METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

1933 JUNE Part 6

I.—PROPERTIES OF METALS

(Continued from pp. 226–232.)

On the Mechanical Properties of Aluminium Conductors. W. W. Usov (*Elektrichestvo* (*Electricity*), **1932**, (14), 727–731).—[In Russian.] The heating of aluminium strip to 80° C. lowers its mechanical strength in the hot state by about 10% but has no appreciable effect in the cold. Cables, owing to the greater degree of work-hardening, lose a greater degree of mechanical strength (25%). Heating to 200° C. causes a 30–50% loss in the hot state. Still greater heating of cables by short-circuit currents may lead to complete annealing.—N. A.

Thermal Expansion of Antimony. Peter Hidnert and H. S. Krider (*Phys. Rev.*, 1932, [ii], **42**, 911).—Abstract of a paper read before the American Physical Society. Measurements were made of the linear thermal expansion of 3 samples of cast antimony between room temperature and 560° C. and the data were correlated with available results obtained by previous investigators to 300° C. The minimum and maximum values for the coeff. of expansion of the 3 samples are given below :

Temperature Range, ° C.	Average Coeff. of Expansion per ° C.
20– 60	$8{\cdot}5$–$10{\cdot}8 \times 10^{-6}$
20–100	$8{\cdot}4$–$11{\cdot}0$
20–200	$8{\cdot}7$–$11{\cdot}3$
20–300	$9{\cdot}2$–$11{\cdot}4$
20–400	$9{\cdot}2$–$11{\cdot}5$
20–500	$9{\cdot}6$–$11{\cdot}6$
20–550	$9{\cdot}7$–$11{\cdot}0$

A report giving additional details and indicating the cause of the differences obtained in the expansion of different samples of antimony is being prepared for publication in *U.S. Bur. Stand. J. Research*.—S. G.

The Effect of Tension on the Electrical Resistance of Single Antimony Crystals. Mildred Allen (*Phys. Rev.*, 1933, [ii], **43**, 569–576).—The adiabatic tension coeff. of resistance of single antimony crystals has been determined for various orientations by a modification of the method previously used for bismuth (Allen, *J.*, this volume, p. 225). The curves connecting the coeff. with the primary and secondary orientations are of the same general type as with bismuth, since the symmetry is of the same nature. The 6 coeff. necessary to describe the effect of tension on resistance were determined from the experiments, and equations then derived to correct for the change in dimensions of the specimen produced by the tension. The coeff. for antimony when the tension and current are parallel to the trigonal axis and perpendicular to it are different both in magnitude and sign, whereas with bismuth the two were negative and nearly equal in magnitude.—W. H.-R.

Cerium. B. S. Hopkins (*Foote-Prints*, 1931, **4**, (2), 1–16).—The sources of supply, methods of extraction, and properties of the metal and its chief compounds are briefly described.—A. R. P.

A New Method for the Formation of Strain Figures on Copper Surfaces. Yogoro Kato and Nagao Hayami (*J. Electrochem. Soc., Japan*, **1932**, 90–97). —See this *J.*, 1932, **50**, 147.—S. G.

New Phenomena in the Change of [Electrical] Resistance of Bismuth Single Crystals in Magnetic Fields. O. Stierstadt (*Phys. Rev.*, 1933, [ii], **43**, 577–579).—The change of resistance of bismuth single crystals in magnetic fields has been studied in a new type of goniometer in which every desired configuration of current, field, and crystal axes could be obtained. Curves connecting the change of resistance $\frac{dW}{W}$ with ψ, the angle between current and magnetic field, are shown for a field of $H = 3000$ AW/cm. The curves are periodic, and are analyzed so as to give Fourier coeff., and it is claimed that one of these coeff. is due to a secondary structure of the crystal as distinct from the primary structure.—W. H.-R.

Chemistry of Indium. Alfred W. Downes and Louis Kahlenberg (*Electrochem. Soc. Preprint*, **1933**, May, 163–166).—The displacing power and electrode potentials indicate that indium is a little less noble than tin in the electrochemical series. The potential behaviour of indium resembles that of cadmium and is only very slightly affected by the presence of gases. Like tin indium acts as a hardener in alloys; it readily alloys with gallium, thallium, gold, lead, tin, cadmium, bismuth, mercury, and sodium. In hydrogen the metal becomes covered with a brown film of hydride which decomposes on heating above 330° C. and re-forms on cooling. Indium is very slightly oxidized by carbon dioxide above 560° C.—A. R. P.

Mesothorium. Herman Schlundt (*Foote-Prints*, 1931, **4**, (1), 1–16).—The method of extracting mesothorium from monazite sand is described and an account is given of its radioactive properties and degradation products.—A. P.

The Electrical Resistance between 160° and 310° C. of Palladium Wires Charged with Hydrogen. Hans Brüning and Adolf Sieverts (*Z. physikal. Chem.*, 1933, [A], **163**, 409–441).—The electrical resistance of palladium wires has been determined at 160°–310° C. in hydrogen under pressures up to 28 atm. With low hydrogen concentrations the lattice constant of the α-face-centred cubic phase increases from 3·880 to 3·92 A. at 100° C. with increase in hydrogen content. Further increase in hydrogen concentration results in the appearance of the β-phase, until finally the whole specimen is converted into β, which also has a face-centred cubic lattice $a = 3{\cdot}97$ A. (minimum) at 100° C. The lower concentration limit of β between 80° and 150° C. lies very close to 33·3 atomic-% hydrogen; between 160° and 200° C. it occurs at lower hydrogen concentrations. These facts do not provide sufficient grounds for presuming the existence of the compounds Pd_2H as a characteristic component of the palladium–hydrogen system.—B. Bl.

Tungsten–Thorium Problem. I.—Activation of Tungsten Containing Thorium. E. Chalfin (*Physikal. Z. Sowjetunion*, 1932, **2**, 59–76; *C. Abs.*, 1933, **27**, 225).—The number of thorium atoms evaporating from a tungsten surface is only 5–10% of the number of thorium atoms reaching the surface. The quantity log $(1 - \theta)$ depends on the previous handling of the wire; only in special cases is it a linear function of the time of activation. When a tungsten wire is activated and deactivated by heating, the work of activation is decreased, as is also a quantity proportional to the total length of the cracks along which the thorium atoms reach the surface. When a wire is heated to 3000° K. not only thorium, but also tungsten evaporates.—S. G.

Thermionic and Adsorption Characteristics of Thorium on Tungsten. Walter H. Brattain and Joseph A. Becker (*Phys. Rev.*, 1933, [ii], **43**, 428–450). —Thorium was deposited on tungsten ribbon by evaporation from a thorium filament, and the thermionic emission was then studied as a function of tem-

perature, and of a quantity, proportional to the amount of thorium on the tungsten surface. As the amount of thorium increases, the emission at a given temperature rises to a maximum, then decreases, and approaches asymptotically to a constant value which agrees within a factor of 2 with the value for clean thorium. These results are compared with those from thoriated tungsten wire in which activation is caused by diffusion from the interior to the surface. If i is the emission current, the results indicate that log i does not vary linearly with the amount of adsorbed thorium. This is in contradiction to the formula of Langmuir (*Phys. Rev.*, 1914, [ii], **4**, 544; 1923, [ii], **22**, 357; *J. Amer. Chem. Soc.*, 1932, **54**, 2798), whose assumption of induced evaporation is shown to be improbable. Additional experiments are described to illustrate the variation of emission with applied field, and the evaporation and migration of thorium atoms on a tungsten surface.—W. H.-R.

Creep Characteristics of Metals at Elevated Temperatures. A. E. White and C. L. Clark (*Trans. Amer. Soc. Steel Treat.*, 1933, **21**, 1–16; discussion, 16–21).—Experience has shown that even the short-time proportional limit modified with a conservative factor of safety is not sufficiently accurate for purposes of design, owing to the tendency to creep. This factor is more important at elevated temperatures. The type of equipment employed at Michigan University for the determination of creep at high temperatures is described. Attention is directed to the importance of using a proper scale to detect a change in the rate of creep. Logarithm plotting is customary. Creep testing methods are as yet unstandardized: the type of testing unit used makes a difference in the results. Comparisons are being made between single step, up-step, and down-step methods of loading. The lowest rate of creep is found in the last named. A hypothesis is put forward that the logarithmic plotting of stress versus rate of creep would, for the same metal at all temperatures below the recrystallization temperature, give lines that are essentially parallel to one another and that, at temperatures above that of recrystallization, the same condition would exist. A further hypothesis is that the rate of creep will be less for fine-grained metals than for coarse-grained metals when at temperatures below the recrystallization temperature, whilst at temperatures above the latter the reverse is the case. Composition and methods of manufacture are important in determining the creep properties of metals. In the discussion *J. J. B. Rutherford* points out that the rate of creep of 18 : 8 alloy, which is very low, is appreciably greater for cold-worked specimens than for similar specimens thoroughly annealed. W. and C. aver that for every metal and alloy of given composition there is a definite equi-cohesive temperature or lowest temperature of recrystallization and that the creep characteristics are closely related to it.—W. A. C. N.

On the Beltrami–Haigh Energy Theory of Rigidity. V. S. Svida (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1932**, (8), 2–5).—[In Russian.] The following points are discussed: sp. energy of deformation for simple and complex stresses; the Beltrami–Haigh conditions of equal rigidity; the determination of permissible stresses in displacement and stretching of the walls of metal vessels by internal pressure. An expression is deduced for selecting the cross-section of bending and the diameter of the roller undergoing a simultaneous bending and twisting stress on the basis of the Beltrami–Haigh theory of rigidity.—D. N. S.

X-Ray Methods of Measuring Internal Stresses. G. I. Aksenov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (2–3), 101–105).—[In Russian.] The procedure previously described (cf. this *J.*, 1931, **47**, 422) for measuring internal stress in isotropic materials by the Debye–Scherrer method has been extended to take into account the anisotropy of individual crystals.—D. N. S.

The Use of X-Rays for the Investigation of Elastic Stresses in Crystalline Substances. A. P. Komar (*Zhurnal Tehnicheskoy Fiziki* (*Journal of Technical Physics*), 1932, 2, (6), 519–528).—[In Russian.] The work of Aksenov, Sachs, Dehlinger, and Laue is reviewed.—N. A.

Small Impurities. Anon. (*Metallurgist* (Suppt. to *Engineer*), 1933, **9**, 18–19).—The considerable effects which may be produced by the presence of very small percentages of certain impurities in some metals are discussed, especially the case of tellurium in lead. By regarding the effect atomically, the remarkable effect of about 0·06% by weight of tellurium can be understood from the large number of lead atoms likely to be influenced by a stranger atom of widely different nature.—R. G.

On the Mechanism of the Exchange of Metal Atoms and Noble Ions. Otto Erbacher (*Z. physikal. Chem.*, 1933, [A], **163**, 196–214).—The electrochemical deposition of noble ions on a metal can take place in two ways: in the first local elements are formed, and large amounts of the more noble metal are consequently deposited, and in the second there is solely an exchange between the metal atoms and the more noble ions corresponding with a monatomic layer of the metal. The reason for this different behaviour is that in the first case the e.m.f. of the local elements is higher than the deposition potential of the more noble ions by an amount sufficient to cause them to deposit electrolytically, whereas in the second case it is below this potential. Examples of deposition in monatomic layers are: bismuth on nickel in 0·1*N*-hydrochloric acid at 79° C., lead on platinum saturated with hydrogen in 12% hydrochloric acid, polonium on platinum and gold in 0·1*N*-hydrochloric acid.—B. Bl.

A Method for the Determination of the Absolute Surface of Metals. Otto Erbacher (*Z. physikal. Chem.*, 1933, [A], **163**, 215–230).—Cf. *J.*, this volume, p. 68.—B. Bl.

A Method for the Absolute Determination of the Active Surface of Noble Metals. Otto Erbacher (*Z. physikal. Chem.*, 1933, [A], **163**, 231–239).—When platinum is charged with hydrogen, the latter becomes electro-chemically active only at the active places where it can be replaced by nobler ions in a monatomic layer; hence this method serves to determine the active surface of platinum. The results show that this surface is more than double the measured surface for emery-papered platinum and is about 85% of the true surface of the metal. After polishing, the active surface is only $\frac{1}{30}$–$\frac{1}{5}$ as great as, and after platinizing much greater than, that of the roughened metal.—B. Bl.

Behaviour of Activated Carbon with Metallic Water-Purification Equipment. A. S. Behrman and H. Gustafson (*Indust. and Eng. Chem.*, 1933, **25**, 59–60).—In all cases in which activated carbons were in contact with metals under water, a p.d. is set up, the activated carbon being cathodic to the metallic element of the couple. The results are tabulated for various carbons and the following metals, *viz.* steel, brass, Monel metal, cast iron, copper, zinc, aluminium, lead, and stainless steel.—F. J.

The Pressure Coefficient of Resistance of Fifteen Metals down to Liquid Oxygen Temperatures. P. W. Bridgman (*Proc. Amer. Acad. Arts Sci.*, 1932, **67**, 305–344).—(1) The pressure coeff. of electrical resistance of the following metals have been measured at 0°, − 78·4°, and − 182·9° C. with pressures up to 7000 kg./cm.^{2}: lead, magnesium, aluminium, silver, gold, copper, nickel, iron, palladium, columbium, platinum, rhodium, molybdenum, tantalum, and tungsten. The general tendency is for the pressure coeff. of resistance to increase numerically at low temperatures, although in some cases the change is very slight. Tantalum and columbium showed a decrease in the pressure coeff. at low temperatures, but the specimens were of inferior purity. Nickel behaved anomalously, and is abnormal in other respects. (2) The apparatus used is described fully. The pressure was applied to the specimen by means of gaseous helium. (3) The results are not in agreement with those obtained at low pressure by Fischer (*Z. physikal. Chem.*, 1930, [B], **8**, 207). This

difference is due to the fact that consistent results can be obtained only after the specimens have been "seasoned" by several applications of a pressure of some thousand kg./cm.^{2}, and the low pressures used by Fischer would not enable stability to be reached. (4) Interesting details of the penetration of metals (steels) by gases under high pressure are given. The cylinders were made to resist the passage of helium by previous treatment with nitrogen, the larger atoms of which served to plug up the pores in the metal.—W. H.-R.

Compressibilities and Pressure Coefficients of Resistance of Elements, Compounds, and Alloys, Many of them Anomalous. P. W. Bridgman (*Proc. Amer. Acad. Arts Sci.*, 1932, **68**, 27–93).—Measurements of the compressibility and the pressure coeff. of electrical resistance have been made at 30° and 75° C. for the following elements: columbium, rhodium, ruthenium, chromium, arsenic, and beryllium. These involve in most cases determinations of specific resistance, and mean temperature coeff. of resistance for purer metals than those previously examined. Chromium behaves abnormally both as regards compressibility and change of resistance with temperature or pressure; this suggests some kind of internal change, and the curves show that this takes place without appreciable hysteresis. For arsenic, measurements were made on single crystals, and the results were abnormal and complex. Measurements were also made for the compound Cu_5Cd_8, gold–silver alloys containing 25, 50, and 75 atomic-% of silver, iron–tungsten alloys containing 10·05, 20·03, and 27·92% tungsten by weight, and some iron–cobalt–tungsten alloys. The results are very complex, and the curves show many breaks and changes in direction. The meaning of these abnormalities is discussed from the point of view of general thermodynamics, and it is concluded that the internal changes are spread over ranges of temperature and pressure, and are not abrupt as in ordinary polymorphic transformations or phase changes involving a change of lattice structure.—W. H.-R.

Mechanical Hardness Influenced by Magnetism. S. R. Williams (*Phys. Rev.*, 1932, [ii], **41**, 386).—Abstract of a paper read before the American Physical Society. In 1931, Herbert published a most interesting article on "magnetic hardening of metals" (*Amer. Machinist*, 1931, **74**, 967). Not only did he find that rotating a ferromagnetic substance in a magnetic field changes the hardness, but that the same thing occurred for substances which are not ferromagnetic. This work of Herbert's confirms some observations on steel rods made by W. in 1924 (this *J.*, 1924, **32**, 521). The work of 1924 has been repeated and confirmed on a series of high-carbon steel rods of different carbon content and hardness. The effect seems to be very clearly shown. Magnetostrictive effects have been the means for studying the changes in hardness due to magnetic fields.—S. G.

Establishment of the Absolute Scale for the Thermo-Electric Force. W. H. Keesom, C. H. Johansson, and J. O. Linde (*Proc. K. Akad. Wet. Amsterdam*, 1932, **35**, 10–14).—[In English.] The formula $e_{abs} = \int_0^T \frac{\sigma}{T} dT$, where $\sigma =$ Thomson heat, expresses the thermo-electric force per degree of a metal in the absolute thermo-electric scale. This quantity is calculated for tin, lead, and a silver alloy from measurements of thermo-electric force and Thomson heat, assuming that $\sigma = 0$ in the superconducting state.—E. S. H.

Third Report of the Committee on Atomic Weights of the International Union of Chemistry. G. P. Baxter, (Mme.) M. Curie, O. Hönigsmid, P. Lebeau, and R. J. Meyer (*J. Amer. Chem. Soc.*, 1933, **55**, 441–452).—Values from recent data are given for Se, Te, La, Tl, Li, B, Na, K, Cs, and Zn. Reference is made to the determination of atomic weights from isotope data, which method still seems inferior to the best chemical methods, although the concordance of the two methods is reassuring. A complete table of the atomic weights of the elements is given.—R. G.

