.01° C.) in the transition temperature for direct and for radio-frequency currents. This is being further investigated. Except for this, all the results, including those of combined d.c. and a.c., can be explained on the basis of the skin effect and the variation of the transition temperature with magnetic field, without additional hypotheses. A conductor can be normally resistant to a.c. and at the same time superconducting to d.c. flowing through the core inside the skin. This was observed.—S. G.

**Thermionic and Adsorption Characteristics of Platinum on Tungsten.** R. W. Sears and J. A. Becker (*Phys. Rev.*, 1933, [ii], 43, 1058).—Abstract of a paper read before the American Physical Society. As the amount ( $A$ ) of platinum adsorbed on a tungsten surface increases, the thermionic activity decreases rapidly up to one layer and then more slowly until at about ten layers it approaches platinum activity. There is no minimum analogous to the maximum observed for electropositive adatoms. The rate of evaporation  $E$  increases with both  $A$  and temperature  $T$ . For a fixed value of  $A$ ,  $\log E$  varies linearly with  $1/T$ . For  $T$  fixed,  $\log E$  increases with  $A$ , rapidly at first and then more slowly until it reaches the value for bulk platinum at about 10 layers. In the region of 1 or 2 layers maxima have been found. When platinum is deposited on one side of a tungsten ribbon it migrates over the surface at temperatures at which evaporation is negligible. The rate of migration increases not only with temperature and concentration gradient but also with the concentration. Hence the mechanism of migration is not like that of ordinary diffusion, but is similar to the mechanism of evaporation.

Very probably migration results from adatoms which leave the surface at one point and return to it at another point.—S. G.

**The Processing of Thoriated Tungsten Filaments.** Milton A. Ausman (*Radio Eng.*, 1933, 13, (June), 15-17; *C. Abs.*, 1933, 27, 4444).—Tungsten filaments containing thoria when raised to 2600° K. showed the presence of a small percentage of metallic thorium and possessed a greater electronic activity. Carbon, boron, and tungsten carbide may be introduced in the metallic powder before being pressed into ingots, and thereby aid in the reduction of thoria to thorium when the film is flashed. Carbon may be introduced by burning the thoriated tungsten filament in a hydrocarbon gas or vapour. Carbonization is easily effected by the use of an inert gas such as hydrogen as a carrier for a volatile liquid rich in carbon. Such an apparatus is illustrated and its operation is outlined.—S. G.

**Elastic Constants of Zinc.** Alvin W. Hanson (*Phys. Rev.*, 1933, [ii], 44, 320).—Abstract of a paper read before the American Physical Society. The elastic constants of zinc have been determined by static torsion and bending experiments. The bending experiments were performed on single crystals of 0°, 45°, and 90° orientation, and the torsion experiments on crystals of 0°, 70°, and 90°. From these measurements three constants are directly determined and certain combinations among the constants are obtained from which the remaining two constants may be computed. The crystals used in the bending experiments were of square cross-section, about 7 mm. on a side. Those used in the torsion experiments were of circular cross-section, approximately 6 mm. in diameter. The crystals were grown in a horizontal electric furnace under conditions which would ensure the least possible strain. Strained crystals were found to give variable results.—S. G.

**Spontaneous Oxidation of Zinc and the Nature of "Pyrophoric Zinc."** W. S. Sebborn (*Met. Ind. (Lond.)*, 1933, 42, 665).—Abstracted from *Trans. Faraday Soc.*, 1933, 29, 659-663. See *J.*, this volume, p. 339.—J. H. W.

**Advances in the Field of the Free Alkali Metals.** H. Alterthum and R. Rompe (*Angew. Chem.*, 1933, 46, 303-311, 545-551).—A review of recent work on the production and uses of the alkali metals.—A. R. P.

**Little-Known Properties of Metals.** E. Raub (*Mit. Forschungsinst. Edelmetalle*, 1933, 7, 51).—Curves are given showing the solubility in tap-water at 18° C. of common metals used in making food utensils; in all cases the solubility decreases rapidly with time of contact to a practically negligible constant value. Owing to the oligodynamic action of metals, especially copper and silver, no bacteria can live in contact with them, hence silverware which is badly soiled with food residues cannot convey infection. The questions of the smell and taste of metallic articles, especially silver, and of the action of sulphur-containing foods on them are critically discussed.—A. P.

**Nature of Polish Layers.** J. A. Darbyshire and K. R. Dixit (*Phil. Mag.*, 1933, [vii], 16, 961-974).—Electron diffraction results suggest that the polished surfaces of the elements bismuth, antimony, zinc, tellurium, cadmium, gold, silver, lead, molybdenum, copper, chromium, selenium, and silicon are amorphous, resembling a supercooled liquid, as originally suggested by Beilby. It is found that in many cases the atoms in the polished surfaces do not retain their normal sizes as given by the atomic volume curve of the elements. In the case of conductors, the atoms appear to be stripped and to have atomic volumes corresponding more nearly with the minimum values of the atomic volume curve. In the case of non-conductors (selenium and silicon) the normal interatomic distances are preserved.—J. S. G. T.

**Gases in Metals.** Earle E. Schumacher (*Bell Laboratories Record*, 1933, 12, 17-20).—Short illustrated descriptions are given of apparatus developed for removing gases from metals and for measuring their gas content. Metal which is to be made gas-free is melted by high-frequency currents in an



Alundum boat sealed in a Pyrex tube. Gases are pumped out of the system by a 4-stage Gaede mercury diffusion pump backed by an oil pump. Alternate melting and partial solidification may be employed to remove the last traces of gas. When the gas content is to be measured, a graphite boat is used, the evolved gases passed over heated copper oxide, and the water and carbon dioxide collected in absorbents contained in light glass baskets suspended from quartz springs. The residual gas is determined volumetrically.—J. C. C.

Some Theoretical and Practical Aspects of Gases in Metals. J. H. Scaff and E. E. Schumacher (*Bell System Tech. J.*, 1933, 12, 178-196).—Reprinted from *Metals and Alloys*, 1933, 4, 7-12. See *J.*, this volume, p. 228.—S. V. W.

Thermal Conductivity of Metals in the Range 0° to 600° C. M. S. Van Dusen and S. M. Shelton (*Phys. Rev.*, 1933, [ii], 43, 1052).—Abstract of a paper read before the American Physical Society. The thermal conductivities method used gives directly the variation of conductivity with temperature, but absolute values are obtained by comparison with pure lead, the conductivity of which at ordinary temperature is fairly well established. If later considered necessary an absolute determination of the conductivity of the lead used as the standard can be made at one temperature under conditions most conducive to accuracy, and all results reduced to this basis. The change of conductivity with temperature is determined by measuring the temperature distribution along a cylindrical bar, one end of which is heated and the other cooled. Heat loss from the convex surface is minimized by a surrounding guard tube. For the comparative measurements, the bar is soldered end to end with a standard bar of the same diameter, and similar measurements made. Data have thus far been obtained on a number of technically important metals, principally ferrous alloys and nickel-chromium alloys. Some investigation has been made of the use of thermal conductivity measurements as a tool in metallurgical research.—S. G.

Note on Contact Potential Difference. A. T. Waterman (*Phys. Rev.*, 1933, [ii], 43, 1048).—Abstract of a paper read before the American Physical Society. Assuming Fermi distribution among the conduction electrons in a metal the condition for equilibrium between 2 metals in contact at the same temperature is:  $A_1 = A_2 \exp. (V_1 - V_2)\epsilon/kT$ , where  $A$ , the Fermi constant, is given here by  $\log A = \xi/kT$ ,  $\xi$  being the thermodynamic potential (Sommerfeld's  $W_1$ ), and  $V$  is the average potential within the metal. Thus  $\xi_1 - \xi_2 = (V_1 - V_2)\epsilon$  (the Volta or junction potential difference). If the work-functions of the metals are different electrons will be displaced across the boundary. Let  $V = w + v\epsilon$ , where  $w/\epsilon =$  intrinsic potential (Sommerfeld's  $W_0$ ) and  $v =$  potential due to loss or gain of electrons. Then  $(v_1 - v_2)\epsilon = \phi_2 - \phi_1$ , where  $\phi = w - \xi$ , the thermionic work-function. If  $v_1 - v_2$  is taken to be the contact potential difference it has the corrected value and sign, and is interpreted as the potential difference between the metals themselves (in the ordinary sense), in a manner similar to the potential difference of a charged condenser. On examination this interpretation appears to be consistent with the facts. This potential difference is shown to exist between any metals the thermionic atmospheres of which are in communication, is strictly independent of the distance between them, and independent of temperature in so far as are  $\xi$  and  $w$ .—S. G.

Diamagnetism and Paramagnetism in Intense Fields. D. H. Moore and F. W. Constant (*J. Elisha Mitchell Sci. Soc.*, 1933, 49, 34).—Abstract of a paper read before the North Carolina Academy of Science. Measurements of the dia- and para-magnetism of copper, silver, bismuth, and platinum have been carried out by the Gouy method, using a Weiss electromagnet giving over 30,000 gauss. The susceptibility of all 4 materials is constant for the

fields investigated. The influence of a ferro-magnetic impurity in the copper is discussed.—P. M. C. R.

**New Work on the Physics of Metals.** J. Dorfman (*Metallwirtschaft*, 1933, 12, 221-223, 235-237).—A summary of recent work of the Physico-Technical Institute of the Urals concerning superconductivity, electromagnetic phenomena in liquid metals, and the relation between ferromagnetism and valency forces in alloys.—v. G.

## II.—PROPERTIES OF ALLOYS

(Continued from pp. 616-623.)

**Influence of Heavy Metals on Aluminium Alloys.** L.—**The Formation of Solid Solutions in Aluminium Alloys.** P. Röntgen and W. Koch (*Z. Metallkunde*, 1933, 25, 182-185).—By microscopic investigation the solubility of nickel, chromium, and molybdenum in aluminium (containing 0.04% silicon + iron + copper) at 360° C. has been determined to be 0.01-0.02% in each case. Ternary alloys with 2% copper and either 0.05% chromium, 0.05% molybdenum, or 0.1% nickel are heterogeneous after annealing and quenching at 360° C. From this the authors conclude [*Note by Abstractor*: without any justification] that copper has no appreciable effect on the solubility of these metals in aluminium.—M. H.

**On the Conductivity of Aluminium Solid Solutions.** W. Fraenkel, W. Bosshard (*Metallwirtschaft*, 1933, 12, 159-161; and (translation) *Light Metals Research*, 1933, 2, (32), 16-22).—The increase in electrical resistance of pure (99.97%) aluminium caused by the presence in solid solution of each 1 atomic-% of a second metal is as follows (in  $\Omega \times 10^{-7}$ ): indium 0.6, gallium 2.4, zinc 2.4, magnesium 5.0, copper 8.0, silicon 8.6, germanium 9.4, lithium 9.4, silver 11.2, manganese 49.0. Norbury's rule is only approximately valid. W. Bosshard (*ibid.*, p. 358) directs attention to his earlier work on this subject (see this *J.*, 1928, 33, 608; 40, 449-450).—v. G.

**On the Mechanical and Chemical Properties of Alloys of Aluminium with Chromium, Iron, Magnesium, Manganese, Titanium, and Vanadium.** H. Bohner (*Metallwirtschaft*, 1933, 12, 251-255, 265-267; and *Alluminio*, 1933, 2, 193-208).—The effect of small additions (0.06-1.5%) of the above-named metals on the mechanical properties and recrystallization of hard-drawn aluminium wire has been determined. Additions of 1-1.5% of chromium or manganese or of about 0.5% of titanium or vanadium produced the best properties in binary alloys. No temper-hardening effects can be obtained in ternary or quaternary alloys. Certain of the polynary alloys tested, especially a chromium-magnesium-titanium-aluminium alloy, possessed a high resistance to corrosion and a high tensile strength combined with high softening and recrystallization points. Additions of titanium invariably produced a fine-grained structure.—v. G.

**The Tempering Effect in Quenched Copper-Aluminium Alloys.** W. Stenzel and J. Weerts (*Metallwirtschaft*, 1933, 12, 353-356, 369-374).—The solubility of copper in aluminium as determined by X-ray methods agrees with the results of Dix and Richardson above 350° C.; at 300° C. it is, however, only 0.35%, and at 225° C. less than 0.1%. On tempering quenched alloys at a constant temperature the rate of separation of  $\text{CuAl}_2$  is greater the higher the copper content, i.e. the more supersaturated is the solid solution. After tempering at 100° C. for one week no precipitation can be detected, and yet there is a considerable change in the mechanical properties. Hence a great part of the ageing effects is to be attributed to changes in the solid solution structure preparatory to precipitation of the  $\text{CuAl}_2$ .—v. G.

**On the Behaviour of "Graphitic Silicon" in Aluminium at Higher Temperatures.** C. Schaarwächter (*Z. Metallkunde*, 1933, 25, 250-251; discussion, 251).—The crystals of "graphitic silicon" which separate on cooling a super-



saturated aluminium solid solution do not appreciably redissolve on annealing at 540° C.; only at 577° C. (eutectic temperature) is the rate of diffusion high enough to complete the dissolution within a short time.—M. H.

The Influence of the Pre-Treatment on the Mechanical Properties and the Electrical Conductivity of Aluminium Containing Magnesium Silicide. G. Grube and F. Vaupel (*Light Metals Research*, 1933, 2, (34), 1-10).—Translated from *Z. Metallkunde*, 1933, 25, 84-88; see *J.*, this volume, p. 294.—J. C. C.

On the So-Called Period of Incubation in the Age-Hardening of Duralumin. W. Fraenkel and R. Hahn (*Z. Metallkunde*, 1933, 25, 185-188).—The conditions under which a period of incubation appears in the age-hardening of Duralumin have been investigated, the process being followed by measurements of the Brinell hardness, tensile strength, and electrical conductivity of sheets and wires. The effects of the following factors have been determined: origin of the alloy, composition (iron, silicon, copper, and magnesium contents), size of sample (e.g., diameter of wires), preliminary heat-treatment (period of annealing at 500° C. before quenching, and quenching temperature), and preliminary mechanical treatment (percentage reduction by cold-rolling before annealing at 500° C. which corresponds with a variation of the grain-size). It was impossible to prove conclusively why one material shows incubation, whilst another does not. Evidently, incubation is the result of several causes, because samples having the same composition behave quite differently. On the other hand, it seems clear that very pure material does not show an incubation period, whereas this phenomenon is produced by an iron content, by long annealing before quenching, and by a coarse structure.—M. H.