II.—PROPERTIES OF ALLOYS

(Continued from pp. 232–238.)

Occurrence of $CuAl_2$ in Duralumin. George L. Clark and Howard A. Smith (*Phys. Rev.*, 1933, [ii], **43**, 305).—A note. X-Ray and microscopic examination of an old Duralumin aircraft propeller blade showed that abnormal precipitation of $CuAl_2$ had occurred just outside the position of the steel hub clamp. The amount of $CuAl_2$ was much greater than that to be expected from any known type of heat-treatment for ordinary lengths of time. The abnormal precipitation may have been caused by a peculiar combination of lattice-strain, fatigue, and high-frequency vibration.—W. H.-R.

The Effect of Cold-Rolling Treatment on the Properties of Duralumin. A. F. Belov and I. S. Repkin (*Legkie Metally* (*Light Metals*), 1932, (5–6), 46–53).—[In Russian.] The properties of cold-rolled sheets of Duralumin containing copper 4·23, magnesium 0·77, iron 1·5, and silicon 0·25% have been studied in the work-hardened, quenched, and aged conditions. In one series of tests the sheets were rolled from 3·5 mm. to 1·65 mm. (a reduction of 47%) in one pass and in another series of tests from 3·5 to 0·8 mm. (a reduction of 77%) in several passes. The strengths of work-hardened sheets in both tests were nearly the same whereas both strength and elongation of quenched sheets were lower in the first than in the second series. With increasing reduction above 55% the hardness of the quenched sheets decreased. The number of passes has no effect on the quality of aged sheets although their hardness tends to rise with more than 45% reduction.—D. N. S.

Suitability of Light Alloys for Machinery Construction. W. M. Krylov (*Legkie Metally* (*Light Metals*), 1932, (5–6), 53–56).—[In Russian.] The properties of steel and Duralumin are compared. With equal volumes and external loads it is calculated that Duralumin can, within the limits of elastic deformation, perform three times as much work as steel. The impact strength of 2 steel specimens was found to be three times that of similar Duralumin specimens. The additional strains in compound structures of steel and Duralumin due to the different moduli of elasticity and coeff. of expansion of the two metals are calculated.—D. N. S.

A Study of the Aluminium-Rich Aluminium–Copper–Silicon Alloys. Chiuyō Hisatsune (*Suiyō-Kwaichi*, 1928, **5**, (7), 559–566; *Japanese J. Eng. Abs.*, 1932, **8**, 85).—[In Japanese.] The constitution of the aluminium–copper–silicon alloys containing up to 70% copper and 8% silicon was studied by thermal and microscopic analysis. Two reactions, Liq. + $\eta \longrightarrow CuAl + Si$, Liq. + $CuAl \longrightarrow CuAl_3 + Si$ were found to take place at 611° C. and 573° C., respectively. The ternary eutectic composition and temperature are given as copper 23·8, silicon 5, aluminium 71·2%, and 522° C.—S. G.

The Influence of the Preliminary Treatment on the Mechanical Properties and Electrical Conductivity of Aluminium Containing Magnesium Silicide. G. Grube and F. Vaupel (*Z. Metallkunde*, 1933, **25**, 84–88).—The best thermal and mechanical treatment of Aldrey wires (containing silicon 0·61, iron 0·26 and magnesium 0·45%) to produce a high tensile strength combined with the maximum electrical conductivity has been determined. Wires of 12 mm. diam. were cold-drawn to 2·8 mm., annealed at 550°–560° C. for 1 hr., quenched and subsequently aged at (*a*) room temperature or (*b*) 155° C. Wires of 12 mm. were annealed at 550°–560° C., quenched, cold-drawn to 2·8 mm. and subsequently aged at (*c*) room temperature or (*d*) 155° C. The tensile strength, elongation, and electrical conductivity were determined at intervals during the ageing period (143–165 hours). Results are shown in tables and graphs. Method *d* in 8 hours gives tensile strength, 35 kg./mm.^{2}; elongation, 8·4%; electrical conductivity 32 m./ohm.mm.^{2}; the corresponding values with method *b* for 100 hrs. are 34·7 kg./mm.^{2}; 10·2%; 32·5 m./ohm.mm.^{2}.—M. H.

Recent Advances in the Field of Silumin [Alpax] Castings. G. Sachs (*Metallgesellschaft Periodic Rev.*, 1933, **7**, 21–29; also (abridged) *Light Metals Research*, 1933, **2**, (24), 6–7; and (abstract) *Found. Trade J.*, 1933, **48**, 342).—[In English.] Silumin castings can now be obtained with almost the same degree of reliability as rolled material. In order to reduce pinholing, which frequently occurs in the modified alloy, treatment with certain salts has been adopted. The alloy is especially adapted for intricate chill-castings and for die-castings. In these the deleterious effect of absorbed iron may be avoided to a certain extent by the addition of manganese. Resistance to corrosion is high. The addition of 0·8% copper causes a pronounced increase in the fatigue strength, and this is used to advantage in the construction of aircraft motors and Diesel engines. A further addition of 0·3% manganese to the copper–Silumin increases the hardness and diminishes the harmful effect of iron. Cobalt and chromium have the same effect as manganese. The addition of magnesium makes it possible to give Silumin much greater strength and hardness by quenching from high temperatures and then tempering. Heat-treated Silumin is also marked by high fatigue strength and almost complete indifference to the abrupt changes of temperature involved in the heat-treatment. The alloy having these properties is known as "Silumin-gamma" and contains silicon 12, magnesium, up to 0·5 (according to the hardness required), and manganese 0·3–0·5%. [*Note*: A patent, it is understood, has been applied for in Great Britain in connection with this alloy; see British Patent Application No. 3527/32.]—W. N.

On the Equilibrium Diagram of the Aluminium–Silicon–Tin System. Tatsuo Matsukawa (*Suiyô-Kwaishi*, 1928, **5**, (7), 567–570; *Jap. J. Eng. Abs.*, 1932, **8**, 85).—[In Japanese.] The ternary diagram of the system aluminium–silicon–tin was determined by the method of differential thermal analysis.—S. G.

Mechanical and Metallographic Characteristics of Some Foundry Light Alloys. C. Panseri (*Alluminio*, 1933, **2**, 59–86).—Cf. *J.*, this volume, p. 11. The shape and dimensions of sand- and chill-cast tensile test-pieces, the mechanical properties of some foundry alloys, particularly Duralite, and the effect thereon of casting conditions are discussed at some length and their influence on the structure, distribution of secondary constituents, presence of intercrystalline cracks, &c., is described. In the heat-treatment of Duralite the best quenching temperature is 530° C., and the best ageing temperatures are: 150° C. for 12 hrs., to obtain maximum ductility, or 190° C. for 4–6 hrs., to obtain the best tensile strength. The macrostructure of the castings has a great influence on the red-shortness, to which some alloys are especially subject. The tensile properties of die-cast light alloys are considerably influenced by the outer skin, removal of which reduces the tensile strength by 17·3%, and the elastic limit by 5·1%. The importance of this fact is emphasized.—G. G.

Mechanical Properties at − 40° C. of Metals used in Aircraft Construction. J. B. Johnson and Ture Oberg (*Metals and Alloys*, 1933, **4**, 25–30).—Data for the tensile strength, yield-point, ductility, impact strength, fatigue resistance, hardness, and elastic properties of 9 aluminium-base alloys and 3 magnesium-base alloys at + 20° and at − 40° C. are tabulated. In all cases the properties at the lower temperatures are as good as, or better than, at room temperature, hence the ordinary tests suffice for ascertaining the value of a metal for use in aircraft designed to operate at high altitudes.—A. R. P.

Contributions to the Knowledge of the Wear-Resistance of Metals, Illustrated by Some Preliminary Researches on Aluminium Alloys. —— Irmann (*Aluminium Broadcast*, 1933, **4**, (3), 17).—Abstract of *Neuhausen Research Report*, No. 525, 1932. Wear-resistance tests on various metals and alloys rubbing against cast iron showed the order of resistance to be roughly: (1) grey iron; (2) nickel–brass; (3) Alufont II; (4) chrome steel; (5) Bohnalite;

(6) Depal (nickel 1·9, copper 2, manganese 2%, aluminium balance); (7) brass; (8) Avional; (9) Silumin. Hardness is no criterion of wear-resistance.—J. C.

A New Piston Alloy. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 496).—The applications are given of an aluminium alloy containing copper 6–12, nickel 1–3, chromium 0·5–5, and magnesium 0·5–2·5%. This alloy depends on its composition, and not on heat-treatment for its hardness. The Brinell hardness of permanent mould castings is 140–150, and the alloy is suitable for pressure castings having a Brinell hardness of up to 170.—J. H. W.

Further Studies on Chromium–Nickel–Iron and Related Alloys. Vsevolod N. Krivobok, with E. L. Beardman, H. J. Hand, T. O. A. Holm; A. Reggiori and R. S. Rose (*Trans. Amer. Soc. Steel Treat.*, 1932, **21**, 22–60; discussion, 60–72).—Two widely discussed limitations with these alloys are the intergranular attack by corroding gases at high temperatures and the grain boundary "decomposition" or disintegration which occurs after the sample has been heated for some time at 550° C. to 830° C. The theoretical considerations concerning the constitutional diagram of these alloys, and especially those factors which determine the existence of metastable phases, have been studied. Previously the so-called disintegration has been thought to be correlated with the precipitation of a constituent consisting of carbides. This may not necessarily be the case, as in low-carbon alloys this constituent is found to be magnetic nickel–chromium ferrite. Decomposition is accompanied by a phase change from non-magnetic to magnetic. Magnetic analysis, microscopic observations, and corrosion tests were undertaken. Alloys with very low carbon content are shown to be immune from decomposition. Above this it is practically independent of carbon content. The addition of certain other elements prevents phase change, but does not suppress precipitation of a constituent, presumably carbides. The larger these additions the lower is the upper limit of the decomposition range. Whilst the copper sulphate corrosion test shows that these alloys are susceptible to attack, the ordinary mechanical properties and resistance to corrosion in standard acid solutions are but little impaired. Changes in the relative quantities of nickel and chromium in the alloy do not improve it so far as decomposition is concerned. Generally it is found that the higher the carbon content the larger must be the additions of special elements to produce beneficial effects. Original quenching temperature has a definite influence on decomposition. In the discussion, *J. A. Matthews* considers that after these alloys have been subjected either locally or wholly to temperatures within the 550°–830° C. range they should be given a high temperature anneal whenever possible. *H. D. Newell* suggests that phase changing resulting from composition does not interfere with many commercial applications of such altered alloys, but carbide precipitation may make the alloy liable to disintegration under corrosive conditions. There are two fields of application for the alloys studied: (1) at temperatures below a point where carbide precipitation can cause damage; (2) at elevated temperatures where fine carbide precipitation may cause damage, and is best eliminated by lowering the carbon content. Fine-grained low-carbon alloys resist corrosion better than large-grained ones. *A. Sauveur* is of the opinion that to prevent decomposition one or more elements should be added capable of producing a solid solution which is stable until a temperature is reached too low to permit decomposition. *F. H. Allison* considers that attention should be paid to the influence of colloids (colloidal carbon) in the solid matrix.

—W. A. C. N.

Aluminium–Bronze. Frank Hudson (*Found. Trade J.*, 1933, **48**, 86–89, 106–107, 121–123; and *Met. Ind.* (*Lond.*), 1933, **42**, 297–299, 327–330, 349–352, 378–380).—Paper read before the Scottish Local Section of the Institute of Metals. The structures of "aluminium–bronzes" as shown by the equilibrium diagram are described and illustrated and the restrictions on composition

dictated by the properties of the alloys are enumerated, particular attention being paid to the high solidification shrinkage of the alloys, the ease of formation of aluminium oxide, and the strong tendency to absorb gases. All the alloys from 5% aluminium upwards are readily forged. The use of the microscope in supplementing fracture tests and in detecting and identifying defects in the alloys is described. The main defects are oxide segregation, self-annealing, and badly balanced composition combined with unsuitable heat-treatment. The heat-treatment, physical properties, corrosion-resistance, and applications of the alloy are described.—J. H. W.

X-Ray Analysis of Cast Alloys.—III. Gunji Shinoda (*Suiyô-Kwaishi*, 1928, **5**, (8), 593–594; *Japanese J. Eng. Abs.*, 1932, **8**, 85).—[In Japanese.] Cf. this *J.*, 1929, **42**, 446; 1930, **43**, 525, 527. S. first determined the equilibrium diagram of the copper-rich copper–tin alloys and found a eutectoid reaction, $\gamma \longrightarrow \beta + Cu_3Sn$ at 637° C. He then studied the effect of quenching and tempering on the physical properties of Perkin's metals by means of thermal analysis and measurements of the electrical resistance and thermo-electromotive force of the alloys.—S. G.

Chemical Investigations of the Ancient Metallic Implements in the Orient. I.—Ancient Chinese Copper Implements. II.—Ancient Chinese Bronze Implements. Tsurumatsu Dōno (*Nippon Kwagaku Kwaishi* (*J. Chem. Soc. Japan*), 1932, **53**, 744–748, 748–753; *C. Abs.*, 1933, **27**, 5).—[In Japanese.] An analysis of copper implements revealed 2·90–26·78% lead; lead was probably added to make casting easy. Chemical tests for estimating the age of bronze implements by studying the ratio of copper and tin agreed well with archæological findings.—S. G.

"Oilite": An Oil-Containing Bearing Bronze. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 430–431).—In the manufacture of Oilite, a loose mixture of powdered metals is pressed into the required shape and sintered at about 1500° F. (815° C.) in a special atmosphere. The hot shape is then quenched in a lubricating oil and left to soak. The resulting bronze is said to have an oil content of 30–40% by volume. The performance of these bearing bronzes is described.—J. H. W.

The Transformation of the β-Solid Solution of Brass. R. Ruer (*Z. anorg. Chem.*, 1932, **209**, 364–368).—Differential heating and cooling curves of 14 copper–zinc alloys with 65·6–44·7% copper have shown that, contrary to earlier suggestions (see this *J.*, 1930, **43**, 463–464), no double transformation occurs in the β-solid solution. The transformation temperature was found to be 453° C. in the $(\alpha + \beta)$-range and 465° C. in the $(\beta + \gamma)$-range. The thermal effect in the heating and cooling curves is similar to that of iron within the temperature interval of its magnetic transformation. From this and other relations R. concludes—in contrast with the general view—that the $\beta \rightleftarrows \beta'$-transformation does not take place in the homogeneous phase, but is a real change of phase (see also R. Ruer, *Z. anorg. Chem.*, 1932, **205**, 230–234).—M. H.

The Transformations of the β-Phase in the Copper–Zinc System. P. J. Saldau and I. Schmidt (*Izvestia Instituta Fiziko-Khimicheskago Analisa* (*Annales de l'Institut d'Analyse physico-chimique*), 1931, **5**, 201–222).—[In Russian.] Apparently the same paper as was published in *Z. anorg. Chem.*, 1928, **173**, 273–286; see this *J.*, 1928, **40**, 514.—M. Z.

I.—The Relation between Mean Atomic Volume and Composition in Copper–Zinc Alloys. II.—Variation of Mean Atomic Volume with Temperature in Copper–Zinc Alloys, with Observations on the β-Transformation. E. A. Owen and Llewelyn Pickup (*Proc. Roy. Soc.*, 1933, [A], **140**, 179–191, and 191–204).—I.—X-ray analysis indicates that in the Cu–Zn series of alloys the mean atomic volume of both phases present in mixed regions is constant. There is approximately a linear increase of mean atomic volume with increasing atomic-% composition in all pure phases. The rate of this increase is practically

the same for the α-, β-, and γ-phases, but that for the ε- and η-phases is greater, whilst that for the η-phase is greater than that for the ε-phase. The change in atomic volume when a copper atom is replaced by a zinc atom can be explained by assuming that the zinc atom is not spherical, and that it packs differently in the various phases. The (β + γ) — (γ) boundary is not at the same composition for all temperatures. A detailed study of the ε- and η-phases shows that the base side of the hexagonal unit varies linearly with composition, but whereas in the ε-phase the base side increases, in the η-phase it decreases with decreasing copper content. The axial ratio, on the other hand, decreases in the ε-phase and increases in the η-phase as the copper content decreases. Pure zinc has the following parameter values at room temperature: $a = 2{\cdot}659_1$ A.; $c = 1{\cdot}856$. II.—Changes in mean atomic volume in the α-, β-, and γ-phases in both the pure and duplex regions of the copper–zinc alloys have been investigated by X-ray precision analysis between 350° C. and 800° C. In all pure phases the mean atomic volume is constant at all temperatures. Both the β- and the γ-phases in the (β + γ) region showed a definite *minimum* mean atomic volume at about 500° C.; the α-phase in the (α + β) region showed a *maximum* value at about the same temperature. Changes in mean atomic volume are not due to changes in composition. Of three possible explanations, one, based on a change of solubility, appears to fit the experimental facts most satisfactorily. The β-transformation occurring at about 470° C. is discussed in terms of this solubility theory.—J. S. G. T.

Some Investigations on High-Tensile Brass.—I. Tomojirō Tanabe (*J. Min. Inst. Japan*, 1928, (**514**), 125–140; *Japanese J. Eng. Abs.*, 1932, **8**, 83).—[In Japanese.] T. carefully investigated the influence of various single elements, *i.e.*, nickel, aluminium, manganese, iron, and tin, on various mechanical properties and the corrosion-resistance to dilute sulphuric acid of rolled brass plate containing 50–60% copper. In order to examine the mechanical properties of the materials, hardness, tension, static impact, and repeated impact tests and hardening by quenching and age-hardening were carried out. The results showed that the elongation and tensile strength of nickel–brass, aluminium–brass, and manganese–brass are superior to those of the "mother" brass. Cf. following abstract.—S. G.

Some Investigations on High-Tensile Brass.—II. Tomojirō Tanabe (*J. Min. Inst. Japan*, 1928, (**515**), 219–231; *C. Abs.*, 1929, **23**, 1093).—[In Japanese.] Cf. preceding abstract. T. made a detailed investigation of the structure and mechanical properties which result on adding several pairs of metals such as manganese+nickel, manganese+iron, manganese+aluminium, manganese+tin, nickel+iron, and nickel+tin to a brass containing 60% copper. The paper contains extensive experimental data, with a few plates of photomicrographs. Among the results, it is stated that (1) with the alloy containing nickel+aluminium, a suitable heat-treatment can give properties comparable to those of steel. Thus, alloys containing nickel 2, and aluminium 1%, attain a tensile strength of 81 kg./mm.^{2} by quenching at 800° C. and annealing at 350° C.; (2) the alloy containing nickel 4·7, and aluminium 4·0% attains a tensile strength of 70–75 kg./mm.^{2}, elastic limit 45–50 kg./mm.^{2}, elongation 19–14% and contraction of area 25–16%.—S. G.

Effect of Work-Hardening on the Properties of Brass. V. Bugakov and N. Davidenkov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (2–3), 105–114).—[In Russian.] The anomalies observed in the curves showing the relations between the degree of reduction of α-brass by cold-rolling and the mechanical properties and rate of dissolution in acids are attributed to a maximum accumulation of residual stress at a certain degree of reduction (about 30%). This assumption is confirmed (*a*) by the disappearance of the anomalies when the residual stress is removed by anneal-

ing, (*b*) by a study of the relation between the stress and the rate of dissolution of the alloy, and (*c*) by direct measurements of the stress.—D. N. S.

Residual Stresses in Brass Cartridges. N. Davidenkov and F. Vitman (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (7), 71–76).—[In Russian.] Season-cracking of brass stampings is accelerated by ammonia vapour corrosion and residual stress in the surface layers. The distribution of residual stress in brass cartridges and the removal of this stress by heat-treatment have been studied. Measurement of the residual tangential stresses showed the presence at the mouth, of extension stresses up to 20 kg./mm.^{2} and at the base of compression stresses not greater than 8 kg./mm.^{2}. Annealing at 290° C. for 2 hrs. removes 80–90% of residual stress without reducing the hardness by more than 10%. No reliable data for the magnitude of the residual stress could be obtained by the use of corrosive liquids.—D. N. S.

The Electrolytic Potential of Ternary Gold–Tin–Mercury Alloys. Franz Griengl and Robert Baum (*Monatsh.*, 1932, **61**, 330–344).—Diagrams have been constructed showing the isopotential lines in the ternary system gold–tin–mercury; the curves show no discontinuities corresponding with the compounds AuSn and $AuSn_2$, which are, however, shown by the potential curves of the gold–tin system. Hence it is concluded that in the presence of mercury these compounds are at least partly dissociated.—A. R. P.

On the Position of Gold in the Potential Series in the Electrolysis of Molten Metallic Alloys. Ludwig Lämmermayr, Jr., and Robert Kremann (*Monatsh.*, 1932–1933, **61**, 345–350).—Experiments on the migration of the constituents when molten alloys of gold with mercury, bismuth, antimony, lead, or aluminium are electrolyzed in capillary tubes indicates that these metals can be arranged in the following order in a potential series: bismuth, antimony, mercury, lead, gold, aluminium.—A. R. P.

The Shape and Structure of Lead Shot. G. Tammann and K. L. Dreyer (*Z. Metallkunde*, 1933, **25**, 64).—Shot made from lead free from arsenic is always elongated, whereas that made from lead with 0·5% arsenic is spherical. These effects are explained as follows: at the surface of the lead drop arsenic is oxidized to trioxide which converts the lead oxide film covering the lead drop into liquid lead arsenite which solidifies at 200° C. In the absence of arsenic, however, the lead drop is covered by a skin of solid lead oxide which thus effects the formation of elongated shot. The structure of the shot consists of several lead dendrites cemented with lead-rich lead–arsenic eutectic.—M. H.

Experiment on the Use of Alkaline Earth Babbitts for Filling Linings of Bearings of Rolling Installations at the Petrovsky Metallurgical Works.—E. Dukhan (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (8), 55–62; (9), 36–55).—[In Russian.] The stability of bronze linings of wire rolling-mills filled with a lead bearing metal containing calcium 1, sodium 0·8%, was found to be greater than when a tin Babbitt was used, and the consumption of electrical energy fell by 43–50%.—D. N. S.

On the Question of Bearing Alloys. N. F. Bolchovitinov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (10), 51–60).—[In Russian.] The nature of bearing alloys and their characteristic properties are reviewed and the effects of additions of zinc, phosphorus, nickel, and antimony to bearing bronzes are described. Methods of testing, and standards for Babbitts are given.—D. N. S.

Arsenic in Lead-Base Bearing Metals. Anon. (*Metallurgist* (Suppt. to *Engineer*), 1933, **9**, 11–13).—See this *J.*, 1932, **50**, 685; this volume, p. 124. A brief review of recent published work on the subject.—R. G.

The Magnetic Susceptibilities of Lead, Silver, and Their Alloys. Carol G. Montgomery and William H. Ross (*Phys. Rev.*, 1933, [ii], **43**, 358–360).—The magnetic susceptibilities of lead, silver, and their alloys were determined by a

modified Curie balance, and may be expressed by the relation $10^9\chi = (116{\cdot}44 \pm 0{\cdot}68) + (0{\cdot}764 \pm 0{\cdot}012)\ P$, where P is the weight per cent. of silver. The susceptibility thus varies linearly with the composition, in contrast to the work of Spencer and John (this *J.*, 1927, **38**, 433), whose results may have been affected by ferromagnetic impurities.—W. H.-R.

Contribution to the Study of the Physical and Mechanical Properties of Magnesium–Aluminium–Copper Alloys Rich in Magnesium. A. Portevin and P. Bastien (*Compt. rend.*, 1933, **196**, 693–696).—Thermal analysis and microscopic study show three distinct regions starting with magnesium and containing respectively 1, 2, and 3 constituents. The solid solution region, as indicated by the hardness and electrical resistance of the sand-cast alloys, is well-defined, but does not coincide exactly with the area shown by thermal analysis, indicating a susceptibility of the alloys to heat-treatment. The alloys containing aluminium+copper $\leq 15\%$ have coeffs. of expansion of $25{\cdot}8$–$27{\cdot}8 \times 10^{-6}$. The binary magnesium alloys containing up to 15% copper and up to 7% magnesium (*i.e.*, corresponding with the saturated solid solutions) can be forged. The mechanical properties of these alloys have been studied. Under rotating tensile tests the magnesium–aluminium–copper alloys, 88 : 9 : 3 or 85 : 9 : 6, gave the same order of results as the Duralumin type alloys.—J. H. W.

Comparative Investigation of Two Magnesium Alloys. M. Sharov and A. Maurah (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), 1931, (11), 18–33; (12), 30–38).—[In Russian.] The mechanical properties of the following piston alloys: (A) magnesium 88·3, aluminium 10, silicon 1·5, and manganese 0·2%; (B) magnesium 91·8, aluminium 2, copper 4, cadmium 2, manganese 0·2%, have been compared with those of the usual 88 : 12 aluminium–copper alloy (C). The tensile strength, elongation, yield-point, Brinell hardness, and impact strength have been determined at 20°–350° C. for the alloys as cast and after annealing at 200°–350° C. for 5–100 hrs., and the behaviour of pistons of the alloys in a 48-hr. test in aero-engines has been examined. Their thermal conductivities are in the order C, B, A. The mechanical properties of A and B at 20° C. are better than those of C, and unlike the latter are practically unaltered by long periods of heating at high temperatures. With rise in temperature, the mechanical properties of A and B fall more rapidly than those of C. B casts better than A, and the weight of pistons made of A or B is only about 75–77% of that of pistons made of C. Magnesium alloy pistons have one fundamental defect, *viz.*, they tend to crack in the connecting-rod sockets; in this respect A is worse than B. Cracking can be obviated by making the structure more robust and by improving the quality of the casting. It is concluded that both magnesium alloys are suitable for the pistons of aero-engines.—D. N. S.

The Specific Heat of Monel Metal between − 183° and 25° C. W. F. Hampton and J. H. Mennie (*Canad. J. Research*, 1932, **7**, 677–679).—The heat capacity of Monel metal over the range − 183° to 25° C. has been measured in an adiabatic calorimeter. By differentiation of the equation representing the heat capacity curve, an equation for the specific heat over this range is obtained and values at various temperatures calculated. The specific heat at 20° C. is found to be 0·0997.—S. G.

Magnetic Properties of the Iron–Nickel Alloys under Hydrostatic Pressure. R. L. Steinberger (*Physics*, 1933, **4**, 153–161).—A series of well-annealed iron–nickel alloys in nominal steps of 10% nickel, including the pure metals, has been examined for the effect of pressures up to 12,500 kg./cm.^{2} on the magnetic flux density. The application of pressure causes a relatively large change of flux, producing usually a decrease followed by an incomplete recovery of flux on release of pressure. The recovery is reversible in the sense that the same curve of flux change is traced with each series of pressure applications, pro-

vided the pressure does not exceed that first applied. The 30% nickel alloy is rendered nearly non-magnetic by application of a pressure of 12,000 kg./cm.^{2}. Of the remainder, pure iron exhibits the greatest, and the 90% nickel alloy the smallest, change of flux due to pressure. At constant field, the different alloys exhibit various types of changes of flux under pressure, *viz.*, linear, non-linear, and types showing hysteresis.—J. S. G. T.

Illium. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 470).—A brief note. It is claimed that Illium a new alloy of nickel, copper, chromium, and tungsten, with small amounts of iron, carbon, manganese, and silicon, has: tensile strength 26·7 tons/in.^{2}; yield-point 22·2 tons/in.^{2}; Brinell hardness 170–200; melting point 1300° C.; sp. gr. 8·3, and that it is very resistant to heat and corrosion. Cf. *J.*, this volume, p. 125.—J. H. W.

The Alloys of Palladium with Iron. A. T. Grigoriev (*Izvestia Platinago Instituta* (*Annales de l'Institut de Platine*), **1931**, (8), 25–36).—[In Russian.] See abstract from *Z. anorg. Chem.*, 1932, **209**, 295–307; *J.*, this volume, p. 126.
—N. A.

Thermoelectric Properties of Platinum–Rhodium Alloys. Frank R. Caldwell (*U.S. Bur. Stand. J. Research*, 1933, **10**, 373–380; and *U.S. Bur. Stand. Research Paper* No. **537**).—The thermal electromotive forces and thermoelectric powers of a series of platinum–rhodium alloys against pure platinum have been determined from 0° to 1200° C. The results obtained are compared with those obtained by other investigators. The specimens used in this work contained the following percentages of rhodium: 0·100, 0·500, 1·000, 5·00, 21·6, 39·0, 51·6, 56·6, 61·2, 80·7, and 100·00.—S. G.

The Rôle of the Platinum Metals in Dental Alloys. III.—The Influence of Platinum and Palladium and Heat-Treatment upon the Microstructure and Constitution of Basic Alloys. E. M. Wise and J. T. Eash (*Amer. Inst. Min. Met. Eng. Preprint*, 1933, Feb., 1–28).—The effect of substituting platinum or palladium for part of the gold in an alloy of gold, silver, copper, and zinc in the atomic ratios 50 : 20 : 29 : 1 has been studied by thermal analysis, micrographic examination, and X-ray methods. In the palladium series the solidus and liquidus rise almost linearly with increase of palladium from 850°–870° C. to 1020°–1080° C. with 0–30 atomic-% palladium; in the platinum series the liquidus rises sharply in a curve concave to the composition axis and reaches 1200° C. at 20 atomic-% platinum, whereas the solidus rises slowly to 948° C. at 14 atomic-% platinum and in alloys with more than 5 atomic-% platinum a peritectic reaction occurs at this temperature. The α-solid solution range in the platinum series extends from 0% platinum at 400° C. to 14 atomic-% platinum at the peritectic temperature; below this line a new θ-phase separates having apparently the composition $AuPt_2Cu_3$. The α-phase in the palladium series decomposes at 400°–500° C., with increase of palladium up to 15 atomic-% giving a mixture of $\alpha + \theta$; alloys with more than 5 atomic-% palladium yield a mixture of $\alpha + \theta + \kappa$ below 600° C., whereas those with more than 28 atomic-% palladium yield $\alpha + \lambda$ on annealing below 600°–700° C. Owing to these changes both series of alloys undergo age-hardening on quenching from above the transformation point and tempering below it. In the palladium series the θ-phase has a face-centred tetragonal structure, $c/a = 0{\cdot}92$, the κ-phase a body-centred tetragonal structure, $c/a = 0{\cdot}96$–$0{\cdot}98$, and the λ-phase a body-centred cubic lattice; the θ-phase in the platinum series has a face-centred tetragonal structure, $c/a = 0{\cdot}98$ for the 20 atomic-% platinum alloy. The phase transformations during ageing of several alloys in both series have been studied and the results correlated with the change in mechanical properties.
—A. R. P.

Studies on the Ternary System Silver–Copper–Nickel. W. Guertler and A. Bergmann (*Z. Metallkunde*, 1933, **25**, 53–57).—The miscibility gap in the liquid state of the ternary system silver–copper–nickel has been determined by

analysis of the layers in specimens quenched slightly above or below the liquidus temperature. The gap which lies between 1·5 and 96% nickel in the binary system silver–nickel extends up to about 42% copper in the ternary system. The critical point lies near 35% silver, 40% copper, 25% nickel. The results of thermal analysis and microscopical examination are in general in agreement with those of de Cesaris. Only two phases exist in the system : a copper–nickel–silver solid solution with a low silver content and a silver-rich silver–copper solid solution. A model of the ternary system is given. Nickel is an unsuitable alloying element for silver even in the presence of copper.—M. H.

Investigations on Age-Hardening Phenomena in Britannia Metal. M. von Schwarz and O. Summa (*Z. Metallkunde*, 1933, **25**, 95–97).—Cf. papers by Egeberg and Smith, this *J.*, 1928, **40**, 527; 1929, **42**, 464. The Brinell hardness of a tin–antimony alloy with 8% antimony changed from 10·5 to 11·5, 8·8, and 7·1, respectively, after cold-working to 24, 51, and 78% reduction and to 9·1–9·7 after subsequent annealing at 175° C. for 90 minutes. The increase of hardness on annealing is shown by X-ray investigation to be due to the precipitation of the compound SnSb which has a crystal lattice of the sodium chloride type.—M. H.

The Diffusion of Mercury on Rolled Tin Foils. F. W. Spiers (*Phil. Mag.*, 1933, [vii], **15**, 1048–1061).—Mercury drops placed on rolled tin foils diffuse into elliptical areas forming an amalgam containing approximately 11·8% of mercury. Features of the diffusion are described, an empirical interpretation of the curves of growth of the ellipses is given, and the elliptical diffusion explained in terms of the rolling effects. The crystal structure of the amalgam, is shown by X-ray analysis to be hexagonal, the unit cell containing one atom and having dimensions $a = 3{\cdot}23$ A, $c = 3{\cdot}00$ A. Density measurements indicate the existence of a liquid phase from 8% mercury onwards; measurements of electrical resistance show the hexagonal phase to be a secondary solid solution and give an indication of the solidus curve for the tin end of the mercury–tin system.—J. S. G. T.

Super-Hard Alloys of the Metallo-Ceramic Type (Sintered Powders). G. A. Meerson (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1932**, (2), 60–67; (3), 67–73; (5), 59–67).—[In Russian.] A detailed description of the production of super-hard alloys, containing tungsten carbide, and cobalt at the Electrozavod works in Moscow. A review of the literature and the characteristics of various super-hard alloys is given.—D. N. S.

The Sulphurization of Non-Ferrous Alloys. J. P. Podolsky and N. M. Zarubin (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (5), 57–62).—[In Russian.] The diffusion of molten sulphur into copper, nickel, and alloys of nickel with copper, iron, and tungsten, has been studied. Copper forms Cu_2S at 600° C., and nickel forms NiS below, and Ni_3S_2 above, 600° C. In the sulphurization of solid solution alloys sulphide layers are formed, the outer consisting of the sulphide of the metal having the greater affinity for sulphur; thus in copper–nickel alloys this layer is copper sulphide, and the inner layer nickel sulphide. This phenomenon is similar to that observed in the "kernel roasting" of copper ores. In the sulphurization of alloys the components of which form chemical compounds with one another no separation into layers can be detected.—D. N. S.