Experiments on the Repeated Age-Hardening of Duralumin Rivets and on the Influence of the Ageing Temperature. Martin Abraham (*Z. Metallkunde*, 1933, 25, 203-206).—Rivet wire of Duralumin "681 A" has been subjected to repeated quenching (at 500° C.) followed by age-hardening at room temperature (a) after having reached the maximum attainable hardness (about 5 days), (b) after premature interruption of the age-hardening process and the shear strength determined at intervals. With (a) the rate of hardening is unaffected by the number of quenchings, with (b), however, a slightly higher rate occurs in the second ageing process. The changes in the shear strength of quenched Duralumin "681 A" rivets and Duralumin "681 A" and "681 ZB" rivet wire on ageing for 8 hrs. at 0°, 15°, 22°, 28°, and 35° C. are shown in graphs. Rivets of Duralumin "681 ZB" wire can be readily worked until the shear strength reaches 25-25.5 kg./mm.<sup>2</sup>; this value is obtained after 10 hrs. at 8° C., hence it is unnecessary to store a day's supply of rivets at a lower temperature.—M. H.

A Critical Study of the Hardness Behaviour of Duralumin. Hugh O'Neill, J. F. B. Jackson, and G. S. Farnham (*Phil. Mag.*, 1933, [vii], 16, 913-929).—The results of "Meyer" analysis indicate that the normal age-hardening of quenched Duralumin, or its accelerated ageing at temperatures below 150-200° C., are not "precipitation" treatments. The age-hardening process has effects somewhat similar to those obtained when a metal is slightly cold-worked. "Precipitation" can be induced in either freshly-quenched or fully-aged Duralumin by sufficiently severe heat-treatment. It has not been found, in general, to give hardness values, ( $P_n$ ), superior to those obtained from normal ageing treatment at room temperature.—J. S. G. T.

Formation of Blisters During Heat-Treatment of the Heat-Treatable Aluminium Alloys. P. Brenner, F. Sauerwald, and W. Gatzek (*Light Metals Research*, 1933, 2, (28), 2-7).—Translated in full from *Z. Metallkunde*, 1933, 25, 77-80; see *J.*, this volume, p. 329.—J. C. C.

The "Y"-Alloy. — Try-Chalons (*Fonderie moderne*, 1932, 28, 430-431).—Based on figures given in *Z. ges. Giesserei-Praxis: Das Metall*, 1932, 53, 282-283; see this *J.*, 1932, 50, 535.—J. H. W.

**Hydronalium, a Light Alloy of High Resistance to Corrosion.** W. Schultze (*Werft. Reederzi. Hafen*, 1933, 14, (19), 280).—See *J.*, this vol., p. 616.—P. R.

**Notes on the Cadmium-Nickel System.** Carl E. Swartz and Albert J. Phillips (*Amer. Inst. Min. Met. Eng. Contribution No. 55*, 1933, 1-4).—The cadmium-nickel system from 0 to 7.5% of nickel has been examined by thermal and microscopic analysis. From the melting point of cadmium the liquidus falls to a eutectic at 318° C. and 0.25% nickel, the constituents of the eutectic being cadmium and a compound which, if simple in composition, has the formula NiCd<sub>7</sub>. The liquidus then rises steeply to 490° C., at which temperature the compound NiCd<sub>7</sub> is probably formed by a peritectic reaction.  
—W. H. R.

**An X-Ray Study of the Diffusion of Chromium into Iron.** Laurence C. Hicks (*Amer. Inst. Min. Met. Eng. Contribution No. 58*, 1933, 1-10).—A piece of pure electrolytic iron was packed in powdered electrolytic chromium, and heated for 96 hrs. at 1200° C. The variation of the chromium concentration was then determined by grinding the specimen to successive depths, and measuring the lattice constants, the data of Preston (this *J.*, 1932, 50, 164) being used to deduce the composition from the lattice constant. The chromium concentration decreases gradually for a considerable distance (of the order  $36 \times 10^{-3}$  in.), and then decreases abruptly to a very small value which gradually approaches zero. This confirms the theory of Bannister and Jones (this *J.*, 1932, 50, 22, 352) that diffusion above the Ac<sub>3</sub> transformation proceeds without re-orientation of lattice up to the extent necessary to inhibit the  $\gamma$  phase, and that further diffusion produces a new phase ( $\alpha$  solid solution), the nuclei of which are immediately absorbed by the growing crystals; the theories of Grube (this *J.*, 1928, 39, 530) and Kelley (this *J.*, 1928, 39, 533) are not confirmed. Etching experiments are also described.—W. H. R.

**Diffusion of Copper in Iron in Connection with the Manufacture of Bimetals.** M. Zakharova (*Zvetnye Metally (The Non-Ferrous Metals)*, 1932, 542-550; *C. Abs.*, 1933, 27, 4508).—[In Russian.] The diffusion of copper (solution) in iron and the formation of a zone of iron-copper solid solution between the copper and the iron are too slow to be economically utilized in the commercial manufacture of copper-clad iron or steel wire.—S. G.

**Beryllium-Copper Alloys.** H. J. Noble (*Found. Trade J.*, 1933, 48, 401).—A short abstract of a paper read before the Hartford Chapter of the American Society for Steel Treating. See *J.*, this volume, p. 344.—J. H. W.

**Transformation and Change of Properties of Gold-Copper Alloy.** E. Schuch (*Metallwirtschaft*, 1933, 12, 145-147).—The changes which occur in the tensile curve, hardness, electrical conductivity, and X-ray pattern of quenched 50 atomic-% copper-gold alloy during transformation into Cu<sub>3</sub>Au have been measured; they show that the transition from cubic solid solution to tetragonal compound proceeds without the formation of intermediate phases, but that severe lattice disturbances occur. No completely satisfactory explanation of the change can, however, be advanced as yet.—v. G.

**On the Behaviour of Phosphorus to Copper and Silver.—II.** K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1933, 7, 75-80).—See *J.*, this volume, p. 237. To determine whether silver or copper-silver alloys are completely deoxidized, the best commercial procedure consists in annealing a portion of the rolled sheet in hydrogen at 520° C. for 1-2 hrs. and determining the Erichsen value; completely deoxidized sheet should give a depth of more than 10 mm. without fracture. This method is more delicate than metallographic examination and more rapid than chemical analysis. Experiments have shown that phosphorus is the best deoxidizer for standard silver alloys (925 or 835 fine), but that 2-5 minutes, according to the oxygen content, should be allowed to elapse after addition of the phosphor-copper before casting, to allow the reaction to complete itself. For new metal only 1 gm. of 10%



phosphor-copper per kg. of alloy is necessary. The oxygen is removed in the form of copper metaphosphate, which rises to the surface of the molten metal as a brown very fluid slag. Excess of deoxidizer should be avoided, since it may lead to trouble in subsequent plating of the article (cf. Moser, Fröhlich, and Raub, *J.*, this volume, p. 708).—A. R. P.

**Age-Hardening Processes in Silver-Copper Single Crystals.** P. Wiest (*Z. Metallkunde*, 1933, 25, 238-240; discussion, 240-241).—The changes in hardness and lattice parameter of single crystals of an Ag-Cu alloy containing 5% Ag quenched from 780° C. have been determined during ageing at 350°, 375°, 400°, 420°, 445°, and 470° C. The results indicate that the supersaturated solid solution passes through three stages during ageing in all of which there is an increase in hardness followed by a decrease. In the first stage no change in the lattice parameter can be detected and in the second a slight broadening of the interference points has been observed; hence the increase in hardness in both cases is due to changes within the lattice caused by atomic movements preparatory to precipitation. In the third stage the increase in hardness is accompanied by a large decrease in the lattice parameter due to the precipitation of the dissolved atoms with the formation of its own lattice.—M. H.

**Industrial Brasses.** M. Lencauchez (*Cuivre et Laiton*, 1933, 6, 343-350).—From *Rev. Fond. mod.*, 1933, 27, 81-88; see *J.*, this volume, p. 378.—W. N.

**The Solid Diffusion of the Pairs of Metals, Gold-Nickel, Gold-Palladium, and Gold-Platinum.** A. Jedele (*Z. Elektrochem.*, 1933, 39, 691-695).—The diffusion in the solid state of the pairs of metals gold-nickel, gold-palladium, and gold-platinum were measured in both directions, and it is shown that the rate of diffusion is different for each metal and that it is greater the nearer the temperature of diffusion is to the freezing point of the alloy. The rate of diffusion of gold in platinum is smaller than that of platinum in gold. At 900° C., the rate of diffusion of the platinum-rich solid solutions is about  $0.1 \times 10^{-5}$  cm.<sup>2</sup>/day, and increases steadily to  $0.5 \times 10^{-5}$  cm.<sup>2</sup>/day for the gold-rich alloys. The diffusion rate of the gold-palladium system increases from about  $0.2 \times 10^{-5}$  cm.<sup>2</sup>/day for the palladium-rich alloys to  $2.0 \times 10^{-5}$  cm.<sup>2</sup>/day for the gold-rich alloys; that of the gold-nickel system ranged from about  $0.3 \times 10^{-5}$  cm.<sup>2</sup>/day for the nickel-rich to  $5.0 \times 10^{-5}$  cm.<sup>2</sup>/day for the gold-rich alloys. The order of the depth of penetration of the metals platinum, palladium, and nickel in gold is the same as that of gold in these metals.

—J. H. W.

**The Atomic Resistance Increase in Dilute Gold, Silver, and Copper Alloys.** J. O. Linde (*Metallwirtschaft*, 1933, 12, 173-175).—A summary of L.'s work published in other journals (see this *J.*, 1932, 50, 15; and this volume, p. 15).

—v. G.

**Nickel-Chromium Resistance Alloys and Their Life.** W. Hossenbruch and W. Rohn (*Metallurgia*, 1933, 8, 181-188).—An abridgment of an article on "High-Grade Chromium-Nickel Alloys and Life Tests Thereon," *Heraeus Vacuum-Schmelze* [10th Anniv. Volume], 1933, p. 247. See *J.*, this volume, pp. 624-625.—J. W. D.

**Influence of Small Amounts of Impurities on the Mechanical and Chemical (Corrosion) Properties of Zinc.** A. Burkhardt and G. Sachs (*Metallwirtschaft*, 1933, 12, 325-329, 339-342).—The tensile strength, elongation, bending strength, fatigue limit, and resistance to corrosion (Cohen test in dilute sulphuric acid) have been determined for rolled and annealed alloys of zinc (99.97%) containing (0.001-1%) of one of the following metals: aluminium, arsenic, silver, bismuth, calcium, cadmium, copper, iron, mercury, lithium, magnesium, nickel, lead, antimony, thallium. All the alloys are more difficult to roll than is pure zinc, the tin alloy being the worst, and the lead and cadmium alloys and those with not more than 0.01% lithium or magnesium,

the best in this respect. Bismuth, mercury, antimony, and thallium have a particularly deleterious effect on the tensile properties, but all additions improve the bending properties. Iron, nickel, and antimony have by far the worst effect on the resistance to corrosion, arsenic, bismuth, aluminium, silver, and copper are also injurious in this respect, whereas cadmium, lead, mercury, lithium, and not more than 0.01% magnesium increase the resistance to corrosion. Attempts to overcome the accelerating action of iron on the corrosion of zinc by adding a third metal failed.—v. G.

**The Interconversion of Atomic, Weight, and Volume Percentages in Binary and Ternary Systems.** Cyril Stanley Smith (*Amer. Inst. Min. Met. Eng. Contribution No. 60, 1933, 1-13*).—In binary systems calculations for the interconversion of atomic and weight percentage compositions involve terms of the form  $\frac{x}{100-x}$ , where  $x$  is the percentage composition, and  $\frac{A}{B}$  where  $A$  and  $B$  are the atomic weights of the two elements. Tables are given showing the values of  $\log \frac{x}{100-x}$  for values of  $x$  in steps of 0.1% from 0.1 to 99.9, and by interpolation calculations accurate to 0.01% of the whole are readily obtained. A second table gives the values of the logarithms of the atomic weight ratios (i.e.  $\log \frac{A}{B}$ ) for most pairs of elements. The use of these tables greatly reduces the time spent in calculation, and their extension to conversions involving volume percentage is discussed. A graphical system based on the intercept theorem of Menelaus is described for the interconversion of atomic and weight percentages in ternary systems where the composition is represented in an equilateral triangle; the method involves only the use of a ruler.—W. H. R.

**Special Alloys.** Anon. (*Z. ges. Geschw.-Praxis: Das Metall, 1933, 54, (A) 349; (B) 369-370; (C) 391-392*).—See *J.*, this volume, p. 552. The composition and, in some cases, the mechanical properties and applications of the following alloys are given: (i) Carbon bronze, Cufinium, Cunilloy, Cupesinium, Coston's bearing metal, Cymric and Tudric pewter, Daimler bearing bronze, Damascene bronze, D'Arcey's free-melting alloys, Dandelion metal, Daws metal, and Dawson bronze; (ii) D'Arcey's golden bronze, Delstet bronze, Delta metal, Dewence bearing metals, Diamond bronze, "German" alloy and "Third Silver" (Drittel Silber,  $\frac{1}{3}$  silver;  $\frac{2}{3}$  aluminium), (iii) Dick's bearing bronze, Dirigold (Orsuzien bronze), Dow metal, Dudley's bearing metal and anti-friction metal, Danlevic bearing, Duralium, and Duralumin.—J. H. W.