Temperature Coefficient of the Moduli of Metals and Alloys Used as Elastic Elements. G. H Keulegan and M. R. Houseman (*U.S. Bur. Stand. J. Research*, 1933, **10**, 289–320; and *U.S. Bur. Stand. Research Paper* No. **531**).—In continuation of the work of W. G. Brombacher and E. R. Melton (*N.A.C.A. Tech. Rep.* No. **358**, 1930) the temperature coeff. of the modulus of elasticity and of Young's modulus of elasticity of 31 alloys and metals (phosphor-bronze; Monel metal; brass; nickel-brasses; Duralumin, beryllium-bronze; tungsten, as well as Elinvar, Modulvar and various steels) have been deter-

mined in the temperature range − 50° C. to + 50° C. The materials were selected on the basis of their possible use as elastic elements for aircraft and other instruments. In most cases the temperature coeff. were determined with the metal in the condition of heat-treatment or cold-work most suitable for its use as an elastic element and also in the annealed condition. The coeff. of each modulus at 0° C., the ratio of the coeff. at + 25° to that at − 25° C., the composition and the heat-treatment or cold-work are given for each sample. The temperature coeff. of Poisson's ratio and the significance of the differences in the two coeff. for a given material are discussed.—S. G.

Internal Friction of Iron and Iron Alloys. R. H. Canfield (*Trans. Amer. Soc. Steel Treat.*, 1932, **20**, 549–574; discussion, 574–576).—Elastic hysteresis is first discussed. The assumption that internal friction in solids is exactly analogous to viscosity in liquids, and that hence the frictional stress is proportional to the rate of change of shear strain is erroneous. C. proceeds to give a mathematical interpretation of the loop in the hysteresis curve. Apparatus and technique are described for measuring the dissipation of energy in a tubular specimen of metal when carried through cycles of alternating torsional stress. The results in this instance apply principally to iron alloys. In plotting the results, the half width of the hysteresis loop is plotted against the stress amplitude, giving a curve showing friction stress–elastic stress. The slope represents a coefficient of internal friction.—W. A. C. N.

Magnetic Properties of Solid Solutions. S. S. Bhatnagar and Pyara Lal Kapur (*J. Indian Chem. Soc.*, 1932, **9**, 347–356).—The properties of solid solutions of salts and metals are briefly surveyed and an experimental study is described having as object the determination of the relationship between magnetic susceptibility and other properties of solid solutions. Three types of solid solutions of salts were used, and were prepared by crystallization or melting. The magnetic susceptibility was determined by a magnetic balance of the Wilson type. The correlation of the results with those for metallic systems is discussed. Heat of formation appears to be analogous to magnetic susceptibility. When the heat of formation of the system is zero, the susceptibility–concentration curve of the system follows a linear course.—R. G.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 238–241.)

Methods of Metallographic Testing of Tungsten and Molybdenum. N. M. Zarubin (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (7), 54–70; (8), 48–54).—[In Russian.] The methods used in the metallographic examination of tungsten and molybdenum in the laboratory of the Electrozavod works in Moscow are described.—D. N. S.

On the Question of Metallographic Investigation of Bimetal. N. M. Zarubin (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (10), 12–21).—[In Russian.] The methods used in the laboratory of the Electrozavod works in Moscow are described. The bimetals examined are: Platinite, Invar–brass, Invar–copper, Invar–nonmagnetic steel, iron–brass, iron–copper, iron–gunmetal. Reagents suitable for etching separately each of the components of the bimetal are given.—D. N. S.

On the Colour-Etching of Metal Surfaces. N. M. Zarubin and G. A. Meerson (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1930**, (7–8), 167–176).—[In Russian.] Experiments on the colour-etching and colour-photography of polished surfaces of tungsten, molybdenum, ferro–

tungsten, iron, and steel are recorded. Tungsten is etched with 10% permanganate solution in acetic anhydride; molybdenum with 50% sulphuric acid containing 10% of permanganate, and ferro–tungsten with 10% ammonium persulphate solution which can also be used for all the other metals.
—D. N. S.

On the Changes in Texture and Mechanical Properties of Duralumin Due to Deformation and Subsequent Thermal Treatment. E. Bachmetev (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1930**, (9–10), 154–167).—[In Russian.] The changes in the crystal structure of Duralumin after rolling to various degrees up to 99·6% reduction followed by thermal treatment, have been investigated by X-ray analysis. After cold-rolling to 89% reduction, the crystallites are oriented about the [111] and the [112] axes and the hardness–% reduction curve shows a sharp point of inflection. On further rolling, the crystallites tend to orient themselves solely in the direction of the [111] axis and the work-hardness rises rapidly. On quenching and ageing Duralumin that has been reduced 89% or more by rolling, the so-called recrystallization texture appears and the mechanical properties are improved, reaching a maximum after a reduction of 89%. It is suggested that the ageing process in Duralumin is dependent on the distortion of the space-lattice produced by the cold-work prior to the heat-treatment.—D. N. S.

Structural Changes in Duralumin Due to Deformation by Extension. E. Bachmetev (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (1), 99–105).—[In Russian.] The structural changes which occur in stretching Duralumin in the annealed condition and at different stages of ageing have been studied metallographically. Fine lines marked on the specimens enabled the same crystal grains to be examined under the microscope and photographed at different stages of the deformation process, while the collation of such photographs gave a means of elucidating the structural changes. In this way bending of the crystal grains, displacements of one grain with respect to another, lines of slip and surface cracks, but no twin formation could be observed both in annealed Duralumin and in Duralumin in various stages of ageing.—D. N. S.

On the Study of Statistical Anisotropy in the Distribution of Microcrystallites. G. S. Zhanov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1930**, (9–10), 149–154).—[In Russian.] In Z.'s new axial "X-Ray-Texture Camera" the axis of the cylindrical film lies parallel to the primary X-ray pencil. During the exposure the specimen is turned through 90° or 180° while the film advances along the axis of the cylinder, the path traversed by it forming the width of the X-ray photograph. The resulting X-ray photographs are the projection of polar figures from a spherical on to a cylindrical surface. Examples of such diagrams for rolled Duralumin are given.—D. N. S.

The Polishing of Specimens for Metallographic Examination. A. R. Matthis (*Ing. Chim.*, 1932, **16**, 188).—A description (illustrated) of a machine designed for the rapid polishing of specimens, in which the different grades of emery paper are carried on a revolving mandril and means provided for adjustment of the position of the specimen. The machine is stated to be capable of satisfactory use with soft metals not easily polishable by hand.—R. G.

Structure Analogies of Alloys. Arne Westgren (*Trans. Amer. Soc. Steel Treat.*, 1932, **20**, 507–528).—X-ray analyses of the copper–zinc, silver–zinc, and gold–zinc systems have shown that they are all built up in the same way and Carpenter's assumption that the crystal structures of these alloy systems are analogous has been corroborated. Certain typical structures recur frequently in other related alloys, *e.g.*, those of copper, silver, and gold with zinc, cadmium, aluminium, and tin. The phases having the same structure as β-brass and γ-brass appear to be formed when the ratio of the number of atoms

assumes the values 3 : 2 and 21 : 13, respectively. Combinations of transitional elements such as iron, palladium, and platinum metals with zinc, cadmium or aluminium also induce the formation of phases analogous to β- or γ-brass.
—W. A. C. N.

The Crystal Structure of the Precipitated Copper–Tin Alloys. H. Kersten and Joseph Maas (*J. Amer. Chem. Soc.*, 1933, **55**, 1002–1004; and (abstract) *Met. Ind.* (*Lond.*), 1933, **42**, 348).—Addition of tin to a neutral or slightly acid aqueous solution of copper sulphate produces a precipitate of composition approximately Cu_3Sn. Precipitates prepared with solutions of varying acidities varied in composition from nearly pure copper to an alloy containing about 40% tin. The X-ray spectra of the alloys showed them to correspond in crystal structure with the α alloys and the compound Cu_3Sn as prepared by fusion.—R. G.

Diffraction of Low-Speed Electrons by a Gold Crystal. H. E. Farnsworth (*Phys. Rev.*, 1932, [ii], **40**, 1049).—Abstract of a paper read before the American Physical Society. A previous investigation of electron diffraction by a silver crystal, for normal incidence on a (100) face showed that, in general, each observed diffraction beam, between 0 and 325 v., is made up of several components of fine structure. As the angle of incidence was changed from normal in small steps, the relative intensities of the components of any one beam changed enormously. The components which are present for normal incidence may disappear and others appear at angles of incidence a few degrees from the normal. For each beam there is a certain angle of incidence at which the most intense component attains its maximum value. No exact correspondence between the characteristics of the various beams was found. Similar observations are now being obtained for a gold crystal. A fine structure is also observed for these beams. The intensities of the components are also very sensitive to a change in the angle of incidence, but the particular characteristics of any one beam differ considerably from those of the corresponding beam for silver. This is particularly significant since gold and silver have the same lattice structure and also the same lattice constant to within 0·4%.
—S. G.

Electron Diffraction by a Silver Film on a Gold Crystal. H. E. Farnsworth (*Phys. Rev.*, 1932, [ii], **42**, 588).—Abstract of a paper read before the American Physical Society. A thin film of silver (not visible) was deposited on the (100) face of a gold crystal by evaporation in a vacuum. The silver formed in a lattice structure having the same orientation as that of the underlying gold crystal. The diffraction beams obtained for the thin silver film have the same characteristic fine structure, which varies with the angle of incidence, as that previously found for a more massive silver crystal (this *J.*, 1932, **50**, 616), except that the relative intensities of the components of one of the lowest voltage beams for the silver film are reversed. As previously observed (see preceding abstract) the fine structure of the diffraction beams for a gold crystal differs from that of the corresponding beams of a silver crystal. Deviations from the plane grating formula for normal incidence are the same for the beams from the thin film as for those from a more massive silver crystal. These results substantiate the previous evidence (this *J.*, 1932, **50**, 616, and preceding abstract) that the fine structure characteristics are at least partly determined by the nature of the atoms composing the crystal rather than by the lattice itself.—S. G.

The Crystalline State of Thin Sputtered Films of Platinum. G. P. Thomson, Norman Stuart, and C. A. Murison (*Proc. Phys. Soc.*, 1933, **45**, 381–387; discussion, 387–388).—Films of platinum sputtered in various gases have been examined by the method of electron diffraction. They often show patterns which indicate that the small crystals are oriented with one face parallel to the face of the specimen, the crystals being otherwise arranged at random. The

width of the diffraction rings shows that in many cases the size of the crystals is of the order 5×10^{-7} cm. Some films of platinum dioxide indicated crystals of dimensions 2×10^{-7} cm.—J. S. G. T.

X-Ray Analysis of Iron–Tin Alloys. W. F. Ehret and A. F. Westgren (*J. Amer. Chem. Soc.*, 1933, **55**, 1339–1351).—The alloys were made in a vacuum furnace and given various treatments in evacuated glass or quartz tubes. One case of non-uniformity was found, the 70% tin alloy separating into two layers, β and $FeSn_2$. The following results were obtained. α-phase—solid solution of tin in α-iron. Solubility at 680° C. 9·8% tin. Length of cube edge in body-centred α-iron lattice increases linearly with increase of tin. β-phase—hexagonal structure with narrow homogeneity range. Corresponds with 3FeSn. β′-phase—possibly a mixture of phases, appearing in alloys containing 27–59% tin. β″-phase—hexagonal, probably $2Fe_2Sn$. γ-phase—nickel arsenide structure. $FeSn_2$ phase—probably hexagonal with narrow range of homogeneity. Sn phase—where occurring in a number of alloys does not differ from pure tin. Iron and all the other phases in the system are therefore insoluble in tin. The discrepancies between the X-ray results and the previously published thermal diagram of Edwards and Preece are discussed. —R. G.

Diffraction of Low-Speed Electrons by a Tungsten Single Crystal. Wayne T. Sproull (*Phys. Rev.*, 1933, **43**, [ii] 516–526).—Single crystals of tungsten were ground and polished so as to give plane surfaces parallel to the (1–1–2) and (1–0–0) planes of the crystal. After thorough outgassing, the diffraction of electrons was then studied, and the following characteristics were noted. (1) The diffracted beams on the whole are less intense, less sharp in co-latitude and azimuth, and have a slower rate of growth and decay than those observed by other workers for nickel, copper, and silver. (2) The volume interference condition plays a relatively greater rôle than in the other metals. These differences are probably due to the fact that in the body-centred cubic structure of tungsten, the planes studied are relatively closer together but more sparsely populated by atoms than those examined in other cases, with the result that the electrons can penetrate the first layer of atoms more easily. The opposite extreme in which the diffraction pattern is due almost entirely to surface interference is found in the case of mica, where the cleavage planes are very densely populated, but spaced at relatively great distances.—W. H.-R.

The Crystal Structure of Uranium. Thomas A. Wilson (*Physics*, 1933, **4**, 148–152).—A method for the X-ray analysis of powders derived from crystals of low symmetry is described. Uranium is shown to crystallize in space-group C_{2h}^{3} of the monoclinic system, with 2 atoms in each crystallographic cell of dimensions $a = 2{\cdot}829$ A.; $b = 4{\cdot}887$ A.; $c = 3{\cdot}308$ A. Axial ratios are 0·5791 : 1 : 0·6771. The corresponding density is 19·05. Uranium atoms appear to be prolate spheroids with major axis of length 3·425 A. and minor axis 2·826 A.—J. S. G. T.

On Co-operative Phenomena [Secondary Structure of Crystals, and Ferromagnetism]. F. Zwicky (*Phys. Rev.*, 1933, [ii], **43**, 270–278).—The term co-operative phenomena is used to describe phenomena due to the interaction of a large number of elementary particles (electrons, atoms, &c.), the interaction extending over distances which are much greater than the usual action radii involved in the effect of a particle on its immediate neighbours. Z. claims that this kind of phenomenon is effective in the recrystallization of metals, the secondary structure of crystals, and ferromagnetism. Secondary structures are suggested to account for the magnetic properties of single crystals of iron, nickel, and cobalt.—W. H.-R.

On the Magnetization of Ferromagnetic Crystals. Francis Bitter (*Phys. Rev.*, 1933, [ii], **43**, 655–660).—The function E_θ was previously (Bitter, *J.*, this volume, p. 231) described, and gives the energy of a ferromagnetic crystal

as a function of the direction of magnetization. Photographs are given of plaster models which represent E_0 for (*a*) undistorted crystals of nickel and iron in zero applied field; (*b*) undistorted crystals of iron in a field of 100 oersteds parallel to the [100], [110], and [111] axes, respectively; and (*c*) iron crystals distorted by compression and extension along the above axes. Magnetization curves for distorted crystals are calculated and illustrated.—W. H.-R.

IV.—CORROSION

(Continued from pp. 241-244.)

Corrosion Research on Light Metals. Freeman Horn (*Met. Ind.* (*Lond.*), 1933, **42**, 173–176, 197–199, 253–254; discussion, 281–282; also (report with discussion) *Chem. and Ind.*, 1933, **52**, 59–60; and (abstract) *Found. Trade J.*, 1933, **48**, 162).—Read before the Chemical Engineering Group of the Society of Chemical Industry. The nature and direction of research on the corrosion of light metals are indicated. Parallel with this research is an investigation into the methods of treating metal surfaces to prevent corrosion. The 3 main fields in this latter investigation are metallizing by spraying or rolling, plating with zinc on chromium and oxidizing chemically or electrolytically. These methods are described, especially the last, of which the Bengough anodic process is the most successful from the point of view of corrosion-resistance. Research is also being extended in the direction of magnesium alloys, but with less success at present, the best method so far being the addition of manganese as an alloying metal.—J. H. W.

Corrosion of Aluminium and Its Alloys. H. Sutton (*Met. Ind.* (*Lond.*), 1933, **42**, 332).—A letter commenting on a paper read by Freeman Horn (cf. preceding abstract). The superiority of the Panalumin or Jirotka process to the anodic system or any chromate dip, as claimed by C. J. Goodwin, is controverted.—J. H. W.

Corrosion of Copper by Coke. Anon. (*Architect and Builder*, 1931, **125**, 231–232; *Building Sci. Abs.*, 1931, [N.S.], **4**, 57).—It is reported that tests carried out by the City of Birmingham Gas Department have led to the conclusion that the use of coke fuel as compared with coal for copper flue-back boilers under the conditions usual in kitchen ranges does not cause any increase of external corrosion. Protective surface treatment of such boilers appears to be neither necessary nor desirable. Boilers of cold-rolled copper show no superiority over those of hot-rolled copper. The use of specially refined copper is advisable. In manufacturing the brazing should be smoothly finished, external projections due to overlaps should be avoided; welding is suggested. —S. G.

Mineralization, Electrolytic Treatment and Radiographic Examination of Copper and Bronze Objects from Nuzi. Rutherford J. Gettens (*Tech. Studies Field Fine Arts*, 1933, **1**, 119–142; *C. Abs.*, 1933, **27**, 1598).—The mineralization of nails found at Nuzi, Iraq, which had been buried about 3500 years under 130 cm. of stiff damp clay, was studied by cross-sectioning the nails along various axes so that all the interior zones would be exposed. Four major zones were observed in the spike portion of the nails: (1) a central core having all the properties of native metallic copper; (2) an inner, nearly colourless zone, translucent where pure, consisting chiefly of CuCl and corresponding with the rare mineral nantokite; the minor components of this layer are distributed in well-defined layers as follows: (*a*) nearest the centre a black opaque layer appearing to be a form of cerargyrite (AgCl); (*b*) a zone of nantokite which is nearly colourless and free from minor constituents; (*c*) a second blank opaque layer of cerargyrite apparently identical with (*a*) but much thinner;

(*d*) a reddish-brown translucent layer having the characteristics of an iron compound consisting probably of a hydrated ferric oxide of the limonite ($2Fe_2O_3.3H_2O$) type; (*e*) a colourless translucent layer apparently of pure nantokite which serves as a matrix and chief component of the whole zone; (3) a deep red opaque zone of cuprite (Cu_2O); (4) a thick outer zone of green oxychloride of copper corresponding to the atacamite, ($CuCl_2 \cdot 3Cu(OH)_2$). From the study of the corrosion products surrounding the copper core, it is evident that reactions have taken place which are similar to those observed under artificial conditions by Bengough *et al.* (this *J.*, 1920, **23**, 65–135), Lean and Whatmough (*J. Chem. Soc.*, 1898, **73**, 150) and Mellor ("Inorganic and Theoretical Chemistry," **1923**, (III), 157–168). This is apparently the first time that the actual presence of CuCl as an intermediate product of corrosion has been reported. The probable causes of the presence of the minor components of zone (2) are discussed. From the experience gained in the electrolytic treatment of the copper nails and also of bronze objects, it is concluded that the method will not bring back original outlines where mineralization has resulted in the almost complete transformation of the objects to the basic copper chloride; this product lacks uniformity and compactness, and is usually penetrated with earthy material. When the chief mineral product is cuprite, electrolysis is successful so far as the recovery of form is concerned, but if the object has been completely transformed to cuprite, even after electrolytic treatment it will be extremely brittle. Only when it has a metallic core surrounded by a layer of cuprite may one hope to restore the object so that it will have both form and rigidity. A study of radiographs of several copper nails and a subsequent sectioning and electrolytic treatment showed that diagnosis of the internal structure of badly mineralized copper and bronze objects (especially small ones) is much aided by the use of X-rays.—S. G.