**Investigations on Segregation (Lignation).** G. Masing and E. Scherer (*Z. Metallkunde, 1933, 25, 173-179*).—Theoretical considerations indicate that the so-called inverse segregation of ingots should normally be expected. The results of recent investigations on inverse segregation are discussed from the point of view of the various existing theories. It is concluded that the relative displacement of the residual melt and the primary crystals which produces the inverse segregation is not the result of a single cause. The sucking effect (capillary effect, pipe effect) which takes place during solidification by contraction of the dendrites forming the marginal zone is chiefly effective with rapid solidification. The pressure of the gases liberated during the freezing of the residual melt is chiefly effective with slow solidification. In certain cases however, the "crystallization pressure" (theory of Bauer and Arndt) seems to be an additional cause. 50 references are given.—M. H.

**Effect of Temperature on the Elastic Properties of Metals Used for Aircraft Instruments.** G. H. Kenigson and M. R. Housman (*J. Franklin Inst., 1933, 215, 473-480*).—Abstract from *U.S. Bur. Stand. J. Research, 1933, 10, 283*. See *J.*, this volume, p. 302.—S. V. W.



**The Superconductivity of Alloys from the Phase-Theory Point of View.** C. Benedicks (*Z. Metallkunde*, 1933, 25, 197-202).—The relations which should exist between Roozeboom's 5 types of equilibrium diagrams of binary systems and the curve obtained by plotting the spring points (*i.e.* the temperatures at which metals and alloys become superconducting) against the concentration are explained. The results of Meissner, Franz, and Westerhoff for the spring points in the indium-lead, mercury-lead, bismuth-lead, tin-thallium, indium-thallium, and lead-thallium systems (*cf.* this *J.*, 1932, 50, 604, 607-608) are essentially in accordance with the equilibrium diagrams, but indicate that a modification is required in the equilibrium diagram of the tin-thallium system. The superconductivity is highly sensitive for the detection of heterogeneity (coring) in solid solutions. The phenomena of superconductivity can be qualitatively explained by the phoretic theory of metallic conduction.—M. H.

**The Supraconductivity of Alloy Systems.** J. F. Allen (*Phil. Mag.*, 1933, [vii], 16, 1005-1044).—The supraconductivity of seven alloy systems, tin-gold-tin, gold-lead, silver-tin, silver-lead, copper-tin, copper-lead, and thallium-tin, has been examined. Different supraconductive characteristics were found for each of three structural types. Simple eutectic mixtures showed a constant supraconductivity temperature except in the neighbourhood of the boundaries. Simple solid solutions or solubility phases showed a continuously varying supraconducting temperature and transition interval. This latter was least at the phase boundaries and greatest in the middle of the phase. The third type, composed of what may be termed a double series of solid solutions, showed supraconductive characteristics similar to the second type. X-ray examination of this type as found in the thallium-tin series showed that the transition temperature varied inversely with the magnitude of the lattice constants. In all types, the supraconductivity curve is a continuous function of the concentration. Hence, supraconductivity is a property of the complete homogeneous structure, and not merely a property of any one of its components. Residual resistance was found to be a structure-sensitive phenomenon exhibiting great variations throughout alloy systems, especially in solubility phases. It is impossible, from the results, to state definitely whether gold, silver, and copper are supraconductive or not at temperatures below 1° K.—J. S. G. T.

**Materials for Electrical Resistances.** Georg Keinath (*Arch. tech. Messen*, 1932, 2, r110-r111).—Alloys intended for resistance coils should possess a low-temperature coeff., reasonable constancy of resistance within the working temperature range, a low thermo-electric effect in contact with copper, high ductility, and minimum liability to oxidation. Alloys specially described are the now obsolete Neusilber (copper 60, nickel 17, zinc 23%), Nickelini (copper 67, nickel 31, manganese 2%), Manganin (copper 84, nickel 4, manganese 12%). Constantan (copper 54, nickel 45, manganese 1%), nickel-chrome containing iron (nickel 60, chromium 15, iron 23, manganese 2%) iron-free nickel-chrome (nickel 80, chromium 20%). Their principal properties are tabulated. A diagram shows the resistance per metre of wires of different diameters for the alloys in question and for certain pure metals.—P. M. C. R.

**On the Influence of Strong Magnetic Fields on the Hardening of Metals and Alloys.** Hans Esser and Heinz Cornelius (*Metallwirtschaft*, 1933, 12, 210-213; and (summary) *Metallurgist* (Suppl. to *Engineer*), 1933, 9, 62-63).—No effect of magnetic fields on the course of the hardening of steels could be detected, but the possibility that fields of different strengths or frequencies have an effect is not excluded. The hardness figures obtained by the Herbert pendulum tester are strongly affected by the room temperature.

—v. G.

**Highly Magnetic Alloys.** Georg Keinath (*Arch. tech. Messen*, 1932, 2, r173).—A summary of recently available information as to the magnetic

properties of the binary nickel-iron alloys, of certain of their ternary derivatives, and of the Perminvar alloys. Magnetization curves are given for the binary series, for which a specific resistance graph is also shown; on the latter the values for Megaperm and Mumetal are indicated. For the Hipernik alloys, a table shows the initial and maximum permeability, strength of magnetic field, saturation value, coercivity, and specific resistance; the compositions stated being nickel 41, 45, and 50%, respectively, remainder iron. Their permeability is compared graphically with that of iron. Among ternary alloys, Permalloy and its derivatives with additions of chromium and molybdenum are especially considered. Recent applications of Perminvar are reviewed.—P. M. C. R.

### III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 628-631.)

**Structure and Origin of the Copper-Cuprous Oxide Eutectic.** L. W. Eastwood (*Amer. Inst. Min. Met. Eng. Contribution No. 59*, 1933, 1-8).—The structure of the copper-cuprous oxide eutectic has been examined in detail for an alloy containing 0-48% oxygen. The eutectic as a whole solidifies in grains by the growth of main axes which branch off to form secondary and tertiary axes in the same way as the growing dendrites of a pure metal. Macroetching reveals grains in each of which the copper has the same orientation. The "complex grains" described by Portevin (this *J.*, 1923, **29**, 239) are not really analogous to the crystal grains of a pure metal, but are the intersections of the polished surface with the branches of the eutectic dendrites, and are termed "intersections." The oxide is present as either spheroids or rods, the former being favoured by rapid solidification. The structure coarsens in the part last to solidify, and comparatively large spheroids are found both at the junction of (a) adjacent grains, and (b) adjacent intersections. These may be distinguished by the fact that only (a) shows a true grain boundary line on etching, since the copper orientation is the same in different intersections of the same dendrite. The growth and orientation of the cuprous oxide particles are discussed.—W. H. R.

**Addendum to: New Additions to the Recrystallization Theory.** U. Dehlinger (*Metallwirtschaft*, 1933, **12**, 298-299).—Cf. *J.*, this volume, p. 189. Aluminium single crystals behave differently according to their method of preparation; those obtained by recrystallization show a well-defined point of inflection in the tensile curve corresponding with a yield-point, whereas those obtained directly from liquid aluminium show no such point and even, with a very small stress, undergo a permanent deformation.—v. G.

**Laws of Transformation in the Solid State of Metals.** U. Dehlinger (*Metallwirtschaft*, 1933, **12**, 207-210).—A systematic review of the mechanism of solid transformations in metals and the application thereto of thermodynamic laws.—v. G.

**X-Ray Analysis of Iron-Tin Alloys.** W. F. Ehret and A. F. Westgren (*Met. Ind. (Lond.)*, 1933, **42**, 611-613).—Abstract from *J. Amer. Chem. Soc.*, 1933, **55**, 1339-1351. See *J.*, this volume, p. 306.—J. H. W.

**The Structure of Nickel-Zinc Alloys.—II.** W. Heike, J. Schramm, and O. Vaupel (*Metallwirtschaft*, 1933, **12**, 115-120).—This second part (for Part I, see *J.*, this volume, p. 17) deals with alloys containing 56-100% Zn and gives the complete equilibrium diagram of the system. The  $\gamma$ -phase shows a maximum melting point at 881° C. with 23% nickel and exists in alloys containing 23.8-13.8% nickel at room temperature; it has a  $\gamma$ -brass type of lattice. Alloys with 10.7% nickel consist of the hexagonal  $\epsilon$ -compound,  $Ni_2Zn_{15}$ . Zinc dissolves only 0.05% nickel ( $\eta$ -phase).—v. G.



**Electron Diffraction Patterns from Platinized Asbestos.** D. A. Richards (*Phil. Mag.*, 1933, [vii], 16, 778-787).—Electron diffraction analysis of platinized asbestos suggests that platinization effects a splitting of the asbestos fibre, so that the platinum diffraction pattern is observed only after a comparatively high degree of platinization of the fibre has been effected.—J. S. G. T.

**The Constitution of Metallic Sodium.** E. Wigner and F. Seitz (*Phys. Rev.*, 1933, [ii], 43, 1048).—Abstract of a paper read before the American Physical Society. The free-electron picture of metals is employed in an investigation of the binding properties of metallic sodium, such as heat of evaporation, lattice constant, and compressibility, under the assumption that the forms of the closed shells are not altered by metallic binding. The boundary conditions to be satisfied by the wave-functions of the outer electrons are derived from consideration of crystal symmetry and the work of Bloch. The Schroedinger equation for each electron is approximated by a spherically symmetric one about each atom which is solved using the field of Prokofiew. The extent to which interactions of electrons are contained in the picture is discussed. It is found that to each value of the lattice constant,  $d$ , there corresponds a definite energy that is to be associated with the electron in the lowest state. This energy is determined as a function of  $d$ . Because of the Pauli principle, only two electrons will possess this energy and the mean energy of all of the electrons is obtained by adding an appropriate correction. The resulting curve possesses a minimum below the energy of the free atom, and from its characteristics the binding properties are determined with favourable agreement.—S. G.

**The Crystal Structure of Tantalum Carbide.** M. von Schwarz and O. Summa (*Metallwirtschaft*, 1933, 12, 298).—Pure tantalum carbide, TaC, has a cubic lattice of the sodium chloride type,  $a = 4.4460 \pm 0.0005$  A.—v. G.

**The Unit Cell of Uranium Calculated from X-Ray Powder Method Data.** Thomas A. Wilson (*Phys. Rev.*, 1933, [ii], 43, 781).—Abstract of a paper read before the American Physical Society. Photographs were supplied by W. P. Jesse which had been obtained by allowing unfiltered iron X-radiation to graze the surface of a block of uranium which had been rendered plane by filing in hydrogen. The uranium was of the highest purity obtainable. The block was rotated by hand in the X-ray camera. Exposure lasted for 2½ hrs. The photographs showed 13 different plane reflections. By a mathematical analysis based on vectors, the equation for the interplanar spacings of the parallelogram containing one uranium atom was found to be:  $2.535^2/d^2 = h^2 + k^2 + l^2 - 0.878hk - 0.758(h+k)l$ . The unit cell of uranium accordingly has equal face perpendiculars of 2.535 A.U. in length, arranged in space at angles of 64°, 67° 45', and 67° 45', respectively. The volume of the cell is 20.26 cubic A.U., which gives uranium an X-ray density of 19.32, as against 18.68 reported previously, a difference of 3.3%.—S. G.

**Does the Change in Lattice Constants in Solid Solution Formation Depend on the Grain-Size?** Arthur Phillips and R. M. Brick (*Metallwirtschaft*, 1933, 12, 161-162).—The lattice parameter of a fine-grained polycrystalline wire of aluminium containing 4.0% copper is the same as that of a coarse-grained wire containing 4.8% copper and of that of a single crystal containing 5.6% copper. These results have been confirmed by careful density measurements.—v. G.

**Concerning W. T. Sproull's Article on "Diffraction of Low-Speed Electrons by a Tungsten Single Crystal."** H. E. Farnsworth. G. P. Thompson (*Phys. Rev.*, 1933, [ii], 44, 417-418).—Notes. H. E. F. suggests that the effects observed by Sproull (*J.*, this volume, p. 306) for a tungsten crystal cut parallel to a (112) plane, are due to the fact that the heat-treatment caused evaporation which etched the surface so as to expose the more densely populated (011) planes. Under these conditions lines which Sproull took to be due to

the volume condition would be due to the surface condition, and *vice versa*. Sproull's criticisms of F.'s work (*J. Opt. Soc. Amer.*, 1927, 15, 290) are answered. G. P. T. also suggests that, owing to the method of preparation, the surface of Sproull's tungsten crystal contained etch pits and pyramids with the (101) plane exposed. This would also account for the low value found for the inner potential, since, if the effects were due to the surface effect of (101) planes, the full inner potential, which would only be reached at a finite distance inside the crystal, would not come into play.—W. H. R.

**Diffraction of Low-Speed Electrons.** H. E. Farnsworth (*Phys. Rev.*, 1933, [II], 43, 778).—Abstract of a paper read before the American Physical Society. Experiments with low-speed electrons have shown many deviations from the results to be expected on the basis of de Broglie's original relation. These deviations exist for normal incidence as well as for glancing angles of incidence used in the Bragg method, and may appear as a secondary or fine structure of the main diffraction beams. The relative intensities of the various components are extremely sensitive to small changes in the angle of incidence. This results in large variations of the relative integrated intensities of the main diffraction beams with small changes in angle of incidence. It thus appears that an understanding of the phenomenon should contain information on still obscure points in the present view of the solid state, such as the concept of an average inner potential, deviations from such an average value, and interaction between electrons in crystals. The following further experiments have been undertaken to determine possible surface effects, and in particular the "surface action" considered by v. Laue: (1) a study of the characteristics of a thin film of one metal deposited by evaporation on a single crystal of another metal; (2) investigation of reflection from opposite sides of a given set of atomic planes when using primary electrons which enter different faces of the same crystal in the two cases. The first experiment shows that the fine structure characteristics for the film are essentially the same as those for a massive crystal of the same metal, and thus eliminates surface irregularities as a possible cause of fine structure differences. The second experiment indicates that there is an unsymmetrical reflection from opposite sides of an atomic plane, and appears to have a significant bearing on the interpretation of the fine structure.—S. G.

**On the Precision Determination of Lattice Constants by the Reflection Method.** Franz Wever and Hermann Müller (*Mitt. K.-W. Inst. Eisenforschung*, 1933, 15, 59-69).—The accuracy of the determination of lattice constants by the X-ray reflection method on plane films has been theoretically and experimentally investigated. The effect of errors in measuring (a) the interference lines and (b) the distance between specimen and film is discussed and shown graphically. The errors in (a) can be determined only indirectly either by Sachs and Weerts' extrapolation method (see *J.*, 1930, 43, 528, and *Z. Krist.*, 1932, 84, 20) or by comparison with a standard material. The latter method is illustrated in detail for the case in which a thin film of the standard is applied to the specimen, the thickness of the film serving to correct (a). The intensity distribution over the width of the interference lines is derived geometrically; it is roughly symmetrical to the position of the line with an infinitely thin primary ray. The deviations from Bragg's reflection law caused by diffraction of the X-rays do not produce displacement, but only broadening of the interference lines with sufficiently fine-grained specimens, since the deviations of the rays on entering and leaving compensate one another.—J. W.

**A New Type of Crystal Structure Model.** George Glockler (*Rev. Sci. Instruments*, 1933, [N.S.], 4, 529).—A cellophane model, which is collapsible and fits into a storage box of dimensions about  $12 \times 7\frac{1}{2} \times 1\frac{1}{2}$  in. is illustrated.

—J. S. G. T.



## IV.—CORROSION

(Continued from pp. 631-635.)

On the Action of Cupriferous Tap-Water on Aluminium. L. W. Haase (*Metallwirtschaft*, 1933, 12, 137; and (translation) *Light Metals Research*, 1933, 2, (24), 10-12).—Copper can be deposited in a metallic form from water only when the water contains sulphuric acid; since this is never the case with tap-water, corrosion pits in aluminium which are surrounded by cupriferous corrosion products can be explained only on the assumption that, during the fabrication of the aluminium, small specks of copper have been introduced, e.g. during rolling, and that these have given rise to the corrosion.—V. G.

Composition of the Patina on a Modern Bronze Statue. Rutherford J. Gettens (*Tech. Studies Field Fine Arts*, 1933, 2, (1), 31-33; *C. Abs.*, 1933, 27, 4514).—Examination of the surface of the bronze statue of Nathan Hale, erected about 1895, showed the presence of an inner, very thin layer of red  $\text{Cu}_2\text{O}$  or cuprite, a middle green layer (constituting the patina) consisting mostly of basic copper sulphate (corresponding approximately to  $3\text{CuO}\cdot\text{SO}_3\cdot 2\text{H}_2\text{O}$ , or antlerite) and containing a considerable amount of tin oxide, and an outside layer consisting of a mixture of soot and finely-divided  $\text{SiO}_2$  (derived from wind-borne material).—S. G.

Some Observations on the Corrosion of Lead. A. H. Loveless, T. A. S. Davies, and W. Wright (*Met. Ind. (Lond.)*, 1933, 42, 614-616).—Abstract from *J. Roy. Tech. Coll. (Glasgow)*, 1933, 3, (1), 57-64. See *J.*, this volume, p. 308.—J. H. W.

The Atmospheric Corrosion of Magnesium. L. Whitby (*Trans. Faraday Soc.*, 1933, 29, 844-853).—Weight increment/time curves have been obtained for magnesium (99.9%) exposed to outdoor atmospheres for 217 days and to indoor atmospheres for 412 days. In the latter case the rate of corrosion depends on the relative humidity, and with constant relative humidity the weight increment is probably a linear function of the time. The film of corrosion products, however, slowly becomes protective owing to the closing of the pores by secondary reactions. The primary film consists of magnesium hydroxide which subsequently becomes converted into hydrated carbonate and sulphate; in both stages a critical relative humidity is necessary to promote the reaction. After 412 days the film contained 46.5% magnesium carbonate, 9.8% magnesium sulphate, 16.3% magnesium hydroxide, and 27.4% water. Film formation in the open air follows a similar course to that indoors, except that there is an intermittent leaching out of soluble sulphate by the rain; during ensuing dry periods the film again thickens but no protective film is ever obtained. After 217 days' outdoor exposure the film consisted of 61.5% magnesium carbonate trihydrate, 26.7% magnesium sulphate heptahydrate, 6.4% magnesium hydroxide, 2.5% carbonaceous matter, and 2.9% ferric oxide + alumina.—A. R. P.

The Dissolution of Magnesium in Aqueous Salt Solutions.—II. L. Whitby (*Trans. Faraday Soc.*, 1933, 29, 853).—*Cl. J.*, this volume, p. 356. No evidence could be found to support the theory that nitride and oxide inclusions in magnesium act as cathodes or as nuclei for anodic attack in sodium chloride solutions. Analysis of a dissolution-time curve of a sample of magnesium which gave accelerated attack with time in 0.1N-sodium chloride solution indicates that the acceleration was caused by progressive redeposition of the more noble impurities in the metal (chiefly copper and iron). Impurities have a marked effect on the rate of dissolution of magnesium in 0.1N-sodium chloride solution, but very little effect in 0.002N-sodium chloride or in 0.1N-sodium sulphate solution; the initial rate of dissolution is practically inde-

pendent of the nature of the impurities and of the concentration of the corrosive solution.—A. R. P.

**Zinc in Dry Batteries.** E. Schrader (*Met. Ind. (Lond.)*, 1933, 42, 659-662, 667).—Abstracted from *Z. Metallkunde*, 1931, 23, 301. See this *J.*, 1932, 50, 435.—J. H. W.

**Corrosion of Light Metals.** Freeman Horn (*Mech. World*, 1933, 93, 75-76). **Duralumin** (*ibid.*, 99). **Corrosion of Magnesium** (*ibid.*, 100). **Corrosion Testing of Light Metals** (*ibid.*, 126-127). **Corrosion-Fatigue of Light Metals** (*ibid.*, 167). **Prevention of Corrosion in Light Metals** (*ibid.*, 242-243).—Abstracts of a paper read before the Chemical Engineering Group of the Society of Chemical Industry. See *J.*, this volume, p. 307.—F. J.

**Corrosion of Metals in Salt Solutions and Sea-Water.** G. D. Bengough (*Chem. and Ind.*, 1933, 52, 195-210, 228-239).—The paper is a series of four lectures, which give a comprehensive survey of a wide range of work, much of which has been published in the Proceedings of the Royal Society during recent years. A large part of the work refers to ferrous materials, but an account is also given of the corrosion of zinc in very dilute solutions of potassium chloride and potassium sulphate. Factors influencing general corrosion in salt solutions are discussed, and the experimental method of attack, using apparently stagnant solutions, is described in detail. It is shown that under such conditions corrosion is controlled by two simultaneous mechanisms, (1) displacement of hydrogen gas, (2) absorption of oxygen. Corrosion curves given for zinc in very dilute solutions of potassium chloride are said to be of historical interest as being the first complete set ever published for any of the metals which corrode both by oxygen absorption and hydrogen evolution. Spectroscopically pure zinc gives much less hydrogen evolution than ordinary commercially pure zinc, but the oxygen absorption rate is quite similar, making allowance for the effect of the hydrogen. The distribution of corrosion over the surface of specimens has also been studied and is illustrated with respect to zinc by means of a series of photomicrographs. The reactions occurring at cathodic and anodic regions and the factors controlling distribution of corrosion are discussed.—E. S. H.

**Deterioration and Restoration, with Especial Reference to Metallic Exhibits.** Alexander Scott (*Museums J.*, 1933, 33, 4-8; *Tech. Studies Field Fine Arts*, 1933, 2, (1), 53; *C. Abs.*, 1933, 27, 4505).—Salts in the soil that are particularly destructive of metallic objects are sodium and calcium chlorides and nitrates and calcium sulphate, sodium chloride being the most active. It does not affect gold, but silver is rapidly changed to silver chloride or to a "horn silver" with a large chlorine content. With copper, iron, and bronze, a relatively small amount of sodium chloride acting in the presence of air and water may start a cycle of chloride, oxychloride, oxide or carbonate which will reduce the metal to a mass of these compounds. Treatment of corroded silver and copper must begin with complete removal of all traces of chlorine, which in many cases can be effected by soaking for several days in strong sodium sesquicarbonate solution, followed by thorough washing. HCOOH is indicated as the best for cleaning, because the HCOOAg can be easily decomposed into carbon dioxide and silver. Sulphuric or hydrochloric acids should not be used in the treatment of copper and bronze, but 3% aqueous citric acid is safe and effective. Application of granulated zinc in a dilute sodium hydroxide solution is preferable to actual electrolysis. Comparatively little can be done for iron objects when they carry a heavy crust of black iron oxide. Presence of active corrosion is usually shown by the appearance on the surface of brown liquid drops giving tests for chlorine, and the pieces may be immersed in or boiled with sodium hydroxide solution and granulated zinc. A test of the effectiveness of the treatment is exposure in a very moist atmo-



sphere for 4-5 weeks; if freed of chlorine it will not show pinhead drops in this time.—S. G.

Some Comparative Corrosion-Fatigue Tests Employing Two Types of Stressing Action. H. J. Gough and D. G. Sopwith (*Engineering*, 1933, 135, 75-78).—An abridged account of a paper read before the Iron and Steel Institute. See *J.*, this volume, p. 309.—W. P. R.

## V.—PROTECTION (Other than Electrodeposition.)

(Continued from pp. 626-633.)

The Electrolytic Oxidation of Aluminium. Anon. (*Oberflächentechnik*, 1933, 10, 175-178).—A review of modern procedures of producing protective and decorative films on aluminium.—A. R. P.

The Electrolytic Oxidation Process [for the Protection of Aluminium and Its Alloys.] Hans Schmitt (*Oberflächentechnik*, 1933, 10, 217-219).—The merits of various anodic oxidation processes are discussed.—A. R. P.

Anodic Polarization of Aluminium and Its Alloys as a Protection Against Corrosion. V. Kroenig and I. Kazakov (*Zvetnye Metally (The Non-Ferrous Metals)*, 1932, 505-512; *C. Abs.*, 1933, 27, 4516).—[In Russian.] A description is given of the anodic polarization methods used in the Central Aero-Hydrodynamical Institute, Moscow. Anodic polarization increases considerably the resistance of aluminium and Duralumin to corrosion by sea-water.—S. G.

Coating and Colouring Aluminium by Alumilite Process. H. Bengston and R. E. Pettit (*Chem. and Met. Eng.*, 1933, 40, 135).—Abstracted from *Machinist (Eur. Edn.)*, 1933, 77, 76-79; see *J.*, this vol., pp. 245, 310.—F. J.

Testing the Thickness of Zinc on Galvanized Wire. Z. Dyakonova (*Zvetnye Metally (The Non-Ferrous Metals)*, 1932, 550-552; *C. Abs.*, 1933, 27, 4514).—[In Russian.] By the use of a solution of  $As_2O_3$  in sulphuric acid, zinc oxide and zinc can be uniformly dissolved. By dipping a wire, previously cleaned in benzene or ether, into such a solution and holding for 15 seconds from the moment of the appearance of the first bubbles, a layer of zinc 0.0001 cm. thick is dissolved off. The wire is then washed in water and quickly dipped into a concentrated solution of ammonium sulphide. If any bare iron is present, black spots due to the formation of  $FeS$  will appear on the portions of the wire unprotected by zinc. To ascertain the presence of ferrous sulphide the wire is placed for a short time in strong acetic acid (3 c.c.), removed, and 2-3 drops of potassium ferricyanide are added to the solution. The change in the colour of the solution indicates the presence of iron.—S. G.

Artificial Production of Natural Protective Coatings [on Metals]. Anon. (*Chem.-Zeit.*, 1933, 57, 662-663).—Modern methods of producing protective films on aluminium, copper, and zinc are briefly outlined.—A. R. P.

Metal Spraying: A Review of the Process. W. E. Ballard (*Indust. Gases*, 1932, 13, 203-209).—After a historical survey of the process, the Schoop pistol is described. It is supplied with air at 50 lb. pressure, cylinder oxygen, and fuel gas. The air drives a turbine which is geared to rolls gripping the wire of metal to be sprayed. About 15 ft.<sup>3</sup> of air is used per minute, and the consumption of fuel gas and oxygen varies according to the metal, lead requiring 1½ ft.<sup>3</sup> of oxygen and 4 ft.<sup>3</sup> of hydrogen, whilst stainless steel requires 40 ft.<sup>3</sup> of oxygen and 100 ft.<sup>3</sup> of hydrogen per 1 lb. sprayed. The usual metal loss is about 15%. The approximate consumption of metal per hr. in the pistol is for lead, 15 lb.; tin, 7 lb.; zinc, 5 lb.; aluminium and copper, 1½ lb. By means of special nozzles, long tubes and orifices of small diameter can be sprayed. The surface of the article to be sprayed must be roughened. This

can be done, in the case of metals, by sand-blasting, but acid etching is useless. Porosity of the coatings can be overcome by chemical doping, heat-treatment, or mechanical battering. The applications of sprayed coatings of zinc, lead, tin, aluminium, and nickel are described.—H. W. G. H.

**Protective Painting of Metal Work.** S. C. Britton and U. R. Evans (*Iron Age*, 1933, 132, 23 and 68).—Abstract of a paper read before the Electrochemical Society. See *J.*, this volume, p. 556.—J. H. W.

## VI.—ELECTRODEPOSITION

(Continued from pp. 639-642.)

**Technique of Electrodeposition of Cadmium.** F. Pietrafesa and E. Lotti (*Galvano*, 1933, (16), 23-26; (17), 24-26).—Translated from *Metallurgia italiana*, 1933, 25, 167-173. See *J.*, this volume, p. 445.—E. S. H.

**Porosity in Cadmium Coatings on Steel.** S. G. Clarke (*Met. Ind. (N.Y.)*, 1933, 31, 307).—Abstract of a paper read before the Electrodepositors' Technical Society. See *J.*, this volume, p. 506.—I. M.

**Discussion on Electrodeposited Cadmium.** — (*Met. Ind. (Lond.)*, 1933, 43, 331-333).—Summary of the discussion of a paper presented by S. G. Clarke to the Electrodepositors' Technical Society. See *J.*, this volume, p. 506.—J. H. W.