Solubility of Lead in the Municipal Water of Leipzig. —— Stich (*Pharm. Zeit.*, 1930, **75**, 1262–1263; *Building Sci. Abs.*, 1931, [N.S.], **4**, 57).—The results of tests of the solubility of lead shavings and pipes in distilled and municipal drinking water emphasize the need for constant control of municipal water supplies in contact with lead conduits.—S. G.

Some Observations on the Corrosion of Lead. A. H. Loveless, T. A. S. Davie, and W. Wright (*J. Royal Tech. Coll.* (*Glasgow*), 1933, **3**, (1), 57–64).—Investigations on the corrosion of lead by sulphuric acid of concentrations 30 to 96·5% at 50° C. show that the resistance offered by lead to attack is due largely to the protective coating of lead sulphate formed by the initial attack, and that the sulphate film formed is less coherent with increasing concentrations of acid. The effect of temperature (0°–200° C.) on the rate of attack depends on the concentration of the acid. Below 93% the increase in the rate of attack is more marked at higher temperatures, whilst above this concentration the increase is greater at the lower temperature ranges. The application of stress (0–200 lb./in.^{2}) increases the rate of corrosion and is noticeable with quite low stresses, whilst there is a rapid increase in the rate of attack when the stress exceeds 100 lb./in.^{2}. The effect of the applied stress on the lead sulphate film is to produce numerous cracks and allow the acid to penetrate to the metal below. Corrosion by hydrochloric acid at concentrations from 0 to 40%, and at two temperatures 15° and 100° C. show that the rate of attack is connected with the solubility of lead chloride in the hydrochloric acids solutions.—J. W. D.

Atmospheric Corrosion of Non-Ferrous Metals and Alloys. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 490).—A brief report of atmospheric corrosion tests on 24 non-ferrous metals and alloys carried out under the auspices of the Sub-Committee on Atmospheric Corrosion of Committee B–3 on Non-Ferrous Metals and Alloys of the American Society for Testing Materials. See this *J.*, 1932, **50**, 548.—J. H. W.

Some Comparative Corrosion-Fatigue Tests Employing Two Types of Stressing Action. H. J. Gough and D. G. Sopwith (*Iron Steel Inst. Advance Copy*, 1933, (May), 1–31).—Corrosion-fatigue tests employing 2 types of stressing have been made on a cold-drawn 0·5% carbon steel, 3 "non-corroding" steels, Duralumin and a magnesium alloy containing 2·5% aluminium. The 2 types of stressing were reversed direct stresses and reversed flexural stresses at a frequency of about 2,200 cycles/min. The corroding medium was a fine air-borne spray of a 3% salt solution. *S/N* curves were plotted on a 25-million basis. It was found that in no case did the curves in the spray tests show a tendency to become parallel to the *N*-axis, *i.e.* no "corrosion-fatigue limit" was observed. After a certain endurance, the curves became simple exponentials. The curves obtained were of 3 types: (1) uniform slope, 0·5% carbon steel, and 18 : 8 chromium–nickel steel (direct stress); (2) decreasing curvature merging into a uniform slope, 15% chromium and 17 : 1 chromium–nickel steels and Duralumin, and 18 : 8 chromium–nickel steel (bending stress); (3) increasing curvature merging into uniform slope, magnesium alloy.

—J. H. W.

Corrosion and Residual Current. F. Tödt (*Z. Elektrochem.*, 1933, **39**, 146–147).—Experimental results on corrosion and residual current provide conclusive evidence that the mechanism of oxygen depolarization corrosion can be reproduced and measured galvanometrically. The determination of the current strength gives a measure of the oxygen produced and diffused on the noble metal surfaces.—J. H. W.

Fixed Surface Film Reactions. Leif Tronstad (*Light Metals Research*, 1933, **2**, (23), 11–16).—Translated from *Z. Metallkunde*, 1932, **24**, 185–188. See this *J.*, 1932, **50**, 741.—J. C. C.

Other's Views on "Modern Metals." G. C. McCormick (*Chem. and Met. Eng.*, 1932, **39**, 679).—Letter to the Editor directing attention to the danger of an unguided use of the data sheets previously published, *ibid.*, 1932, **39**, 504, 567.—F. J.

V.—PROTECTION

(Other than Electrodeposition.)

(Continued from pp. 245–249.)

Formation of Aluminium Oxide Film and Its Colouring. Seiji Kaneko and Chūjiro Nemoto (*Kōgyō Kwagaku Zasshi* (*J. Soc. Chem. Ind., Japan*), 1933, **36**, (3)).—[In Japanese, with English abstract in supplemental binding, pp. 116–117B.] The following solutions are suitable for the formation of an oxide film on the aluminium anode by electrolysis: (*a*) 0·8*N*-H_3PO_4; (*b*) 0·8*N*-H_2CrO_4; (*c*) 1·0*N*-$C_2H_2O_4$; (*d*) 1·0*N*-H_3PO_4 + 0·2*N*-NaOH; (*e*) 1·0*N*-H_3BO_3 + 0·35*N*-NaOH; (*f*) 1·0*N*-H_2CrO_4 + 0·2*N*-NaOH; (*g*) 1·0*N*-$C_2H_2O_4$ + 0·5*N*-NaOH. An oxide film can be formed by electrolyzing one of the above solutions at 100 v. During electrolysis the temperature of the solution is kept at 25° C. Of these solutions, (*d*) is the most suitable for dyeing. Aluminium oxide can be dyed with direct, acid, mordant, and acid mordant colours; basic colours are not suitable. Some of the colours suitable for this purpose are: red—alizarine sice; orange—alizarine orange SW pdr; yellow—azoflavine FFN; green—union green B; blue—water blue; violet—alkali violet ROO; black—alizarine black for silk pdr.—S. G.

X-Ray Investigations of Electrolytically-Oxidized Aluminium. E. Schmid and G. Wassermann (*Mitt. Material., Sonderheft* **21**, 1933, 83–87; and (abbreviated) *Automobiltech.-Z.*, 1932, **35**, 396–397).—Reprint from *Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, **4**, 79–94. See *J.*, this volume, p. 84.—J. W.

Coating and Colouring Aluminium by Alumilite Process. H. Bengston and R. E. Pettit (*Chem. and Met. Eng.*, 1933, **40**, 135).—Abstract of article in *Machinist* (*Eur. Edn.*), 1933, **77**, 76–79; see *J.*, this volume, p. 245.—F. J.

The Characteristics of Sprayed Metal Coatings.—II. H. Reininger (*Z. Metallkunde*, 1933, **25**, 71–73).—Cf. *J.*, this volume, p. 247. The structure of a sprayed metal coating is similar to that of a sand coating, *i.e.* it consists of a pile of irregularly shaped particles held together solely by mutual clamping and surface pressures and interspersed with pores and oxide inclusions. A closer packing of the particles can be effected by surface pressure by cold-rolling, by treatment with rotating steel wire brushes, by annealing in inert gases, or by the application of protective coatings.—M. H.

Metal Spraying—the Process and Devices and the Influence upon Welding of Some Recent Developments. H. B. Rice (*J. Amer. Welding Soc.*, 1932, **11**, (9), 26–30).—The principles of the process and the apparatus used are described in detail. The applications are divided into two general fields—thin impervious coatings over large areas for resisting corrosion, and heavy coatings over small areas for replacement of worn sections, or for resisting abrasion. Examples from both fields are illustrated and described. In the former, zinc, aluminium, lead, and tin are the most commonly used metals; in the latter, hard or high melting-point metals are employed. The limitations of the process are discussed, and it is compared with welding for the applications where both processes are possible.—H. W. G. H.

Combating Corrosion of Piping. C. E. Joos and V. A. Rohlin (*Heating, Piping, and Air Conditioning*, 1932, **4**, 606–607, 671–674; *C. Abs.*, 1933, **27**, 259).—The significance of the p_H reading as an index of the corrosive tendencies of a water is outlined. Deaeration raises the p_H value through the removal of carbon dioxide, but this method is ineffective if the low p_H is due to the presence of a mineral acid. Different types of deaerator are described. The return condensate from vacuum heating systems contains no hardness. It is normally high in oxygen and low in p_H because of carbon dioxide, this giving the water intensively corrosive qualities. The presence of oxygen is due to interleakage or to the return of the condensate to a surge tank. The low p_H is commonly due to the carbon dioxide generated by the break up of the carbonates in the boiler, when a portion of the gas redissolves.—S. G.

The Fight Against Rust. E. Maass and A. Seifert (*Automobiltech. Z.*, 1932, **35**, 287).—Report of addresses given before the (German) National Committee for Metal Protection, Berlin.—P. M. C. R.

VI.—ELECTRODEPOSITION

(Continued from pp. 249–256.)

Modern Chromium Plating Plant. —— Birett (*Oberflächentechnik*, 1933, **10**, 25–27).—Cf. *J.*, this volume, pp. 136, 251. Recent improvements introduced into chromium plating works in Germany include the use of iron tanks set in a hot-water bath to keep the temperature at 45°–50° C. The sides of the tanks are protected from stray currents by thick sheets of glass held loosely against them. Some new types of suspending hooks are also illustrated and a brief account of modern chromium-plating practice is given.—A. R. P.

A Chromium Plating Bath with the Fluoride Ion. Alfred Perlenfein (*Rensselaer Polytechnic Inst. Eng. Sci. Series, Bull.* No. 39, 1933, 1–36, and (short abstract) *Iron Age*, 1933, **131**, 539).—By substituting sodium fluoride for sulphuric acid in the ordinary chromium plating bath brighter plates can be obtained with a wider range of current density and temperature; at high current densities the efficiency is much improved, and hence plating is more rapid and the plate more impervious so that a nickel undercoat on iron is generally unnecessary. Optimum results are obtained with

10 grm. of sodium fluoride with 125–300 grm./litre of chromic acid; with 8 grm./litre of fluoride fairly good results are obtained, but with 15 grm./litre no plate is obtained at low current density and very poor plates at high current density. The throwing power of the bath increases with the current density and is best with 10 grm./litre of fluoride. At 46° C. the current efficiency increases from 15% at 15 amp./dm.^{2} to 27% at 65 amp./dm.^{2} and higher, whilst at 28° C. an efficiency of 26% is obtained at 25 amp./dm.^{2}. The current density range at which bright plates can be obtained extends from 3 to 7 amp./dm.^{2} at 20° C. to 5–18 amp./dm.^{2} at 35° C. and from 15 to more than 75 amp./dm.^{2} at 45° C.—A. R. P.

Grey Chromium Plating. Richard Justh (*Oberflächentechnik*, 1933, **10**, 27–28).—To produce a matt-grey finish the chromium bath is made up by dissolving in 1 litre of water 500–600 grm. of chromium trioxide which has previously been heated at 170°–200° C. to obtain a small proportion of lower oxides (about 20 grm.). The bath is operated at 15°–18° C. with a current density of 20 amp./dm.^{2} which produces a deposit 0·02 mm. thick in 1 hour. At 0° C. with 80 amp./dm.^{2} the bath gives good hard grey deposits with a current efficiency of 50–60%. The metal is deposited in minute cubic crystals and is extremely hard, but can be polished with chromic oxide paste.—A. R. P.

Chromium Plating Screw Gauges. Anon. (*Machinery* (*Lond.*), 1933, **41**, 573–574).—It is shown that the usual practice for making allowance for the thickness of the deposit on plated gauges which consists in finishing them with all their diameters reduced by twice the deposit thickness is incorrect. If a uniform deposit is applied to a standard Whitworth gauge made in this manner, the thread form will be distorted, and over half the deposit on the flanks must be ground away. The need for a modified thread form is suggested. —J. C. C.

Electro-Chromium and Tool Work. E. E. Halls (*Machinist* (*Eur. Edn.*), 1933, **77**, 189–190E).—The plating scheme recommended for tool work is: (1) degrease in trichlorethylene; (2) acid clean; (3) polish; (4) degrease in electrolytic alkali bath; (4) rinse in 10% sulphuric acid; (6) nickel plate in hot agitated filtered solution; (7) buff; (8) degrease as in (4); (9) rinse in sulphuric acid as in (5); (10) chromium plate in a solution of 40 aq. chromic acid and 4 oz. sulphuric acid per gall. at 40°–50° C. and 70–80 amp./ft.^{2} at 3½–4 v.; (11) lightly buff.—J. H. W.

Surface Hardening by Chromium Plating. K. Altmannsberger (*Oberflächentechnik*, 1933, **10**, 41–42).—The use of chromium in plating tools and precision instruments is discussed.—A. R. P.

The Economic Importance of Chromium Plate. Richard Justh (*Oberflächentechnik*, 1933, **10**, 42–43).—The use and value of chromium plate are described.—A. R. P.

Free Cyanide in Copper Electroplating. L. C. Pan (*Metal Cleaning and Finishing*, 1932, **4**, 585–588, 651–654, 658; *C. Abs.*, 1932, **27**, 1277).—The resistivity of a cyanide copper solution decreases rapidly with increasing amounts of free NaCN or Na_2CO_3, NaCN being the better conductor. The anode polarization is practically inversely proportional to the content of free NaCN, but only in the absence of Na_2CO_3. When the solution contains sufficient Na_2CO_3 (40 grm./litre), the latter acts as anode depolarizer, and any variation in the free NaCN content does not further affect the anode polarization appreciably. The cathode polarization is practically unaffected by any change in the free NaCN content either in the presence or absence of Na_2CO_3. In the absence of Na_2CO_3 the bath voltage decreases rapidly with increasing amounts of free NaCN, this relationship being hyperbolic. In the presence of Na_2CO_3 the effect of free NaCN on the bath voltage is negligible. Either in the presence or absence of Na_2CO_3 there is a sharp maximum throwing power at a molar ratio of approximately 0·27 between free NaCN and

copper. In the presence of Na_2CO_3, however, the maximum throwing power is 65% higher than in the absence of Na_2CO_3. The anode efficiency is almost directly proportional to the free NaCN content and approaches 100% at a molar ratio of 2·5 between free NaCN and copper. The efficiency is generally higher in the absence of Na_2CO_3. By increasing the molar ratio of free NaCN to copper from 0 to 0·7, the cathode efficiency is decreased to one half. It is reduced to 0 when the molar ratio reaches 2·3. In the presence of Na_2CO_3 the anode film is blue and soluble, causing little polarization. When Na_2CO_3 is absent and the free NaCN low, the anode film is brown. No anode film is visible when the free NaCN amounts to 14 grm./litre or more. The character of the deposit is improved by increasing the content of free NaCN. The presence of Na_2CO_3 makes the deposit generally brighter than that obtained when Na_2CO_3 is absent.—S. G.

Gold as a Corrosion Protection. René Leonhardt and P. Steen (*Oberflächentechnik*, 1933, **10**, 83–85).—Very thin gold plate can be applied to nickel plated articles to protect them against corrosion and enhance their beauty. The plate is free from porosity after polishing, adheres well, and closes up any pores that may be present in the nickel. Suitable plating baths are described. —A. R. P.

Nickel Plating of Fabricated Zinc in a Barrel. Albert Hirsch (*Electrochem. Soc. Preprint*, **1933**, May, 129–133).—Zinc-base die-castings are not improved by ball-burnishing and the burnished surface is unsatisfactory for plating, since copper or nickel deposits thereon readily peel when polished. Citrate nickel baths give poor results on burnished zinc, and baths containing magnesium sulphate produce black streaks. Satisfactory plates on zinc die-castings may be obtained by the following procedure: the articles as they come from the press are tumbled in a barrel containing maplewood sawdust and pumice to remove the grease; treatment for 5 hrs. at 30 r.p.m. is required, after which the articles are cleaned in a solution containing sodium carbonate 4, trisodium-phosphate 4, and sodium hydroxide 2 oz./gall. After rinsing, the articles are plated in a bath containing cuprous cyanide 3 and sodium cyanide 4·5 oz./gall. using 12 v. at 60°–77° C. for 30 minutes. The copper deposit (0·2 oz./ft.^{2}) is ball-burnished in a barrel for 20 minutes, again cleaned in the alkali cleaner, rinsed, and barrel-plated in a solution containing nickel sulphate crystals 14–28, nickel chloride crystals 3–6, boric acid 2, sodium metaborate 0·1 and ammonia 4·5–9 oz./gall.; 6–12 v. are used at 32°–60° C. for 1 hr.—A. R. P.