**Prevention of Discoloration of Cadmium Plate.** Gustaf Soderberg (*Metal Cleaning and Finishing*, 1932, 4, 561-562).—Cf. *J.*, this volume, p. 27.—S. G.

**The Electrodeposition of Ternary Alloys of Cadmium, Zinc, and Antimony.** Lawrence E. Stout and Leonard Goldstein (*Trans. Electrochem. Soc.*, 1933, 63, 99-119; and *Metal Cleaning and Finishing*, 1933, 5, 257-260).—See *J.*, this volume, p. 249.—S. G.

**Advances in Chromium Plating.** Anon. (*Oberflächentechnik*, 1933, 10, 219-221).—A review.—A. R. P.

**Shaped Anodes in Chromium Plating.** R. J. Piersol (*Metal Cleaning and Finishing*, 1933, 5, 235-238; *C. Abs.*, 1933, 27, 4485).—Special designs of anodes required for the various shapes of inside surface for securing uniform current density in chromium plating are discussed.—S. G.

**Replating Hard Chromium.** R. J. Piersol (*Metal Cleaning and Finishing*, 1933, 5, 279-282; *C. Abs.*, 1933, 27, 4485).—A method for chromium replating is described (U.S. Patent 1,774,901) with which successive layers of chromium have been deposited to a total thickness of 0.5 in.—S. G.

**Shading in Chromium Plating.** R. J. Piersol (*Metal Cleaning and Finishing*, 1933, 5, 207-210; *C. Abs.*, 1933, 27, 4485).—P. discusses the principles of calculating the current density to be employed in the chromium plating of irregularly-shaped articles so as to avoid "shading."—S. G.

**Chromium Plating of Considerable Thickness.** R. J. Piersol (*Galvano*, 1933, (9), 25-27, (10), 23-25).—Translated from *Chem. and Met. Eng.*, 1931, 38, 445-448. See this *J.*, 1932, 50, 46.—E. S. H.

**The Determination of the Sulphate Content of Chromium-Plating Baths.** K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1933, 7, 64-65).—Removal of the chromium and other metals from the plating solution prior to determination of the sulphate content by the barium chloride method is unnecessary for technical purposes.—A. R. P.

**Note on the Electrodeposition of Copper.** E. Vuigner (*J. Four élect.*, 1933, 42, 363-367).—As a result of a series of experiments, it is concluded that a superior quality of copper deposits with the minimum expenditure of current can be obtained by the following means: using anodes of well-refined copper; using cores prepared in a pure electrolyte with a moderate current; maintaining the baths at a sufficiently constant temperature and avoiding any addition of chlorine or of glue.—J. H. W.



**The Electrodeposition of Magnesium.** D. M. Overcash and F. C. Mathers (*Met. Ind. (Lond.)*, 1933, 43, 473-474).—Abstract of a paper read before the Electrochemical Society. See *J.*, this volume, p. 558.—J. H. W.

**The Influence of the Composition and Acidity of the Electrolyte on the Characteristics of Nickel Deposits.** D. J. Macnaughtan, G. E. Gardam, and R. A. F. Hammond (*Trans. Faraday Soc.*, 1933, 29, 729-754).—The surface appearance and Brinell hardness of nickel deposited from sulphate solutions of different  $p_H$  containing one or more of the following: boric acid, potassium sulphate, potassium chloride, nickel chloride, have been examined and the results are shown in photographs and curves; the cathode efficiencies of the various electrolytes have also been determined. In all cases solutions of high  $p_H$  give the hardest deposits, reduction in  $p_H$  rapidly producing reduction in hardness until a critical  $p_H$  is reached. In solutions containing chlorides little change in hardness occurs below the critical  $p_H$ ; the deposit from such solutions containing potassium is harder than that from solutions free from this metal. In chloride-free solutions, however, the hardness of the deposits rises with reduction in  $p_H$  below the critical value, and eventually reaches a well-defined maximum, after which further reduction in  $p_H$  produces softer plates especially when potassium is present. That the great hardness of deposits from high  $p_H$  solutions is due to the occlusion of basic material has been confirmed, but no direct relation can be found between the hardness and the amount of hydrogen discharged. It is suggested that the basic material is first formed in the colloidal state by depletion of hydrogen ions from the liquid around the cathode and is positively charged so that it migrates towards the cathode and is deposited on the crystal faces, thereby restraining grain growth, and thus causing a hard fine-grained deposit to be formed. Negatively charged anions tend to flocculate the basic material, and the resulting neutral precipitate is either swept into the body of the solution and there dissolved, or remains as an obstructive or semi-permeable membrane in the neighbourhood of the cathode. Chloride ions have a greater flocculating effect than sulphate ions, whilst potassium ions tend to oppose flocculation. In the absence of chloride ions the flocculated precipitate appears to hinder the free movement of the solution, and thus promotes formation of more colloid; this effect is less when potassium is present. The action of these phenomena in determining the hardness of the deposits at various  $p_H$  values is critically discussed. Pitting appears to be associated with the absence of potassium and the presence of chloride, and to depend on the  $p_H$  of the solution, never appearing when the  $p_H$  is less than 2.6; it reaches a maximum in the  $p_H$  range in which the greatest quantity of flocculated matter is produced. The influence of chloride in stimulating, and potassium ions in inhibiting, pitting is thus clearly associated with their respective actions in flocculating and stabilizing the basic material.—A. R. P.

**Scientific Control of Electro-Deposits of Nickel and Chromium in Industry.** M. Ballay (*Chim. et Ind.*, 1930, Special No. (March), 253-262).—See abstract from another source, this *J.*, 1931, 47, 41.—S. G.

**Practical Plating. The Deposition of Nickel-Solutions.** E. A. Ollard (*Met. Ind. (Lond.)*, 1933, 43, 377-378).—The use of a knowledge of the  $p_H$  value and the nickel ion concentration in the control of nickel plating solutions is explained. See *J.*, this volume, p. 558.—J. H. W.

**Deposition of Nickel-Cobalt Alloys.** S. A. Pletencw and W. W. Kuznetzova (*Met. Ind. (Lond.)*, 1933, 42, 598).—Short abstract from *Z. Elektrochem.*, 1933, 39, 201-204. See *J.*, this volume, p. 312.—J. H. W.

**Discussion on the Electrodeposition of Palladium.** — (*Met. Ind. (Lond.)*, 1933, 43, 203-204).—Summary of the discussion of a paper by R. H. Atkinson and A. R. Raper, read before the Electrodepositors' Technical Society. See *J.*, this volume, p. 509.—J. H. W.

**Recent Advances in the Electrolytic Deposition of the Platinum Metals.** Anon. (*Oberflächentechnik*, 1933, 10, 201-202).—A review of recent German, American, and British patents dealing with platinum-, palladium-, and rhodium-plating.—A. R. P.

**A New Method of Testing Plating Baths and Its Application to Silver- and Copper-Plating.** K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1933, 7, 37-44).—The wearing qualities of electrolytic deposits may be determined by measuring the quantity of sand which, when allowed to fall in a thin stream on a flat plate, just causes the base metal to be exposed. The sand, which should pass a 30 mesh but be retained on a 50 mesh, is placed in a funnel provided with a long tube terminating just above the plate, which is inclined at an angle of 45°. Tests on silver-plates produced from baths of varying composition under various conditions have shown that the proportion of free cyanide and alkali carbonate, and considerable variations in the temperature have practically no effect on the rate of wear of the plate; high current density gives a slightly harder plate, but substitution of sodium salts for potassium salts is without effect. With a current density of 2 amp./dm.<sup>2</sup> increase in the free acidity of sulphate copper-plating baths from 0 to 30 gm./litre decreases the rate of wear by about 30%; reduction of the current density, however, reduces the resistance to wear.—A. R. P.

**Silver Plating of Alloys Containing Phosphorus. A Contribution to the Question of Electrolytic Degreasing.** — Moser, K. W. Fröhlich, and E. Raub (*Metall u. Erz*, 1933, 46, 562-565).—In melting 830-fine silver alloys in Germany phosphor-copper is almost invariably used as deoxidizer, and frequently as much as 0.1% phosphorus is left in the alloy. When examined under the microscope, this phosphorus is seen to be present as the ternary silver-copper-copper phosphide eutectic regularly distributed as minute particles along the grain boundaries. After fabrication of the metal into articles, the general practice is to silver-plate to produce a high-quality finish; frequently this plate is exceedingly porous and badly adherent. The cause of this trouble has been traced to the action of nascent hydrogen, produced in the electrolytic degreasing vat, on the phosphide eutectic; hydrogen phosphide is evolved and the surface becomes pitted, and these pits entrap gas which produces the pores in the plate. Satisfactory plating can be obtained if the articles are degreased by boiling in an alkali cleaner or brushed with an alkaline solution without the use of a current.—A. R. P.

**New Facts in the Field of Silver-Plating.** Anon. (*Oberflächentechnik*, 1933, 10, 165-167).—A review of recent work.—A. R. P.

**The Nature of Spongy Zinc Deposits Obtained by the Electrolysis of Aqueous Solutions of Zinc Sulphate.** W. S. Sebborn (*Trans. Faraday Soc.*, 1933, 29, 825-829).—The formation of spongy zinc deposits during the deposition of zinc from sulphate solutions is connected with the production of zinc hydroxide at the cathode. Thus under conditions which produce a spongy deposit on a vertical cathode coherent deposits are obtained on a horizontal cathode in a still solution, since any zinc hydroxide formed is then kept from contact with the metal by the surface effect of hydrogen bubbles. Analysis of the spongy metal showed it to contain about 80% of zinc metal, the remainder being zinc oxide, hydroxide, basic carbonate, and basic sulphate. These facts support the theory of Förster and Günther that sponge formation is due to formation of zinc hydroxide by reaction of zinc ions with hydroxyl ions at the cathode, and the subsequent occlusion of the hydroxide in the deposit whereby crystal growth is retarded. The production of spongy deposits is favoured by a high current density and by a low metal concentration.—A. R. P.

**Zinc or Cadmium Plating.** S. Wernick (*Galvano*, 1932, (3), 19-25).—Translated from *J. Electroplaters' and Depositors' Tech. Soc.*, 1931, 6, 129-152. See this *J.*, 1931, 47, 357.—E. S. H.



**New Electrolytic Deposits.** H. Krause (*Feinmechanik u. Präzision*, 1933, 41, 106-108; *C. Abs.*, 1933, 27, 4486).—A review. Platinum, palladium, gold, silver, rhodium, indium, molybdenum, tungsten, &c., are used. Rhodium deposits are recommended where hardness is of importance. It is best deposited from a sulphate bath containing 1 gm. rhodium per litre, and requiring 4-6 v.; it develops a noxious mist. Molybdenum is deposited from a solution of 10 gm. ammonium molybdate and 10-20 gm. ammonium nitrate in 1 litre of water, with 0.2-0.3 amp./dm.<sup>2</sup> at about 2 v.; a fine black deposit is obtained.—S. G.

**Specifications for Electrodeposits.** Marcel Ballay (*Aciers spéciaux*, 1933, 8, 240-257).—The specifications of electrodeposits which may be required by a user are considered, and in particular: the quality of the deposits, their adherence, their thickness, methods of solution of copper, nickel, chromium, silver, zinc, and cadmium deposits, porosity, corrosion resistance, their hardness and fragility, and standard commercial specifications.—J. H. W.

**On the Measurement of the Throwing Power of Plating Baths.** A. Onitchenko (*Z. Elektrochem.*, 1933, 39, 815-818).—The efficiency of plating baths as regards throwing power and ability to fill cavities and produce an adherent metal deposit is discussed. A simple method of accurately and quickly determining these properties and the factors governing throwing power are described.—J. H. W.

**Cleaning in Acids before Electrodeposition.** [Clayton M. Hoff] (*Galvano*, 1932, (5), 23-27).—Translated from *Brass World*, 1931, 27, 129-131. See this *J.*, 1931, 47, 496.—E. S. H.

## VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition and Electro-Refining.)

(Continued from p. 642.)

**The Electro-Deposition of Beryllium.** Anon. (*Metallurgist* (Suppt. to *Engineer*), 1933, 9, 50-52).—A review of the methods of production of beryllium by fusion electrolysis above 500° C. from a bath of beryllium and sodium fluorides, on to a copper cathode. Heat-treatment leads to the gradual diffusion of the beryllium throughout the mass with the formation of a homogeneous alloy.—R. G.

**The Deposition of Beryllium on Copper and Other Metals in Fused Electrolytes.** H. Fischer and W. Schwan (*Metallwirtschaft*, 1933, 12, 187-189).—An adherent film of beryllium can be deposited on copper by electrolysis at 800° C. of a 3:1 molecular mixture of beryllium and sodium fluorides. Ammonium fluoride is added to the bath during melting to ensure expulsion of the last traces of water. The current yield falls if the temperature is raised or lowered or if the current density is above 1000 amp./dm.<sup>2</sup>. The deposited film first consists of a copper-beryllium alloy but the copper content decreases as the film thickens, until, when pure beryllium begins to be deposited, the film no longer is adherent but becomes powdery.—v. G.

**Production of Oxygen-Free Electrolytic Copper.** Anon. (*Met. Ind. (Lond.)*, 1932, 40, 617).—Abstracted from *Metallwirtschaft*, 1932, 11, 68. Cf. *Met. Ind. (Lond.)*, 1932, 40, 637).—J. H. W.

**Faraday and His Electrochemical Researches.** R. S. Hutton (*Met. Ind. (Lond.)*, 1933, 43, 329-330, 379-380).—See *J.*, this volume, p. 561.—J. H. W.

## VIII.—REFINING

(Continued from p. 643.)

**The Electrolytic Refining of Mercury.** E. Newbery and S. M. Naude (*Met. Ind. (Lond.)*, 1933, 43, 415-418).—Summary of a paper read before the Electrochemical Society. See *J.*, this volume, p. 562.—J. H. W.

## IX.—ANALYSIS

(Continued from pp. 644-649.)