The Improvement of Sheet Zinc by Electroplating. T. Hausen (*Oberflächentechnik*, 1933, **10**, 55–56).—Methods of plating zinc sheet articles with nickel and other metals are described. Deeply recessed articles must first be cleaned in xylene. In all cases an electrolytic clean is recommended, after which the article is dipped in 1% hydrofluoric acid or in 5–10% hydrochloric acid for a few seconds to remove surface films. A preliminary nickel coating is essential; this should be produced in a bath containing only 70 grm./litre of nickel sulphate, together with sodium citrate or 100–200 grm./litre of sodium sulphate to prevent dissolution of the zinc during plating. A nickel deposit of 0·0075 mm. thickness is sufficient to protect the zinc in further plating operations and to prevent diffusion of any finishing coat into the metal. Chromium or copper are the usual finishing coatings applied.—A. R. P.

The Question of the Electrodeposition of Alloys. I. Nickel–Cobalt Alloys. S. A. Pletenew and W. W. Kuznetzova (*Z. Elektrochem.*, 1933, **39**, 201–204).—The influence of the current density, p_H of the solution, temperature, and rate of stirring on the deposition of cobalt–nickel alloys from sulphate solutions has been investigated, and the results of Fink and Lah were not generally confirmed. The amount of cobalt obtained by the deposition of a 40% cobalt alloy from a sulphate solution in which the ratio of nickel to cobalt was 15 was determined.—J. H. W.

On the Electrochemical Behaviour of Palladium. The Electrodeposition of Palladium and Palladium–Silver Alloys from Complex Salt Solutions. G. Grube and D. Beischer (*Z. Elektrochem.*, 1933, **39**, 131–133).—Joint electrodeposition of palladium and silver from potassium cyanide and potassium thiocyanate baths has been effected. Deposition of metal from a potassium palladium cyanide solution takes place with a current efficiency of less than 1%. With a mercury cathode, reduction products of the palladium salts, having similar properties, were formed. A silver deposit, with a colour and crystal size similar to those of a deposit from a potassium cyanide–silver bath, can be obtained from a potassium thiocyanate–silver bath at ordinary temperature. With low current densities, the deposits from the palladium, potassium thiocyanate baths are darker in colour and contain a larger amount of organic material.—J. H. W.

A Study of Cyanide Zinc Plating Baths Using the Aluminium–Mercury–Zinc Anode. A. Kenneth Graham (*Electrochem. Soc. Preprint*, **1933**, May, 135–146).—The behaviour of zinc anodes containing 0·5% aluminium, and 0·3% mercury in *N*-zinc cyanide baths at 20 amp./ft.^{2} and 120° F. (49° C.) has been investigated with various quantities of sodium cyanide and sodium hydroxide. Anode and cathode efficiencies are 100%, the anode polarization and bath voltage are low for values of R above 2 (R = normality of sodium cyanide + normality of sodium hydroxide divided by the normality of zinc cyanide), and 22-hr. cathodes are very smooth and of good texture and colour when the sodium hydroxide is 4·5–10 oz./gall. and the sodium cyanide 5–8·5 oz./gall. The best bath is that containing 7 oz./gall. each of sodium cyanide and sodium hydroxide; addition of sodium carbonate up to 4 oz./gall. produces no effect, but reduction of the zinc cyanide to 0·75*N* lowers the efficiency at both electrodes and gives less favourable values of anode polarization and bath voltage. A pure zinc anode gives too high an anode efficiency and a large amount of sludge.—A. R. P.

The Adsorption of Colloids by Metallic Surfaces and Its Influence on the Adherence of Electrolytic Deposits. P. Jacquet (*Compt. rend.*, 1933, **196**, 921–923; and (abstract) *Génie civil*, 1933, **102**, 334).—To test if the poor adherence of electrodeposits of metals from solutions containing colloids is due to the existence of a skin of colloid on the base metal, a copper sheet, carefully polished, degreased, tempered for 30 sec. in a given colloidal solution and washed, was placed in a solution containing 125 grm. copper sulphate and 50 grm. sulphuric acid per litre and electrolysed for 1 hr. at 2 amp./dm.^{2}. The resulting deposit was examined for adherence by various methods. The colloids arranged themselves in 2 groups: (*a*) those that affect the adherence, such as proteins, (*b*) those that do not, the hydroxyl colloids such as gums and dextrin. In the first group, the adherence varies with the concentration of the colloid solution; the time of tempering is practically immaterial, and the colloid film adheres strongly to the sheet and is not easily removed.—J. H. W.

The Requirements for Good Electroplating and the Characteristics of the Most Important Plates. Hugo Krause (*Oberflächentechnik*, 1933, **10**, 15–20).—The various faults which may occur in plating and methods for avoiding them are discussed, together with the structure and characteristics of nickel, iron, zinc, cadmium, tin, lead, copper, brass, silver, and gold deposited from several types of bath.—A. R. P.

Resistance in Electrotype Metals. Samuel Epstein (*Platers' Guide*, 1933, **29**, (3), 9–11).—A summary of the results of an examination of samples of copper and nickel electrotypes recorded in an address to the Ohio State Electroplaters' Association (U.S.A.).—J. H. W.

P_3 in Plating Technique. Richard Justh (*Oberflächentechnik*, 1933, **10**, 57; and *Metallwaren-Ind. u. Galvanotech.*, 1933, **31**, 127–128).—The use of trisodium phosphate solutions as alkaline cleaning baths in plating shops is discussed.—A. R. P.

Practical Plating. Preparation of Work. I.—Polishing. II.—Cleaning. E. A. Ollard (*Met. Ind.* (*Lond.*), 1933, **42**, 403–405, 451–454).—(I.—) Polishing is distinguished by an abrasive and by a burnishing action, and an appreciation of the mechanism of these two effects will assist in the selection of suitable polishing materials and technique. Cleaning is largely concerned with the removal of grease by: (*a*) washing in an organic solvent; (*b*) treatment by organic vapours; (*c*) boiling in an alkaline solution; (*d*) electrolytic cleaning; (*e*) scouring; (*f*) scratch-brushing and (*g*) various other processes. These are all discussed in some detail. (II.—) Describes in detail cleaning with trichlorethylene, electrolysis, scouring, and scratch-brushing, and summarizes the various methods that have been described.—J. H. W.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition and Electro-Refining.)

(Continued from pp. 256–257.)

Electrolysis of Silver-Bearing Thiosulphate Solutions. K. Hickman, W. Weyerts, and O. E. Goehler (*Indust. and Eng. Chem.*, 1933, **25**, 202–212).—Much of the silver accumulating in motion picture fixing baths used to be reclaimed as silver sulphide. It is now recovered as metallic silver by electrolysis, the bath which used to be thrown to waste being replenished and re-circulated. The electrolytic regeneration involves the use of large cells containing 100 ft.^{2} of cathode surface through which a current of 300 amp. is passed at 1–1·5 v. At the anode, thiosulphate is oxidized to tetrathionate and trithionate sulphate; at the cathode, silver is deposited with small quantities of silver sulphide and gelatine; some of the tetrathionate is reduced to thiosulphate. Vigorous agitation, together with the presence of acid, sulphite, and certain promoting agents, is essential. The yield per million ft. of film is about 1200 oz. The consumption of fixing baths is reduced to 35% of the quantity previously used.—F. J.

VIII.—REFINING

(Including Electro-Refining.)

(Continued from p. 257.)

Description of Continuous Lead Refining at the Works of the Broken Hill Associated Smelters Proprietary Ltd., Port Pirie, South Australia. G. K. Williams (*Proc. Austral. Inst. Min. Met.*, 1932, (**87**), 75–133, and (abstract) *Chem. Met. & Min. Rev.*, 1932, **25**, 8–12).—A theoretical and mathematical discussion with curves of the mechanism of the Parkes process of desilverizing lead is followed by descriptions of the old batch process of working and of the modifications introduced to convert this process into a continuous operation with, as far as possible, gravity flow of the lead through the various stages. The latter method effects considerable economy in fuel and labour cost and allows much higher rate of treatment; it gives a smaller quantity of by-products from which antimony and silver can be recovered, and yields a much purer lead. The procedure is as follows: the blast-furnace lead (A) from the storage kettle is pumped continuously into one end of a softening furnace where it is heated to 750° C. by two oil-burners, whilst a current of furnace gases with 6–8% of oxygen is passed counter-current to the flow of metal to oxidize the antimony and arsenic and drive the dross towards an overflow notch at the bullion intake end of the furnace. The softened lead (B) which flows continuously from a notch at the other end of the furnace runs into a degolding kettle while the dross passes through a dross-

ing furnace where its lead content is reduced by treatment with fine coal, the reduced lead being returned intermittently to the softener. In the degolding kettle 8 lb. of zinc per ton of lead are added and the temperature is maintained at 500° C. at the top and 330° C. at the bottom; the dross containing the gold is skimmed off, liquated, and the lead returned to the kettle. The degolded bullion (C) is siphoned from the bottom of the kettle to a storage kettle, from which it runs continuously to the desilverizing kettle, which is operated in a similar way to the degolding kettle, except that more zinc is added to form a layer of zinc above the lead through which the new lead is added until the upper layer is 3 ft. thick and contains 6000 oz./ton of silver, when it is removed and fresh zinc added. The desilverized lead (D) passes through a second softening furnace similar to the first, and is then ready for the market (E). The products from the various stages in the purification have the composition given in the following table :—

	A	B	C	D	E
Copper, %	0·068	0·070	0·0098	0·004	0·0004
Arsenic, %	0·182	0·0005	...	trace	nil
Antimony, %	0·410	0·03	...	0·028	0·0017
Zinc, %	nil	nil	0·16	0·560	0·0002
Gold, grm./ton	3·105	3·2	0·35	nil	nil
Silver, oz./ton	47·2 oz.	48·1	45·7	0·03	0·03

The first softener dross contains arsenic 8·6, antimony 20, and lead 56·3%; the final dross, zinc 11 and antimony 0·5%; the gold dross, copper 10, zinc 32%, 350 oz./ton silver and 15 oz./ton gold, and the silver dross, lead 15, copper 0·5, zinc 64, and silver 20%. The weights of these residues per ton of refined lead are approximately 37·5, 15, 18·2, and 120 lb., respectively.—A. R. P.

IX.—ANALYSIS

(Continued from pp. 257–260.)

The Case Against Standardization of Chemical Analysis. P. F. Thompson (*Chem. Eng. Mining Rev.*, 1932, **25**, 31–32).—Abstract of a paper read before the Analytical Group of the Victorian Branch of the Australian Chemical Institute. It is claimed that it is not possible to standardize chemical analysis, since it is an art requiring skill and understanding and into which the personal element enters. The solution to the problem lies in the proper training of analytical chemists and in not reporting results so as to give a specious idea of their accuracy.—J. H. W.

The Case Against Standardization of Chemical Analysis. Clement Blazey. W. Rayner Hebblewhite. Edward S. Simpson. E. Holl. Miller. P. F. Thompson. G. R. Anderson. R. J. Craig (*Chem. Eng. Mining Rev.*, 1932–1933, **25**, 64–65, 99–102, 137–138, 174–175). Correspondence: C. B. claimed that standardization is of assistance in routine work and for referee analyses. W. R. H. stated that standardization of routine work left greater freedom for original research and was necessary in judging of specifications. E. S. S. considered that standardization cramped initiative and tended to give concordant but not necessarily accurate results. E. H. M. thought standardization useful when routine work was carried out by other than qualified chemists. An anonymous contributor feared that standardizing a method of analysis might hinder improvements in the method being effected. G. R. R. thought that standardization was of assistance to the manufacturer. R. J. C. stated that

there was a best procedure for every operation and standardization was the recording of that procedure. In his replies, P. F. T. restated his case and reviewed the evidence submitted against it.—J. H. W.

What Precautions Should be Observed in Sampling Alloys Containing Precious Metals. W. Stein (*Mitt. Forschungsinst. Edelmetalle*, 1932, **6**, 81–83).—Drillings should be made at intervals across the diagonals of the ingot; in thin ingots the drill should go right through, but in thick ingots both sides should be drilled to the centre of the ingot and the drillings from each side assayed separately to test for segregation. High-speed tool steel drills are best, as contamination of the sample with iron is avoided; in no case should lubricants be used.—A. R. P.

Determination of Various Metals in the Chromium Plating Bath. Darwin Harris (*Chemist-Analyst*, 1932, **21**, (5), 7).—For the determination of Cu, Fe, Ni, and Zn in the Cr plating bath the CrO_3 is removed with $Pb(NO_3)_2$ and the Fe, Ni, and Cu are precipitated by addition of Na_2O_2. The precipitate is dissolved in acid, and the Cu, Fe, and Ni are separated and determined in the usual way. Zn is determined as phosphate in the combined filtrates from the Ni glyoxime and the Na_2O_2 separation.—A. R. P.

A Systematic Analysis of "Widia" Metal. S. Zinberg (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1931**, (2–3), 119–121).—[In Russian.] The alloy is roasted in a Pt crucible to convert the W into WO_3, and the powder thus obtained is fused with 3 times its weight of $NaKCO_3$. The fusion is extracted with hot H_2O and the filtered solution treated with $HgNO_3$. The precipitate of Hg_2WO_4 is collected and ignited to WO_3 for weighing. The Co in the residue from the leaching is converted into a complex cobaltammine, the solution of which is electrolyzed for Co. Fe is determined iodometrically or gravimetrically as Fe_2O_3. C is determined in a separate sample by the usual combustion method.—D. N. S.

Tantalum and Columbium [Niobium] Cathodes versus Platinum Cathodes for Electro-Analysis. D. F. Calhane and C. Malcolm Alber (*Electrochem. Soc. Preprint*, **1933**, May, 61–67).—Ta and Nb cathodes give equally good results as Pt cathodes in the electrolytic determination of Cu from acid $CuSO_4$, Zn from Na_2ZnO_2, and Ni from ammoniacal $NiSO_4$ solutions. Good deposits of Ag can also be obtained on Ta and Nb cathodes from the usual electrolytes. In depositing Zn on Pt cathodes these must first be plated with Cu or Ag, but this is unnecessary when using Ta or Nb cathodes. Erratic results are obtained with Ta cathodes during repeated use, unless the surface is mechanically cleaned after every few depositions; Nb cathodes do not seem to suffer from this disadvantage.—A. R. P.

New Methods of Analysis of Materials Used in Aviation. J. Vásquez-Garriga (*Rev. Aeronautica*, 1932, **1**, 79–82; *C. Abs.*, 1933, **27**, 2119).—A brief description of quantitative X-ray spectroscopy as applied to metals and alloys.—S. G.

Electron Tube as Spark Producer in the Spectrum Analysis of Minute Quantities of Metals. —— Goroncy and —— Urban (*Z. anorg. Chem.*, 1933, **211**, 28–32).—The spark produced by the device described has the advantage of a very great constancy and protective action on the material with maximum efficiency. The spark is suitable for the spectrographic analysis of metals. Pb and Hg can be detected in amounts as small as 10^{-8} grm. in a drop.—M. H.

Chloramine as a Reagent in Volumetric Analysis. O. Tomíček and B. Sucharda (*Coll. Trav. chim. Tchécoslov*, 1932, **4**, 285–299).—$Sn^{\cdot\cdot}$ and $Sb^{\cdot\cdot\cdot}$ may be accurately determined by potentiometric titration in *N*-HCl at 55°–60° C. with a 0·1*N*-solution of chloramine (Na *p*-toluenesulphonechloramide). CO_2 should be passed into the flask during titration. Good results are also obtained by using methyl red as indicator. Standardization is best effected

with As_2O_3. The titre of the solution remains unchanged for 3 months when stored in a dark-coloured glass bottle.—A. R. P.

The Use of Potassium Hydroxide as a Fusion Reagent. P. F. Thompson (*Soc. Chem. Ind. Victoria Proc.*, 1932, **32**, 699–702).—The use of KOH is advocated for a variety of fusions of ores, &c. Fusion is carried out in a nickel crucible. Oxidation may be hastened by addition of a very small amount of sodium peroxide.—R. G.

On the Solubility of Nickel Dimethylglyoxime. P. Nuker (*Z. anal. Chem.*, 1932, **91**, 29–32).—The Ni dimethylglyoxime precipitate is more soluble in hot H_2O than in cold, C_2H_5OH increases the solubility, and $CH_3{\cdot}COOH$ or $CH_3{\cdot}COONa$ reduce it. For correct results, therefore, the solution should always be cooled before filtration and the minimum of C_2H_5OH used.—A. R. P.

Three Indicators. P. F. Thompson (*Soc. Chem. Ind. Victoria Proc.*, 1931, **31**, 536–544).—The use is described of dimethylglyoxime in the dichromate–iron titration, of a modified indicator for Zn titration and of a molybdo-ferrocyanide p_H indicator.—R. G.

The Use of Metallic Electrodes as Indicators. Sidney J. French and John M. Hamilton (*Proc. Indiana Acad. Sci.*, 1930, **40**, 171–174).—The features of the known metallic electrode indicators are reviewed. Al used with Rose's alloy was found to have advantages for acid solutions, giving a large change in e.m.f. at the end-point.—R. G.

The Reduction of Ferric Salts by Mercury (Borar's Method). F. H. Campbell and R. H. Hook (*Soc. Chem. Ind. Victoria Proc.*, 1931, **31**, 544–547).—The method was simplified by omitting the filtration of the excess Hg and drawing off a portion of the reduced solution through a cotton-wool filter fixed to the end of a pipette, for titration. A quantity of Hg sufficient to render the method rapid can be used and the determination is accurate. Re-oxidation is desirably slow.—R. G.

Dimethylglyoxime as a Test Reagent for Metals. Irwin Stone (*Chemist-Analyst*, 1932, **21**, (6), 8).—The reactions of Ni, Co, Bi, Fe″, Pd, Pt″, and Au with dimethylglyoxime are described.—A. R. P.

Spectrographic Investigations. XII.—On the Detection of Antimony, Arsenic, and Tellurium. Else Riedl (*Z. anorg. Chem.*, 1932, **209**, 356–363).—"Kahlbaum" As was found to contain traces of Ag, Cu, Fe, Pb, Sb, Sn, but to be free from Al, Bi, Cd, Hg, Mn, Si, Zn. Methods are described for the spectrographic detection of As, Sb, and Te. $2{\cdot}10^{-8}$ grm. As in Pb–As and Zn–As alloys and 10^{-7} grm. Te in Pb–Te and Bi–Te alloys can be detected with certainty. In solutions free from heavy metals the limit of detection lies at 0·01% As and 0·002% Te if 2 c.c. are evaporated in the arc. To increase the sensitivity an electrolytic method of deposition has been developed by which it is possible to detect $0{\cdot}5\times10^{-6}$ grm. As, $0{\cdot}05\times10^{-6}$ grm. Te, and $0{\cdot}05\times10^{-6}$ grm. Sb in 1 c.c. of solution.—M. H.

A Sensitive Test for Bismuth. Lewis Bernstein (*Chemist-Analyst*, 1932, **21**, (5), 15).—The test depends on the colour of the PbI_2 precipitated from a CH_3COOH solution of Bi to which $(CH_3CO_2)_2Pb$ has been added. Traces of Bi colour the PbI_2 orange to crimson.—A. R. P.

A Composite Reagent for Calcium. Gerald J. Cox and Mary L. Dodds (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1932, **4**, 361).—The reagent is made by dissolving 200 grm. of $H_2C_2O_4{,}2H_2O$ and 500 grm. of NH_4Cl in 3500 c.c. of water, adding 1000 c.c. of glacial CH_3COOH and 10 c.c. of 0·04% methyl-red solution, and filtering. For a determination 50 c.c. of the reagent are added to the HCl solution of Ca, the mixture boiled, and treated with NH_4OH until alkaline to precipitate CaC_2O_4.—A. R. P.

A New Reagent for Magnesium. C. Franklin Miller (*Chemist-Analyst*, 1932, **21**, (5), 6–7).—The HCl solution is treated with a 0·05% solution in dilute NaOH of the brown dye made by coupling tetrazobenzidine with

resorcinol; on addition of 10% NaOH to alkalinity a dark blue lake is formed if Mg is present. Ca gives a reddish precipitate in amounts exceeding the solubility of $Ca(OH)_2$ and Cd gives a light blue precipitate.—A. R. P.

Reactive Paper for Detecting Molybdenum; Application to the Detection and Rapid Determination of This Element in Steels. E. Bertrand (*Bull. Soc. Chim. Belg.*, 1932, **41**, 98–103).—A drop of the solution to be tested for Mo is placed on a piece of filter paper previously coated with a thin film of H_2WO_4, and one drop of an HCl solution of $SnCl_2$ is placed in the middle of the first drop. A grey-blue spot surrounded by a colourless halo appears when Mo is present; the intensity and rate of development of the colour are a function of the amount of Mo present.—A. R. P.

Characterization of the Chemical Nature of a Substance by its Catalytic Properties. The Case of Silver. Georges Denigès (*Bull. Soc. Pharm. Bordeaux*, 1932, **70**, 13–16; *Chem. Zentr.*, 1932, **103**, II, 747).—Traces of Ag may be detected by boiling the solution with $MnSO_4$ and $(NH_4)_2S_2O_8$ when $HMnO_4$ is formed if Ag is present in amounts exceeding 0·02 mg./litre. The method is suitable for the detection of traces of Ag on a metal surface.—A. R. P.

Some Reactions of Vanadium Carbide. S. E. Oldham and W. P. Fishel (*J. Amer. Chem. Soc.*, 1932, **54**, 3610–3612).—VC reacts with HCl at high temperatures to form CH_4, H_2, VCl_2, and VCl_3. It is insoluble in aqueous HCl, but is soluble in hot oxidizing acids, forming hydrated pentoxides.—R. G.

Studies of Various Methods for the Separation of the Common Elements into Groups. I.—The Precipitation by Ammonium Hydroxide. Ernest H. Swift and R. C. Barton (*J. Amer. Chem. Soc.*, 1932, **54**, 2219–2228).—The results are given of various modifications of the ammonia separation of Cr, Al, and Fe from Mn, Ni, Co, and Zn.—R. G.

On the Separation of Hafnium and Zirconium.—I. Wilhelm Prandtl (*Z. anorg. Chem.*, 1932, **208**, 420–426).—The separation is carried out by fractional precipitation with ferrocyanogen-ion which is based on the smaller solubility of hafnium ferrocyanide.—M. H.

Investigations into the Analytical Chemistry of Tantalum, Niobium and Their Mineral Associates. XXI.—A Reliable Method for the Quantitative Separation of Titanium from Tantalum and Niobium. W. R. Schoeller and C. Jahn (*Analyst*, 1932, **57**, 72–78).—The mixed oxides are fused with $K_2S_2O_7$, the melt is dissolved in hot water containing 2 grm. of $(NH_4)_2C_2O_4$; 5 grm. of sodium salicylate are added, and the boiling solution is treated with 20% $CaCl_2$ solution until no further precipitate forms. The precipitate is collected, washed with hot salicylate solution, and boiled with HCl and $KMnO_4$ to destroy oxalates; the Ta_2O_5 and Nb_2O_5 are then separated by boiling with tannin. The yellow Ti filtrate from the $CaCl_2$ treatment is boiled with $CH_3{\cdot}CO_2NH_4$, NH_4Cl, and tannin, and the red precipitate collected, washed with half-saturated NH_4Cl solution, ignited, and fused with $K_2S_2O_7$. The fusion is extracted with a 1% solution of tannin in 5% H_2SO_4 and the small quantity of earth acid precipitate collected, washed, and purified as usual. Ti is best determined by difference between the original weight and the weight of the Ta_2O_5 and Nb_2O_5.—A. R. P.

Investigations into the Analytical Chemistry of Tantalum, Niobium and Their Mineral Associates. XXII.—The Separation of the Earth Acids from Metals of the Hydrogen Sulphide Group. E. F. Waterhouse and W. R. Schoeller (*Analyst*, 1932, **57**, 284–289; discussion, 289–290).—Treatment with H_2S, of tartrate solutions containing the earth acids and Sb, Bi, and Cu yields a precipitate of Sb_2S_3, Bi_2S_3, and CuS which always contains small amounts of earth acids. The precipitate should be redissolved in H_2SO_4, HNO_3, and tartaric acid, the solution made ammoniacal and poured into $(NH_4)_2S$ solution to precipitate Bi_2S_3 and CuS, and the filtrate treated with CH_3COOH to

recover Sb_2S_3. Directions are given for the recovery of the Ta and Nb from the filtrates.—A. R. P.

Investigations into the Analytical Chemistry of Tantalum, Niobium and Their Mineral Associates. XXIII.—The Quantitative Separation of Tantalum, Niobium, Titanium, and Zirconium and a New Analytical Grouping. W. R. Schoeller and A. R. Powell (*Analyst*, 1932, **57**, 550–559).—From a neutral oxalate solution half saturated with NH_4Cl, tannin precipitates Ta, Nb, and Ti, whereas Zr, Hf, Th, and Al remain in solution; the former group is referred to as the "acid tannin group" and the latter as the "basic tannin group."
—A. R. P.

Determination of Small Quantities of Antimony in Solder in the Presence of Iron. C. W. Anderson (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1933, **5**, 52).—Fe interferes in the usual bromate determination of Sb, but its effect may be overcome by adding 25–30 c.c. of H_3PO_4 (*d* 1·37) to the solution before reducing the $SbCl_5$ with Na_2SO_3. The $NaBrO_3$ solution should be standardized against pure Sb solution to which about as much Fe has been added as is present in the assay solution.—A. R. P.

Determination of Arsenic: Iodometric Acidimetric Method. R. C. Wiley, J. P. Bewley, and R. Irey (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1932, **4**, 396–397).—The solution (20 c.c.) of the sample containing the As as As_2O_3 is introduced into a distillation flask together with 10 grm. of 20-mesh Zn; 10 c.c. portions of 75% H_2SO_4 are then added at intervals of 10 minutes for 40 minutes, and the solution then boiled for 5 minutes. All the gases evolved, which contain the As as AsH_3, are passed through a Meyer bulb tube containing a measured amount of 0·1*N*-I_2, whereby the AsH_3 is oxidized to As_2O_5. Excess of I_2 is then titrated with 0·1*N*-$Na_2S_2O_3$; 1 c.c. of 0·1*N*-I_2 consumed = 0·001237 grm. As_2O_3. As a check, the titrated solution may be titrated with 0·1*N*-NaOH using phenolphthalein as indicator (1 c.c. 0·1*N*-NaOH = 0·0009896 grm. As_2O_3). The reactions are $AsH_3 + 4I_2 + 4H_2O = H_3AsO_4 + 8HI$ and $H_3AsO_4 + 8HI + 10NaOH = Na_2HAsO_4 + 8NaI + 10H_2O$.—A. R. P.

Beryllium. IV.—Micro Qualitative Analysis of Beryllium. Harold Simmons Booth and Spencer Guildfrary (*J. Physical Chem.*, 1932, **36**, 2641–2649).—The micro-detection of Be either by the use of potassium malonate or by the production of beryllium basic acetate recrystallized from glacial acetic acid is considered to be superior to the ordinary macro-analysis methods, *viz.*, the potassium oxalate and chloroplatinic acid methods, both in simplicity and in accuracy. A bibliography of literature of the subject is appended.
—J. S. G. T.

Determination of Boron Spectroscopically. J. S. McHargue and R. K. Calfee (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1932, **4**, 385–386).—The B is separated as $(CH_3)_3BO_3$ by distilling the solution with CH_3OH and determined by burning the distillate in O_2 and observing the spectrum through a cell containing water to which 0·01*N*-$KMnO_4$ is added until the green B lines are completely absorbed. The c.c. of $KMnO_4$ added are a measure of the B; the method is accurate to 0·01 mg. B.—A. R. P.

Determination of Cæsium in the Presence of Rubidium and Other Alkali Metals. N. A. Tananaev and E. P. Harmash (*Z. anal. Chem.*, 1932, **89**, 256–262).—The hot concentrated solution is treated with a hot solution containing a large excess of BiI_3 dissolved in HI, whereby, on cooling, $Cs_3Bi_2I_9$ separates. The precipitate is collected, washed with ice-water, dried at 140°–150° C. for 1½–2 hrs., and weighed. The results are about 1% low.—A. R. P.

Volumetric Determination of Calcium and Magnesium in the Presence of One Another. Emöd von Migray (*Chem.-Zeit.*, 1932, **56**, 924).—When only small quantities of the elements are present in a solution free from other metals (except K and Na) the solution is boiled with *N*-$(NH_4)_2C_2O_4$ and NH_4OH in slight excess, acidified with CH_3COOH, treated with Na_2HPO_4, again

made ammoniacal, and boiled for 5 minutes. After cooling, the precipitate is collected in a Gooch crucible, washed with cold H_2O, and rinsed into a porcelain basin. The suspension is heated at 80°–90° C. and titrated with 0·1*N*-HCl until methyl-red indicator just becomes rose-coloured; this gives the Mg. H_2SO_4 is then added and the liberated $H_2C_2O_4$ corresponding with the Ca titrated with $KMnO_4$.—A. R. P.

Volumetric Determination of Cerium with Arsenious Acid. Rudolf Lang and Josef Zwerina (*Z. anal. Chem.*, 1932, **91**, 5–12).—In von Knorre's $K_2S_2O_8$ method for Ce the $Ce(SO_4)_2$ can be reduced with standard As_2O_3 if 10 c.c. of 1 : 1 HCl, 1 drop of 0·005*M*-KIO_3 solution and 5 grm. of $MnSO_4,5H_2O$ are added. Ce''' can be oxidized to Ce'''' in NaOH solution by boiling with $Ni(OH)_2$ and $K_2S_2O_8$.—A. R. P.

Determination and Separation of Cobalt as Cobaltic Nitroso-β-naphthol. C. Mayr and F. Feigl (*Z. anal. Chem.*, 1932, **90**, 15–19).—The precipitate of Co nitroso-β-naphthol obtained under the usual conditions cannot be weighed, as it invariably contains cobaltic salts. A compound of definite composition can be obtained, however, by treating the Co solution with H_2O_2, NaOH (to alkalinity), CH_3COOH (until the $Co(OH)_3$ precipitate is dissolved), and 2% α-nitroso-β-naphthol in 50% CH_3COOH; the substance after drying at 130° C. has the formula $(C_{10}H_6ONO)_3Co,2H_2O$ and contains 9·645% Co. The results are accurate to ± 2% for 1–30 mg. of Co.—A. R. P.

Rapid Method of Estimating Copper in Brass, Aluminium Alloys, &c. M. V. Churakov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), 1932, (2), 84–85; and (French abstract) *Chim. et Ind.*, 1932, **28**, 1344).—[In Russian.] The sample (1 grm. for Al alloys, or 0·3 grm. for brass) is dissolved in 10 c.c. of warm HNO_3 (*d* 1·2), 50 c.c. of H_2SO_4 (1 : 4) are added, and the mixture heated for 15 minutes on a sand-bath. After addition of 15 c.c. of KCNS solution, the liquid is cooled, 10 c.c. of KI solution are added and the I_2 titrated with 0·1*N*-$Na_2S_2O_3$.—D. N. S.

Electrolytic Zinc: The Determination of Small Amounts of Germanium. Harald Lundin (*Electrochem. Soc. Preprint*, 1933, May, 191–195).—Minute amounts of Ge cause serious trouble in the production of electrolytic Zn. The following procedure is recommended for the determination of Ge in material containing SiO_2 which adsorbs Ge: the sample is dissolved in H_2SO_4 and the solution evaporated twice with HF in a Pb dish until the H_2SO_4 reaches about 300° C., and no test for HF can be obtained with a glass rod. The mixture is then distilled with a large volume of HCl, Cl_2 being bubbled through the liquid during distillation. The condensate is collected in an ice-cooled receiver, treated with $NaHSO_3$ until the yellow colour disappears, then with Br until yellow, and with $NH_2OH{\cdot}HCl$ until colourless, adjusted to 4–6*N*-HCl, and saturated with H_2S. The GeS_2 is collected, washed with 4*N*-H_2SO_4, saturated with H_2S until free from HCl, and heated gently at first, then at 500°–600° C., until converted into GeO_2 for weighing. —A. R. P.

A Physical Method of Estimating Ferrous and Ferric Iron Formed by the Actions of Potassium Dichromate and Potassium Permanganate upon Ferrous Salt. Mata Prasad and P. Y. Deshpande (*J. Indian Chem. Soc.*, 1932, **9**, 133–136).—The amounts of ferrous and ferric iron were determined by the use of absorption spectra.—R. G.

On the Problem of Determining Lead in Mixed Solder and White Metal Residues. Wolfgang Boehm (*Metall u. Erz*, 1933, **30**, 47–48).—The material is dissolved in HBr and Br and the solution evaporated to dryness twice with HBr to volatilize $SnBr_4$ and $SbBr_3$. The residue is evaporated with H_2SO_4 and the Pb determined as $PbSO_4$ in the usual way.—A. R. P.

Volumetric Determination of Lead. A. Travers and —— Lu (*Compt. rend.*, 1933, **196**, 548–549).—The usual determination of Pb as sulphate gives

incorrect results in the presence of Bi and Ba, owing to the hydrolysis of salts of the former and to the formation of mixed crystals with Pb of the latter. The following method, however, can be used: A neutral solution of the Pb salt is boiled with excess Javelle water and the Pb precipitated as PbO_2, 1% KCl added and the whole shaken with the required quantity of KI + KCl. PbI_2 is precipitated and the clear, supernatant liquid titrated. In the case of Bi-alloys, the Bi is separated with excess $NaHCO_2$, filtered, and the filtrate evaporated to dryness. H_2CO_2 is destroyed by concentrated H_2SO_4 and the Pb determined as above. To separate Ba and Pb the latter is precipitated in a weak acid solution with H_2S under pressure. The Pb is precipitated after standing for 2 hrs. on a water bath and the sulphide converted to sulphate in the ordinary way.—J. H. W.

The Solubility of Lead Chromate in Ammonium Acetate and Acetic Acid Solutions and the Determination of Small Amounts of Lead. E. A. Goode (*Soc. Chem. Ind. Victoria Proc.*, 1932, **32**, 686–693).—Conditions are described for the rapid and accurate precipitation of Pb as chromate in amounts of the order of 1 mg.—R. G.

Volumetric Determination of Large Percentages of Manganese. Frank W. Scott (*Chemist-Analyst*, 1932, **21**, (6), 6–7).—The alloy (*e.g.*, 0·5 grm. of ferro-manganese) is dissolved in 25 c.c. of HNO_3, the brown fumes are expelled, and the Mn is precipitated by boiling with $KClO_3$ until Cl_2 ceases to be evolved. The mixture is boiled down to 15 c.c., treated with 0·5 grm. of $KClO_3$, boiled for 1 minute, cooled, and diluted to 200 c.c.; the MnO_2 is then dissolved by addition of a known volume of H_2O_2, the excess of which is determined by titration with $KMnO_4$.—A. R. P.