**The Most Important Advances in Analytical Chemistry in the Past Year.** R. Fresenius (*Angew. Chem.*, 1933, 46, 615-618).—A review with especial reference to new methods of detecting and determining the metals.—A. R. P.

**New List of Standard Samples.** Anon. (*J. Franklin Inst.*, 1933, 215, 486).—A supplement to the *U.S. Bur. Stand. Circ. No. 25*, contains a new list of standard samples for use in chemical analyses. A number of non-ferrous alloys is included.—S. V. W.

**Some Practical Applications of X-Ray Analysis.** V. E. Pullin (*Met. Ind. (Lond.)*, 1933, 43, 393; discussion, 393-394).—Abstract of a paper read before the Midland Metallurgical Society. The principles underlying X-ray analysis and the practical applications of this method to the analysis of metals and alloys are briefly described.—J. H. W.

**Spectrographic Recognition of Small Quantities, "Traces" [of Impurities in Metals].** Walther Gerlach (*Angew. Chem.*, 1933, 46, 557-562).—The use of the spectrograph in detecting traces of impurities in "commercially pure" metals is described with reference to specific examples. The purest platinum obtainable shows two very faint copper lines, but ordinary chemically pure platinum shows the lines of copper, silver, palladium, rhodium, nickel, and, if it has been melted on lime, calcium. All commercial qualities of pure aluminium contain silver, cadmium, copper, chromium, iron, gallium, manganese, nickel, lead, silicon, titanium, vanadium, and zinc; German aluminium is particularly rich in gallium, Italian in titanium, and American frequently contains scandium.—A. R. P.

**Quantitative X-Ray Analysis of Iron Alloys.** S. Shimur and M. Takasu (*J. Iron Steel Inst. Japan*, 1930, 16, 961-970; *Brit. Chem. Abs.*, 1932, [B], 26).—[In Japanese.] With Fe-Mn-Ni alloys the results were largely in error (Mn 0-25%, Ni 0.5-15%).—S. G.

**Studies on Eliminating the Effects of  $PO_4$ -Radical in Qualitative Analysis.**—I. Saburo Ishimaru (*Kinzoku no Kenkyu*, 1933, 10, 423-430).—[In Japanese, with English abstract.] The precipitation of  $PO_4^{3-}$  with  $Fe^{3+}$  salt is preferred to precipitation with  $Pb^{2+}$  salt.—A. R. P.

**Analysis of Tin, Antimony, Lead, Bismuth Alloy.** Gordon Abbey (*Chemist-Analyst*, 1933, 22, (4), 14-15).—For alloys containing 10-30% Sn, 30-40% Pb, and 30-40% Bi the Sn is determined by titration with  $NaIO_3$ , and the Sb with  $KMnO_4$ . The Pb is determined gravimetrically as sulphate, and the Bi in the filtrate from the  $PbSO_4$ .—A. R. P.

**Method for the Determination of Bismuth in Refined Lead.** J. E. Hendrick (*Chemist-Analyst*, 1933, 22, (4), 15).—Double precipitation of  $BiOCl$  is recommended using a 25 grm. sample of Pb.—A. R. P.

**Determination of Calcium in Lead-Calcium Alloys of Low Calcium Content.** Beverly L. Clarke and Leland A. Wooten (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1933, 5, 313-315).—The Pb (20 grm.) is dissolved in 100 c.c. of 1:3  $HNO_3$  and the Pb precipitated with 20 c.c. of 1:1  $H_2SO_4$ . The filtrate (150-175 c.c.) is neutralized with  $NH_4OH$ , and 15 c.c. excess of  $NH_4OH$  are added, followed, after filtration, by 30 c.c. of 95%  $C_2H_5OH$  and 2 grm. of  $(NH_4)_2C_2O_4$ ; after boiling for 3 minutes and cooling to 45°-55° C., the  $CaC_2O_4$  is collected in a porous glass crucible, washed first with 1%  $(NH_4)_2C_2O_4$ , then with  $NH_4OH$ , and dissolved in  $H_2SO_4$  for titration with  $KMnO_4$ .—A. R. P.

**Determination of Lead, Copper, and Manganese in Manganese Bronze.** James Brinn (*Chemist-Analyst*, 1933, 22, (2), 14-15).—Pb is determined as  $PbSO_4$ , Mn by precipitation with  $(NH_4)_2S_2O_8$  and conversion into  $Mn_2P_2O_7$ , and Cu by electrolysis.—A. R. P.



**Detection and Determination of Lead in [Tinplate] Preserving Cans.** — Cheftel (*Ann. Falsif.*, 1932, 25, 156-157; *Brit. Chem. Abs.*, 1932, [B], 606).—In testing for Pb in tinplate, C. emphasizes the great importance of ensuring that very minute droplets of Pb solder, sometimes far removed from the seams, are not included in the test-sample. It is recommended first to search the selected surface with a lens, then to heat the tinplate over a small flame, and scrape with a nickel knife. For analysis, 20 mg. of such metallic dust are evaporated with 2 c.c. of concentrated HNO<sub>3</sub>. The process is thrice repeated and the residue taken up with H<sub>2</sub>O, filtered from metastannic acid, and the Pb in the filtrate determined in the usual way.—S. G.

**Tantalum and Columbium [Niobium] Cathodes vs. Platinum Cathodes for Electro-Analysis.** D. F. Calhane and C. Malcolm Alber (*Trans. Electrochem. Soc.*, 1933, 63, 173-179).—See this *J.*, 1933, 53, 316.—S. G.

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

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

(Continued from pp. 649-650.)

**A Thermocouple Potentiometer.** A. Egerton and A. R. Ubbelohde (*J. Sci. Instruments*, 1933, 10, (10), 310-311).—This instrument is of the type in which the greater part of the e.m.f. of the thermocouple is balanced against a known p.d. which can be varied in steps, and the small residual e.m.f. read on a sensitive millivoltmeter. The known p.d. are obtained by mounting twelve or more copper-Constantan thermo-couples in series, with the hot and cold junctions in two accurately controlled thermostats. The temperature difference of the thermostats is adjusted so that the e.m.f. of each copper-Constantan element corresponds with 100° C. of the main couple. In order to keep the resistance in the circuit constant, copper resistances equal to those of the Constantan elements are automatically cut out as the latter are inserted.  
—W. H.-R.

**Temperature Measuring and Regulating Instruments.** A. Grunwald (*Siemens Rev.*, 1933, 9, (2), 32-37).—Reviews the Siemens instruments for temperature measurement and regulation. Mention is made of "Sinterkorund," (sintered corundum), a pure aluminium oxide, fired at 1800° C. by a special process and used for thermocouple protective tubes. See *J.*, this volume, p. 656.—R. Gr.

**Universal Chamber for X-Ray Photographs.** K. V. Vasil'ev (*Trans. Inst. Econ. Mineral (U.S.S.R.)*, No. 55, 1932, 20-31; *C. Abs.*, 1933, 27, 4444).—[In Russian.] The tube of the Debye-Scherrer type is adopted for taking exposure by different methods. The Debye chamber is enlarged to permit exposures by the Laue method, while the insertion of a watch mechanism permits rotation of the crystal during the exposure. All diaphragms are demountable and the object might be located at any desired position. It is possible to use either the transmitted or reflected rays.—S. G.

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## XI.—PHYSICAL AND MECHANICAL TESTING AND RADIOLOGY

(Continued from pp. 651-656.)

**Energy Loss Testing of Magnetic Materials Utilizing a Single Strip Specimen.** C. Dannatt (*J. Sci. Instruments*, 1933, 10, 276-285).—Describes a method for measuring the energy loss in magnetic materials under alternating magnetization. The tester takes a specimen 12 in. long with a maximum of 4 in. wide.

The chief advantage compared with other methods is that the actual quality of a single piece is obtained, instead of the average quality of a number of pieces in parallel, so that studies of the effect of direction of rolling, variation in properties with sheet position, &c., may be rapidly and accurately made. The small size of the specimen makes the method useful in metallurgical research. The theory of the method is given in the appendices.—W. H. R.

**On the Problem of the Fatigue Limit with Polyaxial Stresses.** K. Hohenemser and W. Prager (*Metallwirtschaft*, 1933, 12, 342-343).—Fatigue tests are described with a machine by means of which thin-walled tubes can be submitted simultaneously to (a) alternating and static tensile or compression stresses, or (b) alternating and static torsional stresses and static internal pressure.—v. G.

**The Deep-Drawing Test.** A. Krecek (*Metallwirtschaft*, 1933, 12, 189-192).—A modification of the Erichsen test is described, and the influence of the width of the test-piece on the values obtained has been determined.—v. G.

**A New Method for the Measurement of the Modulus of Elasticity.** P. Le Rolland and P. Sorin (*Metallurgist* (Suppt. to *Engineer*), 1933, 9, 63-64).—A summary of a paper by Le R. and S. (*Rev. Mét.*, 1933, 30, 112-116). See *J.*, this volume, p. 518.—R. G.

**Hardness Testing of Metallic Structural Materials.** Johann Gieth (*Werkstatt u. Betrieb*, 1933, 66, 316-321).—Existing methods of hardness testing are classified as follows: static and dynamic impression methods, impact and rebound tests, and scratch-hardness testing. A description is given of the best-known processes, with some remarks as to the special applicability of each. Brinell hardnesses for a 3000-kg. load and 10 mm. diam. ball are tabulated for a variety of ferrous and non-ferrous materials; a series of scratch-hardness values on the Mohs and Martens scales is also given.—P. R.

**Hardness Values for Electrochemical Products.** Raymond R. Ridgway, Archibald H. Ballard, and Bruce L. Bailey (*Trans. Electrochem. Soc.*, 1933, 63, 369-392; discussion, 392-393).—See this *J.*, 1933, 53, 375.—S. G.

**Simplified Hardness Tester.** Anon. (*Canad. Mach.*, 1933, 44, (10), 36).—See *J.*, this volume, pp. 568, 569.—P. M. C. R.

#### RADIOLOGY

**Radium in Engineering Practice.** V. E. Pullin (*Proc. Inst. Mech. Eng.*, 1933, 124, 305-322; and (summaries) *Engineer*, 1933, 155, 304-306; *Engineering*, 1933, 135, 340-342; *Met. Ind. (Lond.)*, 1933, 42, 320; *Machinery (Lond.)*, 1933, 41, 763-766; *Mech. World*, 1933, 93, 340-344; *S. African Eng.*, 1933, 44, 87).—The use of  $\gamma$ -rays from radium for the detection of flaws in castings is described, and the apparatus is illustrated together with typical photographs. With specimens up to about 3 in. in thickness, X-ray radiology is much more suitable than radium except where the specimen must be radiographed *in situ*, and is mounted in an inaccessible position. For thick specimens radium has many advantages, especially where the thickness of the sample varies greatly.—W. H. R.

**The Physics of Röntgen Rays as the Basis of X-Ray Testing.** W. E. Schmid (*Arch. teck. Messen*, 1932, 2, 116).—A summary of the source and properties of X-rays, their detection, and their applications to the testing of materials to the investigation of crystal structure, and to spectroscopic analysis.—P. R.

**X-Ray Testing of Castings in Dock.** — Schatzmann (*Werft, Reederei, Hafen*, 1933, 14, 207-209).—An illustrated account of the work of an X-ray testing installation at Wilhelmshaven.—P. M. C. R.

**Radiographic Examination of Pressure Vessels.** R. E. Hiller (*Indust. Gases*, 1933, 14, 102-106).—From *Iron Age*, 1933, 131, 736-739; see *J.*, this volume, p. 375.—H. W. G. H.



## XII.—PYROMETRY

(Continued from p. 656.)

**Thermo-Elements.** Georg Keinath (*Arch. tech. Messen*, 1932, 2, 1156).—A summary of the principle of the thermo-couple is followed by a discussion of the factors influencing the selection of an element. Comparative curves show the influence of temperature on e.m.f. in elements composed of platinum with Constantan, Kahlbaum nickel, steel, iron, copper, carbon, and chrome-nickel. A thermoelectric table of metals in relation to platinum is given, and suitable couples are recommended for temperatures ranging from below 800° C. to about 2400° C. The merits of thermocouples are summarized.—P. M. C. R.

**Partial Radiation Pyrometers.** Anon. (*Arch. tech. Messen*, 1932, 2, (15), 120).—Four types of proprietary pyrometer of the "glowing wire" type, and one of the cross-wire type, are described, with an account of their special uses and adaptations.—P. M. C. R.

**The Ardometer.** Anon. (*Arch. tech. Messen*, 1932, 2, (16), 122).—See this *J.*, 1932, 50, 492, 757.—P. M. C. R.

**Tube Protectors for Pyrometers.** Georg Keinath (*Arch. tech. Messen*, 1932, 2, (18), 1185).—Pyrometer protectors should themselves evolve no harmful gases on heating. They should be gas-tight, good conductors of heat, be of sufficient mechanical strength, be unaffected by rapid changes of temperature, and be stable at high temperatures. K. considers that no protective material is perfectly satisfactory above 1200° C., the necessary combination of qualities being achieved by the concentric use of 2 or more protectors. Among metallic protectors, K. considers copper, bronze, Monel metal, cast iron, Armco, enamelled iron, Calorized and "Alitized" iron, ferro-chromium alloys, nickel, nickel-chromium, and nickel-chromium-iron alloys; for inner tubing, the properties of quartz, porcelain, alundum, and sinter-corundum, are considered. Ceramic materials for outer tubes are carborundum, graphite, and fireclay. Appropriate temperature ranges are indicated.—P. M. C. R.

**Tube-Protectors for Pyrometers: Measurement of Penetrability by Gases.** Georg Keinath (*Arch. tech. Messen*, 1932, 2, (15), 1138).—Adapted from a contribution by W. F. Roesser to the *U.S. Bur. Stand. J. Research*, 1931, 7, 485-494. See this *J.*, 1931, 47, 587.—P. M. C. R.

## XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 657-660.)

**Non-Ferrous Metals in the Foundry.** C. Edward Williams (*Met. Ind. (Lond.)*, 1933, 42, 664-665).—Summary of the Presidential Address to the Institute of British Foundrymen.—J. H. W.

**Graphical Solution of Technical Melting Calculations.** Alfred Köster (*Metall u. Erz*, 1933, 30, 406-408).—Graphical methods are given for making up binary or ternary alloys of a predetermined composition from mixtures of similar alloys of different compositions.—A. R. P.

**Metals Melted in a Vacuum.** Anon. (*Metallurgist (Suppt. to Engineer)*, 1933, 9, 62).—A review of a commemorative volume "Heraeus Vacuum-schmelze" (published by the German firm Heraeus Vacuum-schmelze A.G.), referring particularly to the contribution by W. Rohn on the development of vacuum melting on a commercial scale, and those describing the properties of the materials produced. [Abstracts of the papers published in this volume have already been published in this *J.*]—R. G.

**Runners and Risers.** T. R. Harris (*Found. Trade J.*, 1933, 49, 151-152).—The functions of runners and risers are discussed and typical examples from practice are described.—J. H. W.

**Porosity.** Thomas E. Green (*World Power*, 1933, 19, 114-115).—A short general article on the subject which on the whole tends to present an exaggerated view of the troubles caused by porous castings.—S. V. W.

**Principal Factors in the Castability of Metals.** A. Portevin and P. Bastien (*Usine*, 1932, 41, (11), 29).—Summary of a paper read before the Académie des Sciences. See this *J.*, 1932, 50, 329.—R. B. D.

**Castability of Alloys. Relation to the Freezing Range.** A. Portevin and P. Bastien (*Usine*, 1932, 41, (13), 27).—Abstract of a paper read before the Académie des Sciences. See this *J.*, 1932, 50, 329, 708.—R. B. D.

**Precautions to be Observed in the Design of Sand-Cast and Machined Components.** A. F. C. Pollard (*J. Sci. Instruments*, 1933, 10, 265-272).—The design of apparatus and instruments is discussed to show how difficulties in casting and machining may be overcome, and labour costs lowered. The importance of avoiding complicated shapes in castings is emphasized; two or three simple forms to be bolted together are preferable to one complicated casting. The relative thicknesses of different parts of the casting and their effect on internal strains set up in cooling are discussed. In the design of machined components, complicated shapes should again be avoided if they imply difficulty in holding the work in the machine tool, inaccessibility of machined faces, a number of parallel machined faces at different levels, &c. A common fault is that of not allowing sufficient "landing space" for tools. Examples of bad design are given.—W. H.-R.

**Removal of Gases and Other Impurities from Aluminium and Its Alloys with the Aid of Aluminium Chloride in Combination with Other Salts.** —Steinhäuser (*Metallwirtschaft*, 1933, 12, 284-285).—Technical aluminium can be freed from gases and slag by stirring the molten metal with a small quantity (about 1%<sub>100</sub>) of mixture of 2 parts of aluminium chloride and 1 part of sodium chloride, provided that the crucible is completely dry. The process is effective only with charges not exceeding 150 kg.—v. G.

**Small Aluminium Hand Wheels Cast in Chill Moulds.** Anon. (*Z. ges. Giesserei-Praxis: Das Metall*, 1933, 54, 368-369).—The casting of aluminium hand wheels in chill moulds is described. The moulds are made of nickel grey cast iron and are preheated to 120°-180° C. The aluminium alloy is made up of 85% aluminium (99.6% fine) and 15% of a 50:50 copper-aluminium alloy, and is melted in a crucible furnace, the pouring temperature being 720°-760° C. Silumin (Alpax) can also be used for this purpose, but the casting temperature is then higher (about 780°-840° C.).—J. H. W.

**A New Casting Process for Aluminium.** K. Thomas (*Stahl u. Eisen*, 1933, 53, (28), 741).—An abstract of a paper by Kessner, *Metallwirtschaft*, 1932, 11, 583-584. See *J.*, this volume, p. 40.—J. W.

**Gases and Cast Aluminium Alloys.** H. Nipper (*Met. Ind. (Lond.)*, 1933, 42, 618).—Abstract of a paper in *Z. Metallkunde*, 1933, 25, 65-67; see *J.*, this volume, p. 326.—J. H. W.

**Process for Producing High-Quality Large Castings of Aluminium Light Alloys.** W. Claus (*Found. Trade J.*, 1933, 48, 378).—Reproduction of an abstract in *Light Metal Research*, 1933, 2, (24), 8. See *J.*, this volume, p. 377.—J. H. W.

**Casting of Aluminium Billets for Rolling.** P. Pontremoli (*Usine*, 1931, 40, (43), 31-33).—Long abstract of a paper presented to the 6e. Congrès International de Fonderie. See this *J.*, 1932, 50, 195.—H. W. G. H.

**Properties of Aluminium Castings as a Function of Casting Temperature. Cooling Conditions, and Dissolved Gas.** M. Barbero (*Usine*, 1931, 40, (43), 31).—Long abstract of a paper presented to the 6e. Congrès International de Fonderie. See this *J.*, 1932, 50, 195.—H. W. G. H.



**Effect of Melting Loss on the Cost of Copper Alloys.** G. d'Ardigny (*Rev. Fonderie moderne*, 1933, 27, 231-232).—The cost of copper alloy ingots can be calculated from the formula :

$$p = c \cdot \frac{(1-l) + f\left(l + \frac{M}{Pn}\right)}{(1-l)(1-f)}$$

where  $l$  = coefficient of sound ingots,  $n$  = number of ingots,  $P$  = weight of an ingot,  $c$  = mean price of unit weight of material charged in,  $f$  = melting loss per cent. of the metal charged,  $M$  = weight of the feeding head, &c., and  $p$  = the cost of a good ingot.—J. H. W.

**A New Casting Machine for the Manufacture of Copper Anode Plates and Copper Bars.** Anon. (*Z. ges. Giesserei-Praxis: Das Metall*, 1933, 54, 367-369).—Abstracted from *Demag-Nachrichten*, 1933, July. The casting machine consists of horizontal moulds of the required shape arranged on the circumference of a turn-table. The moulds are brought under the casting ladle as desired. The various devices connected with the machine are described.

—J. H. W.

**Aluminium Bronze Parts Cast in Permanent Moulds.** E. Griffith (*Machinist (Eur. Edn.)*, 1933, 77, 616-617).—The mechanical properties of aluminium bronze and details of casting the alloy in permanent moulds are described with examples.—J. H. W.

**Melting and Casting of Lead-Rich Copper Alloys.** Werner Fröhlich (*Chem. Zeit.*, 1933, 57, 741-742).—The composition and various methods of producing homogeneous castings of lead bearing bronzes are discussed.—A. R. P.

**Some Notes on Phosphor-Bronze.** R. C. Stockton (*Met. Ind. (Lond.)*, 1933, 43, 391-392).—Some difficulty may be experienced in producing sound castings in phosphor-bronze owing to incorrect casting temperature, bad arrangement and shape of runners and risers, bad moulding and melting practice, and to poor design of castings. These result in porosity, drawn parts, gas holes, and included oxides. The precautions for obviating each of these defects are given.—J. H. W.

**Phosphorus Bronze.** Alfred Hopwood (*Met. Ind. (Lond.)*, 1933, 43, 449).—A letter criticizing statements in R. C. Stockton's paper (preceding abstract). Low tin and phosphorus bronzes are easier to handle than those of higher tin and phosphorus content, and porosity cannot readily be overcome by control of casting temperature. The difficulty of founding these alloys lies in their exceptionally long freezing range and their type of structure. The practice of raising the casting temperature for a mould containing chills is deprecated. An initial minimum temperature of 150° C. for the chills is considered too high. Precautions to prevent dross formation are not required, and centrifugal casting is recommended to solve the problem of porous heavy castings, especially in high phosphorus bronze.—J. H. W.

**Manufacture of Propellers.** Wesley Lambert (*Syren and Shipping*, 1933, 146, 332).—Abbreviated from a paper read before the Institute of Engineering Inspection. See *J.*, this volume, p. 378.—P. M. C. R.

**Casting a Bronze Rod, 90 mm. Diameter and 3000 mm. Long.** Anon. (*Z. ges. Giesserei-Praxis: Das Metall*, 1933, 54, 391).—The moulding, gating, and casting of a long bronze rod in a vertical dry-sand mould are described. The rod was very porous for a depth of 3 mm. over half its length, but the centre was quite free from pores.—J. H. W.

**New Demands on the Bronze Foundry.** J. Arnott (*Rev. Fonderie moderne*, 1933, 27, 225-227).—Abstracted from *Found. Trade J.*, 1933, 48, 27-28. See *J.*, this volume, p. 378.—J. H. W.

**A Cost Analysis of Zinc-Base Die-Castings vs. Machined Castings.** L. H. Morin (*Met. Ind. (N.Y.)*, 1933, 31, 168-169); **Size Limits of Brass and Other Die-Castings.** L. H. Morin (*Iron Age*, 1932, 130, 803-804).—From a paper

read before the American Society of Mechanical Engineers. Comparative cost data are given. See *J.*, this volume, p. 381.—A. R. P.

Composition of Typical Die-Casting Alloys. Physical Properties and Applications of Die-Casting Alloys. Anon. (*Machinery* (N.Y.), 1933, 39, 440A).—Tabulated data based on paper by Louis H. Morin read before the American Society of Mechanical Engineers. See *J.*, this volume, p. 381, and preceding abstract.—J. C. C.

Successful Finishing of Die-Castings. Edgar Parkinson and Frank V. Faulhaber (*Found. Trade J.*, 1933, 48, 412, 418).—Abstract from *Iron Age*, 1933, 131, 783; see *J.*, this volume, p. 393.—J. H. W.

Shockless Jolt Moulding Machine with Pneumatic Pressing Device and for High Lift Stroke. — Weil (*Met. Ind.* (Lond.), 1933, 43, 242).—See *J.*, this volume, p. 573.—J. H. W.

Some Properties of Oil-Sand Cores. C. Hansen (*Bull. Assoc. Tech. Fonderie*, 1932, 6, 27-31).—Summary of an address published in *Trans. Amer. Found. Assoc.*, 1926, 34, 577-607. See this *J.*, 1926, 36, 631.—W. N.

## XV.—FURNACES AND FUELS

(Continued from pp. 661-663.)

Some Factors Affecting Furnace Practice. R. J. Sargant (*Trans. Ceram. Soc.*, 1933, 32, 113-140).—An account of the properties of heat-resisting steels suitable for use in the construction of furnaces for low, medium, and high temperatures. Also a note on the storage of heat in furnace walls.—S. V. W.

Description of Electric Furnace Installations in an Aluminium Plant. H. Nathusius (*Electrowärme*, 1933, 3, 149-156; *C. Abs.*, 1933, 27, 4483).—Melting, hardening, and tempering furnaces in the plants of Brown-Boveri are described in detail. The charge for the melting furnaces amounts to 500-2000 kg. and consists of 19% pig aluminium, 22% bars from scrap, 42.5% sheet scrap (baled) and 16.5% other scrap; energy consumption is 430-500 kw.hr. per ton of aluminium and 250 kw. for a 2000 kg. charge. Continuous furnaces are used for the heat-treatment and heating of ingots and slabs.

—S. G.

A Simple Induction Furnace for Melting Copper Alloys. E. Fr. Russ (*Metallwirtschaft*, 1933, 12, 268).—A description is given of an induction furnace with iron core and a ring-shaped melting channel for melting 100 kg. of copper alloy using 35 kva. The current consumption in melting brass or bronze is about 25 kw.-hr./100 kg., and the loss of metal by burning is only 1-2.5%.

—v. G.

Operation and Temperature Regulation of Electric Furnaces with Current Rectifiers. — Büchting and H. Klempere (*Siemens Z.*, 1933, 13, 300-303).—Description of the temperature regulator.—M. H.

Siemens Industrial Heating Exhibits at the Electric Heating Exhibition at Essen. Anon. (*Siemens Rev.*, 1933, 9, (2), 46-51).—Includes a description of furnaces for metallurgical work.—R. Gr.

The Construction and Application of Calrod Heating Units. I.—II.—The Calrod Unit. K. M. Cherry and F. E. Finlayson (*Gen. Elect. Rev.*, 1933, 36, 354-360, 411-415).—(I.—) Details are given of a new form of heating element known as Calrod. It consists of a nickel-chromium resistor insulated from a tubular sheath by means of magnesium oxide. The sheath material used depends on the conditions under which the heater will operate. Steel, brass, nickel-brass, Calorized steel, and stainless steel have been used for this purpose. The rating and form of the units are also varied according to the application. A major application is the melting of soft metals such as tin, solder, type metal, and tin. For this purpose a cast in type of unit is used. For most of the cast in type of units grey iron is used as the casting materials, although in special cases aluminium or copper has been used. A number of the cast in types are illustrated, and a number of special applications are



discussed. (II.—) Further particulars of the Calrod type of heating unit. Cartridge units and strip heaters such as are used mainly for domestic purposes are discussed.—S. V. W.

## XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 663-664.)

**Refractory Linings for Coreless Induction Furnaces.** H. Siegel (*Siemens Z.*, 1933, 13, 147-150).—Some experiences in the manufacture of crucibles for high-frequency furnaces are described.—M. H.

**The Testing of Refractory Materials.** W. Steger (*Arch. tech. Messen*, 1932, 1, (8), T20-T21).—A tabulated classification of refractories gives also the binding media usually employed with each. The following qualities are generally tested: chemical composition, resistance to heat (Seeger cone method), porosity, sp. gr., shrinkage, growth, compressive strength at room and at elevated temperatures, effect of high temperatures on material under load, resistance to abrupt changes in temperature, resistance to slagging, microstructure, penetrability by gases, liability to crumble, thermal expansion, specific heat, thermal conductivity, radiating power, and electrical resistance. Methods are indicated in each case. A bibliography is appended.—P. M. C. R.

**Some Notes on the Practice of Heat Insulation.** A. Lindsay Forster (*J. Inst. Fuel*, 1933, 6, 255-260; discussion, 261-265; and (abstract) *Mech. World*, 1933, 93, 504-506).—Representative costs of thermal energy derived from various fuels are tabulated. There is considerable need for specifying the insulating material to be used on plant; large amounts of inferior materials are still used. The use of these makes it possible to increase rather than reduce heat losses. Apparatus for the practical testing of insulation is briefly described. The characteristic properties of the insulators "Alfol" (a form of thin aluminium foil) and "glass silk" are discussed. Mattresses of glass silk are robust and keep their shape. A form of calorimeter for determining heat losses from insulation *in situ* is described.—J. S. G. T.

## XVII.—HEAT-TREATMENT

(Continued from pp. 664-665.)

**On the Heat-Treatment of Metal Strip in the Continuous Annealing Furnace.** O. Junker (*Z. Metallkunde*, 1933, 25, 45-49).—See *J.*, this volume, p. 276. The effects of variation of the furnace temperature, time of annealing, and rate of passage of the metal through an electric continuous annealing furnace and a laboratory furnace on the Erichsen number, elongation, tensile strength, and structure of 63:37 brass strip (0.4 mm. in thickness) have been determined. To obtain the highest Erichsen number the annealing temperature should be below the  $\alpha - (\alpha + \beta)$ -phase boundary (about  $640 \pm 20^\circ \text{C.}$ ), and the time of annealing should not be prolonged, otherwise a coarse-grained structure is formed. A number of works' experiences are described.—M. H.

**Heat-Treatment of Beryllium-Copper.** Edwin F. Cone (*Machinist (Eur. Edn.)*, 1933, 77, 620-622).—Precipitation-hardening is particularly effective for the beryllium-copper alloys. The cast alloys are held for at least 2 hrs. at a maximum temperature of  $1475^\circ\text{-}1500^\circ \text{F.}$  ( $800^\circ\text{-}815^\circ \text{C.}$ ), which results in the complete solution of the precipitated beryllides. After soaking, the casting is quenched in cold water as soon as possible, and will then have its maximum softness and elongation and minimum tensile strength. Precipitation-hardening which follows consists in heating the material to  $525^\circ\text{-}575^\circ \text{F.}$  ( $275^\circ\text{-}300^\circ \text{C.}$ ), but no higher, for various periods of time. The precautions to overcome distortion in thin or complicated sections, the physical properties of the cast, annealed, precipitation-hardened and rolled alloys containing 1.5-2.5% beryllium and the applications of the alloys, are given.

—J. H. W.

## XVIII.—WORKING

(Continued from pp. 665-668.)

**On a New Method for the Technical Working of Nickel.** G. Hamprecht and L. Schlecht (*Metallwirtschaft*, 1933, 12, 281-284).—A very pure nickel powder free from all traces of copper, arsenic, sulphur, and silicon, and containing less than 0.05% oxygen and carbon (which later are almost completely expelled as oxides of carbon) can be obtained by the thermal dissociation of nickel carbonyl. The grain-size of this powder is 0.0005-0.005 mm. Compact bodies can be made from it by sintering at 1200° C. for 2 hrs. in a closed container or by pressing and subsequent sintering in a protective atmosphere; these rods or sheets have a density of 6.5-7.5, and can be further consolidated by hot pressing, forging, or rolling. Annealed nickel made in this way has a yield-point of 12 kg./mm.<sup>2</sup>, a tensile strength of 40 kg./mm.<sup>2</sup>, elongation of 50%, reduction in area 80%, and Brinell hardness 90 kg./mm.<sup>2</sup>. Alloys with manganese, iron, and other metals can be prepared by addition of powders of these metals to the nickel prior to pressing. Owing to the absence of all impurities iron-nickel alloys prepared in this way have a high permeability and magnetic saturation. They can be accurately reproduced, which is important where a constant coefficient of expansion is required. Bimetals can be produced by using powders of two different metals in the pressing, and the process can also be adapted to welding.—v. G.

**Manufacture of Non-Ferrous Seamless Tubes by Piercing and Extrusion Methods.** Gilbert Evans (*Metallurgia*, 1933, 8, 167-170).—See *J.*, this volume, p. 389. The rotary piercer and the extrusion press are essential in the modern manufacture of seamless tubes, the first named for the production of tubes of large size, and the latter for tubes of smaller diameter. The practical phases of rotary piercing and of the extruding method of tube manufacture are reviewed, and include the Serck extrusion press, the Krupp vertical hydraulic extrusion press, and the movable container type of press. The extrusion of tubes by use of a movable mandrel and by use of a fixed mandrel are also discussed in detail. Brief reference is also made to pure technical phases of the methods adopted such as temperatures and velocities of extrusion.

—J. W. D.

**Modern Plants for Wire Drawing.—I.** K. Bernhoeft (*Z. Metallkunde*, 1933, 25, 125-127).—B. gives detailed directions for the establishment of plants and the construction of machines for the manufacture of rolled or extruded wire. The power requirements and drawing speeds (minimum and optimum) for the drawing of copper wire in different dimensions and reductions are tabulated.—M. H.

**Stress Distribution and Material Flow in the Roll-Gap.** Werner Lueg (*Stahl u. Eisen*, 1933, 53, 346-352).—Abstract of a paper by E. Siebel and W. Lueg, *Mitt. K.-W. Inst. Eisenforschung*, 1933, 15, 1-14. See *J.*, this volume, p. 276.—J. W.

**Cold Pressing of Screw Bolts.** W. Aumann (*Met. Ind. (Lond.)*, 1933, 43, 135).—Short abstract from *Z. Metallkunde*, 1932, 24, 200. See *J.*, this volume, p. 50.—J. H. W.

**Diamond as a Tool Material.** P. Grodzinski (*Arch. tech. Messen*, 1932, 1, (11), 779).—The varieties of diamond in use as tool materials are described; specific gravities are given, with hardness values on the Mohs and absolute scales. The applications of diamond in hardness testing are enumerated; it is employed in the Shore, Martens, Brinell (high values), Rockwell, and Herbert methods. A bibliography is given.—P. M. C. R.

**The Economic Uses of Cemented Carbide and Other High-Duty Alloy Tools.** J. H. Garnett and E. W. Field (*Machinery (Lond.)*, 1932, 41, 61-65, 97-100;



correspondence, 133).—An abstract of a paper to the Birmingham Branch of the Institution of Production Engineers. See *J.*, this volume, p. 668.—J. C. C.

**Free-Cutting [Brass].** Alan Morris (*Automotive Ind.*, 1933, 68, (13), 398).—Abbreviated from a paper, "Machinability of Free-Cutting Brass Rod," published in *Trans. Amer. Inst. Min. Met. Eng.*, 1932, 99 (Inst. Metals Div.), 323-330. See this *J.*, 1932, 50, 260, and this volume, p. 215.—P. M. C. R.

## XIX.—CLEANING AND FINISHING

(Continued from pp. 668-669.)

**Cleaning Metal Parts for Finishing.** Wm. J. Miskella (*Metal Cleaning and Finishing*, 1933, 5, 289-290, 298; *C. Abs.*, 1933, 27, 4514).—A general discussion of the open-tank method for cleaning metal products.—S. G.

**Methods of Cleaning Metals.** Joseph Geschelin (*Automobiletech. Z.*, 1933, 36, 383).—An abstract of two articles in *Automotive Ind.*, 1933, 68, 466-470, and 522-526; see *J.*, this volume, p. 584.—P. M. C. R.

**Finishing Aluminium.** Henry R. Power (*Metal Cleaning and Finishing*, 1933, 5, 301-302; *C. Abs.*, 1933, 27, 4510).—Blasting and finishing methods employed on aluminium are described in detail.—S. G.

**Coppering of Aluminium.** Anon. (*Cuivre et Laiton*, 1933, 6, 281).—From *Illustrierte Zeitung für Blechindustrie*, April 24, 1931. The piece is washed in luke-warm 20% caustic soda solution, then in water, and afterwards in a large bulk of sulphuric acid, followed by a further rinsing in water. The specimen is then immersed immediately in a solution of one part of copper chloride dissolved in 8 to 12 parts of water and heated to 50° C. An addition of 2 parts of potassium chloride favours the deposition of the copper. Plunging into an alcoholic solution of copper chloride tends to give greater adherence.

—W. A. C. N.

**Researches on Chlorate Colouring Baths.** H. Krause (*Mitt. Forschungsinst. Edelmetalle*, 1933, 7, 66-70).—In continuation of earlier work (see *J.*, this volume, p. 527) the effect on the colouring action of chlorate baths on copper and its alloys of additions of various metal sulphates has been determined.—A. R. P.

**Colouration of Metals by Sea-Water.** E. Beutel and A. Kutzelnigg (*Galvano*, 1932, (8), 26).—Translated abstract from *Inst. Technol.* See *J.*, this volume, p. 53.—E. S. H.

## XX.—JOINING

(Continued from pp. 669-675.)

**The Assembly of Steel Stampings by Continuous Furnace Brazing.** C. L. West (*Metal Stampings*, 1933, 6, 173-176).—The bronzing is effected in electric furnaces with controlled reducing gas atmosphere at temperatures ranging from 1400°-2100° F. (760°-1150° C.). Silver solders are used where a low melting temperature, 1400°-1600° F. (760°-870° C.), is necessary, but they are expensive. Brass wire and powder are used where a very strong bond is the prime consideration. The former is worked at 1740° F. (950° C.), and the latter at nearly 2000° F. (1095° C.). Copper is the best brazing medium, used as wire ribbon or powder, but it requires a temperature of 2100° F. (1150° C.), which increases maintenance costs. The preparation of the work and particulars of the brazing operation are described.—J. H. W.

**Soft Solder and Soldered Joints.** [S. J. Nightingale] (*Usine*, 1931, 40, (14), 33).—Long abstract from *Engineering*, 1930, 130, 794-797, of the

pamphlet published by the B.N.-F.M.R.A. in 1929. See this *J.*, 1930, 43, 647, 738.—H. W. G. H.

**On the Diffusion of Heavy Metals into One Another and of Aluminium into Zinc, Tin, and Their Alloys (a Contribution to the Kinetics of the Soldering Process).** A. Merz and E. Imbusch (*Metallwirtschaft*, 1933, 12, 295-297, 311-314).—The rate of diffusion of zinc and aluminium into liquid alloys has been measured with a view to elucidating the mechanism of soldering zinc and aluminium. The diffusion coeff. ( $K_D$ ) for zinc from a lead-tin-zinc alloy into a lead-tin alloy at 370° C. is 2.6 cm.<sup>2</sup>/day for a lead : tin ratio of 2 : 1, 2.6 for a 1 : 1 ratio, 3.4 for a 1 : 3 ratio, and 4.1 for a 0 : 1 ratio. For the diffusion of lead from a lead-tin alloy into pure tin at 325° C.  $K_D$  decreases from 2.1 with a 10 : 90 alloy to 1.6 with a 90 : 10 alloy, hence the lead concentration has relatively little effect on the rate of diffusion. For the diffusion of aluminium from a 40 : 60 aluminium-zinc alloy into pure zinc  $K_D$  increases linearly with the temperature from 3.4 at 610° C. to 4.8 cm.<sup>2</sup>/day at 710° C. For the diffusion of aluminium from a 14.5% aluminium-tin alloy into pure tin  $K_D$  rises linearly from 4.3 at 560° C. to 5.4 cm.<sup>2</sup>/day at 660° C. The values of  $K_D$  for the diffusion of aluminium from a liquid aluminium-tin-zinc alloy into a tin-zinc alloy are intermediate between the values for the pure metals given above and lie on a slightly concave curve. Thermal and dilatometric measurements have confirmed the absence of a transformation point in pure zinc.

—v. G.

**Aluminium Flux.** Anon. (*Metal Stampings*, 1933, 6, 220).—Oxweld aluminium flux serves the purposes of the 2 fluxes at present used, the one for welding pure aluminium and the other for aluminium alloys.—J. H. W.

**Some Economic Aspects of Welding Aluminium.** D. E. Roberts (*J. Amer. Weld. Soc.*, 1933, 12, (2), 18-20; also *Indust. Gases*, 1932, 13, 218-220; 1933, 14, 20; and *Welding Industry*, 1933, 1, 61-62).—See *J.*, this volume, p. 586.

—H. W. G. H.

**Welding Aluminium and Alloys.** J. R. Schmidgall (*J. Amer. Weld. Soc.*, 1933, 12, (4), 22-24).—Brief instructions for welding by metallic arc, oxy-acetylene, and oxy-hydrogen.—H. W. G. H.

**Repair of Aluminium Crankcases.** A. F. Davis (*J. Amer. Weld. Soc.*, 1933, 12, (3), 23).—A copper backing strip is clamped on the underside of the part to be welded.—H. W. G. H.

**Repair by Welding of a Cast Aluminium Motor Crank-Case.** J. Leemann (*Autogene Metallbearbeitung*, 1933, 26, 166-169).—A detailed description of the practice adopted.—H. W. G. H.

**The Repair of Aluminium Alloy Crank Cases.** Anon. (*Soudure et Oxy-Coupage*, 1933, 10, 173).—The particular technique necessary, useful hints, and the method of preheating are discussed.—H. W. G. H.

**Electric Welding of Aluminium.** [A. J. T. Eyles] (*Elektroschweissung*, 1933, 4, (3), 58).—Abstract of an article in *Elect. Rev.*, 1932, 110, 564, discussing arc, Arcatom, and resistance welding. See *J.*, this vol., p. 397.—H. H.

**Resistance Welding of Aluminium and Its Alloys.** D. I. Bohn and G. O. Hoglund (*Canad. Mach.*, 1933, 44, (10), 40).—Abstract of a paper read before the American Society of Mechanical Engineers. See *J.*, this volume, p. 587.

—P. M. C. R.

**Selection and Application of Welding Rods.** Stuart Plumley (*Welding*, 1933, 4, 63-67).—See *J.*, this volume, p. 403.—H. W. G. H.

**Belgian Welding Symbols.** Anon. (*Welding Industry*, 1933, 1, 107-108).—See *J.*, this volume, p. 675.—H. W. G. H.