Determination of Molybdenum and Lead by Fajans's Method.—I. Z. Raichinschten and N. Korobov (*Zhurnal Obschtchey Khimii* (*Journal of General Chemistry*), 1932, **2**, (8), 661–665).—[In Russian.] In the titration of Pb salts with $(NH_4)_2MoO_4$ the recognition of the end-point is facilitated by addition of certain dyes, *e.g.*, alizarin red which are first adsorbed by the precipitate, then displaced therefrom by the slightest excess of MoO_4'', thereby producing a colour-change in the solution. Heavy metals intefere but Al salts are inert. —M. Z.

A New Rapid Method for the Macro- and Microchemical Determination of Silver. G. Spacu and P. Spacu (*Z. anal. Chem.*, 1932, **90**, 182–185).—The neutral or feebly ammoniacal Ag solution is treated with KI until the AgI first precipitated just redissolves, then with a hot concentrated solution of $[Cupn_2]SO_4$ (pn = propylenediamine), whereby $[Cupn_2][AgI_2]_2$ separates in bluish-violet crystals containing 23·07% Ag. The precipitate is collected in a filter crucible, washed with 1% KI solution containing 0·5% of $[Cupn_2]SO_4$, then with C_2H_5OH and $(C_2H_5)_2O$, dried for 10 minutes in a vacuum dessicator, and weighed. The sensitivity of the test is 1 in 200,000.—A. R. P.

Estimation of Small Amounts of Silver in the Presence of Both Copper and Chlorides. Naoto Kameyama and Shoji Makishima (*Kōgyō Kwagaku Zasshi* (*J. Soc. Chem. Ind. Japan*), 1932, **35**, (8); *C. Abs.*, 1932, **26**, 5274).—[In Japanese, with full English summary in supplemental binding, pp. 372–373B.] From 0·1 to 10 mg. of Ag can be determined in 100 c.c. of solution containing as much as 6·3 grm. of Cu^{++} and 15 grm. Cl^- by heating with an excess of NaOH to precipitate CuO, filtering and measuring the colour produced on adding rhodamine.—S. G.

Volumetric Determination of Tin. Application to the Separation of Antimony and Tin. P. Ed. Winkler (*Bull. Soc. chim. Belg.*, 1932, **41**, 115–137).—The HCl solution of the Sn is reduced with Zn to obtain $SnCl_2$, which is determined by adding an excess of I_2 to reoxidize the Sn and then titrating the excess with $Na_2S_2O_3$. Sb is best separated from Sn by H_2S in $H_2C_2O_4$ solution.—A. R. P.

Analysis of Ferro-Tungsten: Determination of Tungsten Content. P. Sokolovsky (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1930**, (9–10), 128–129).—[In Russian.] The powdered metal (0·5 grm.) is roasted for 2 hrs. at 800°–850° C., the sintered product digested with 50 c.c. of hot HCl (*d* 1·19), the solution treated with 3–5 c.c. of HNO_3 (*d* 1·4), the mixture diluted and the precipitated WO_3 collected, washed with 1 : 10 HCl, ignited and weighed.—D. N. S.

On the Determination of Zinc in Aluminium and Aluminium Alloys. H. Wagner and H. Kolb (*Chem.-Zeit.*, 1932, **56**, 890–891).—In the electrolytic determination of Zn in solutions obtained by dissolving Al or its alloys in NaOH the deposited Zn always contains Fe derived from reduction of the suspended Fe_2O_3. The deposit, after weighing, should therefore be dissolved in HCl and the Fe determined as Fe_2O_3 after precipitation with NH_4OH.
—A. R. P.

Notes on the Volumetric Determination of Zinc by Means of Potassium Ferrocyanide and on a Sensitive Reaction for Iron. J. Guéron (*Ann. chim. analyt.*, 1932, [ii], **15**, 393–396).—The feebly acid (H_2SO_4) sulphate solution of Zn is titrated at 60°–70° C. with $K_4Fe(CN)_6$ using 3 drops of 0·1% $Fe_2(SO_4)_3$ solution as indicator. The blue colour of the liquid disappears at the end-point.—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from p. 261.)

A Comparison Microscope for Reflected Light. E. Stach (*Z. wiss. Mikroskopie*, 1932, **49**, 361–366).—Light from the two objects to be compared passes through two objectives thence through two rhombic prisms into the comparison Ramsden eyepiece. For comparison of two sections absolutely even illumination is obtained by two opaque illuminators which are focussed for brightness on a barytes plate by the aid of a photo-cell fixed to the eye-piece. Polarized light can be used with the instrument.—B. Bl.

A New Illuminator for Stereo-Microscopes of the Greenough Type. O. Scheerpeltz (*Z. wiss. Mikroskopie*, 1932, **49**, 333–337).—The illuminator is mounted rotatably on a movable quadrant fixed to the tube of the microscope. The beam of light remains focussed on the object when the tube is moved, when the quadrant is swung round and when the lamp is moved along the quadrant.
—B. Bl.

An Automatic Apparatus Assembly for Thermal Analysis. C. T. Eddy (*Rev. Sci. Instruments*, 1933, [N.S.], **4**, 200–205).—Apparatus is described for the determination of thermal critical temperatures, accurate to within 4° C. and for the investigation of other properties, *e.g.*, resistivity and thermal energy.—J. S. G. T.

The Physical Society's Exhibition. —— (*Engineering*, 1933, **135**, 49–79, 169).—Illustrated descriptions of a number of exhibits including instruments for hydrogen-ion determination, and for indicating, recording, and controlling temperatures.—W. P. R.

The Physical Society's Exhibition. —— (*Engineer*, 1933, **155**, 37–92).—Illustrated descriptions of exhibits.—W. P. R.

Withdrawable Embedded-Type Immersion Heaters. Anon. (*Mech. World*, 1932, **92**, 612).—The new embedded-type immersion heater for electrical water-heating equipment is illustrated and described. Each element consists of a pair of heating coils of nickel–chromium alloy accommodated in channels in a cast-iron former. After filling in the space round the coils with refractory

material, and drying and baking, the element is placed in a mould and a special aluminium alloy cast round it. The aluminium alloy completely protects the refractory material and windings, whilst providing a path of high thermal conductivity for the transmission of the heat liberated in the windings.—F. J.

The Production of Homogeneous Magnetic Fields. A. Bühl and F. Coeterier (*Physikal. Z.*, 1932, **33**, 773–774).—The use of a cylindrical coil and two short coaxial coils to produce a homogeneous magnetic field is discussed mathematically. By the use of a principal coil 40 cm. long and 6 cm. diameter, it is possible to obtain a magnetic field 10 cm. long and of 5 cm. diameter, of constant strength to within less than 7/100,000th part of its strength at the middle point of the field.—J. S. G. T.

Progress in the Manufacture and Application of Mercury Interrupters. André Léauté (*Bull. Soc. franç. Élect.*, 1932, [v], **2**, 1178–1190).—Recent improvements in the Pyrex-tungsten interrupter are first described. Oxidation of the electrode tends to set up a high internal resistance. If a bead of platinum is welded on to the tungsten before insertion, a clean unoxidized surface is presented, and the sensitiveness of the part is much increased. Other modifications of interrupters for use with low and high tensions are described. Types of thermostat depending on the combination of bi-metallic spirals with mercury contact breakers are described and illustrated.—P. M. C. R.

Photo-Electric Cells. R. Jouauste (*Bull. Soc. franç. Élect.*, 1932, [v], **2**, 1024–1070).—The principles of photo-electric cell construction, and the working of evacuated and gas-filled cells, are described. Some applications of the cells are enumerated, notably their uses as transformers in radiotherapy (cadmium or uranium cell), in sound-films, and in photometry (the copper-oxide cell).—P. M. C. R.

Preparation of Collodion Filters for X-Rays. H. Kersten and Joseph Maas (*Rev. Sci. Instruments*, 1933, [N.S.], **4**, (1), 14).—The manufacture of thin collodion filters containing manganous oxide, having a K absorption edge between that of the $K\alpha$ and $K\beta$ lines of the anticathode element, is described. —J. S. G. T.

Two Rulers for Use in Analyzing Rotating Crystal [X-Ray] Photographs. Maurice L. Huggins (*Rev. Sci. Instruments*, 1933, [N.S.], **4**, (1), 10–13).—Rulers for constructing a reciprocal crystal-lattice and for reading interplanar distances directly are described.—J. S. G. T.

XI.—PHYSICAL AND MECHANICAL TESTING AND RADIOLOGY

(Continued from pp. 262–265.)

The Theoretical Basis of Metal Testing at the Present Time. W. Engel (*Danmarks Naturvidenskabelige Samfund, Ingeniørvidenskabelige Skrifter A*, Nr. **65**, 1931, 1–96; *Building Sci. Abs.*, 1931, [N.S.], **4**, 239).—The principles underlying the mechanical testing of metals and the phenomena observed under static and dynamic loading are discussed under the following heads: (1) internal structure; (2) crystal deformation-twinning, slip, strain-hardening, space lattice distortion, crystal orientation; (3) deformation of polycrystalline metal, effect of grain-size on the quasi-isotropic character of metal; elasticity and plasticity; (4) practical stresses; static loading, strain, yield-point, creep; dynamic loading, impact; (5) aim of mechanical testing.—S. G.

Vibrations of Structures and Materials. Walter M. Pohl (*Machinist* (*Eur. Edn.*), 1933, **77**, 203–205E).—The importance and significance of vibration tests of structures and materials are discussed and the methods of carrying out such tests and their interpretation are described.—J. H. W.

New Developments in Photoelasticity. A Purely Optical Method of Stress Analysis. Arshag G. Solakian (*J. Opt. Soc. Amer.*, 1931, **21**, 293–306).—A description of the experimental working of the method of H. Favre, which is based on Neumann's theory (accidental double refraction of a ray of circularly polarized monochromatic light in a strained isotropic transparent medium) and depends on the measurements of the absolute phase retardation of the two refracted rays. Close agreement between the experimental and theoretical results is shown.—R. G.

Notes on the Testing of Welded Joints. Anon. (*Elect. Welding*, 1932, **2**, (7), 17–18).—Refers only to steel; tensile, torsion, bending, Izod, hardness, and fatigue tests are briefly discussed.—H. W. G. H.

Percentage Elongation. A. C. Vivian (*Welder*, 1932, **4**, (33), 1–7).—Experiments with flat test-pieces of thin rubber, cut into various shapes, are described.—H. W. G. H.

Recommended Practice for Testing Bolts, Screws, Nuts, Studs, and Pins. Sub-Committee on Bolts, Recommended Practice Committee, American Society for Steel Treating (*Metal Progress*, 1933, **23**, (3), 25–26, 58).—A list of permissible tests is followed by notes on certain individual tests, which in some respects apply only to the bolt industry. These include appearance and finish, mechanical inspection methods, hardness testing, tensile tests, and their evaluation in the case of threaded sections, elongation, bead test, bend testing on shank, inspection of shank fractures, impact tests, shear and thread-stripping tests, micro- and macro-examination, inspection of coatings, and distribution of results. Coating inspection includes exposure and salt-spray corrosion testing, estimation of the thickness of the coating, and porosity tests; among the latter the trichloracetic acid method is described in detail.—P. R.

Tests on Threaded Sections. E. M. Slaughter (*Metal Progress*, 1933, **23**, (3), 18–20).—A series of tests is described with a view to establishing a reliable general method for calculating true tensile strength in threaded sections. The three methods in general use are: (1) the calculation of the net area from the root diameter; (2) the use of a mean area calculated from the average of root and pitch diameters; (3) the calculation of the pitch area, from the pitch diameter, Cap screws made from a single bar of standard material (steel was actually employed) were tested to destruction, together with plain tensile bars of the same material, and the results calculated by the above methods were correlated with those given by the plain bar. The results show that the second (mean area) method, whilst giving somewhat low results, is the most nearly accurate. The strengthening effect of the thread is briefly considered.—P. M. C. R.

A Rapid Method of Determining Endurance Limit by Means of Measuring Electrical Resistance. Shōji Ikeda (*J. Soc. Mech. Eng. Tokyo*, 1928, **31**, (136), 447–466; *Japanese J. Eng. Abs.*, 1932, **8**, 11).—[In Japanese.] Cf. this *J.*, 1929, **42**, 563.—S. G.

Tensometer for Measuring Small Deformations. A. F. Lorenz (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), 1932, (1), 68–76).—[In Russian.] The results obtained with a simple new tensometer are compared with those obtained with the Martin apparatus and a Cambridge extensometer. The new instrument consists of a flexible steel strip, fixed between 2 bearings in such a way as to be "dead-beat." In the centre of the plate is attached a rod with a mirror, in which the image of the scale is observed through a telescope. During deformation of the specimen the strip bends and the resulting angle of turn of the mirror is determined by the displacement of the scale image. This apparatus is not sufficiently accurate for big deformations, but for small deformations it compares not unfavourably with the Martin instrument, while its stability is greater and fixing is very simple. It can be used for measuring the deformation of wire.—D. N. S.

"New" Indentation Hardness Tests. Anon. (*Metallurgist* (Suppt. to *Engineer*), 1933, **9**, 5–6).—The commonly used hardness tests are reviewed. A new development of the Brinell test by T. Matsumura (*Mem. Coll. Eng. Kyoto Imp. Univ.*, 1932, **7**) is described. Although this test, in which the load producing a definite depth of impression by a 4 mm. ball is measured, has advantages, the values do not agree with the results of diameter of impression measurements. By taking the normal definition of indentation hardness, the Matsumura machine would give rational hardness values and would be almost identical with other available hardness testing methods. In all depth measurements, the exact diameter of the impression is not necessarily obtained.—R. G.

RADIOLOGY

On the X-Ray Determination of Stresses in Welds. John T. Norton (*J. Amer. Welding Soc.*, 1932, **11**, (9), 5–7).—"Pinhole" radiographs indicate the state of perfection of the grains of a metal, since any deformation of the atomic planes produces asterism, *i.e.*, elongation of the spots of the radiograph. Usually asterism is apparent only when plastic deformation has taken place and, in the case of a weld, shows where stresses were large enough to require relief through deformation. "Stress-relief" annealing does not remove asterism, although the ductility of the material is improved, but annealing above the recrystallization point will remove the asterism, provided that no further deformation is produced by mutual interference of the grains during growth. Many secondary effects can produce small amounts of plastic deformation, and it is, consequently, often difficult to interpret the exact significance of the asterism. Its presence, however, is definite proof that the grains are not perfect and, therefore, have not their maximum capacity for deformation. Impact resistance and fatigue resistance of welds are undoubtedly very much influenced by small local deformation of the grains: correlation with the "pinhole" radiographs should, therefore, be valuable.—H. W. G. H.

Röntgenographic Examination of Large Chemical Apparatus. W. Busse (*Chem. Fabr.*, 1932, **11**, 185–186).—Tables are given showing the voltage and optimum exposure time for various thicknesses of iron, copper, and aluminium which is being examined for flaws by X-rays. Prolonged exposure or too high a voltage tends to blur the contrast between sound and unsound places.

—A. R. P.

Making Radiographic Inspections of Chemical Equipment. Herbert R. Isenburger (*Chem. and Met. Eng.*, 1933, **40**, 130–132).—The examination of pressure vessels and of welded seams by X-rays and by γ-rays is discussed. A double-exposure technique is described and its advantages over the stereoscopic method are discussed. For field-work in the chemical industry it is necessary to have a compact and rigidly-built outfit capable of penetrating 3 in. of steel in a 1-minute exposure. An outfit of this kind is described and by its use considerable economy is effected.—F. J.

Recent Developments in X-Ray and Gamma-Ray Inspection of Power-Plant Materials. Herbert R. Isenburger (*Steam Plant Eng.*, 1933, **11**, January).—Both X-rays and γ-rays are now used for the examination of power-plant materials. The former are employed for steel up to 4 in. in thickness, but the latter do not give sufficient definition even up to a thickness of 2 in. Examples are quoted and illustrated by photographs. X-ray examination of welded seams is compulsory for most machine parts made in the U.S.A. Particulars are given of a 300,000 v. X-ray unit which will penetrate 3 in. of steel in a 1-minute exposure. The respective merits of X- and γ-rays are set out in tabular form.—W. A. C. N.

X-Ray Investigation of Metals. D. Faggiani (*Rivista di Fisica*, **1932**, (1), 16–23).—The scientific, industrial, and technical importance of X-rays in metallurgy is discussed.—G. G.

XII.—PYROMETRY

(Continued from pp. 265–266.)

Experiments with a Registering Photo-Cell Pyrometer. G. Müller and H. J. Zetzmann (*Z. tech. Physik*, 1933, **14**, 90–94).—The relation between black-body and true temperature and its practical utility is explained. Experiences with an almost inertia-free pyrometer for the control of the maximum temperature in point-welding are described; it is probably possible to control point welding automatically with the aid of additional apparatus.—J. W.

Some Observations of Automatic Temperature Control. C. E. Foster (*Metallurgia*, 1933, **7**, 187–190).—The component parts of an automatic temperature control system and their interaction are considered, and also the application of automatic temperature control to various types of furnaces. Two types of control are referred to, the first known as the "hit or miss" system, because within predetermined limits the heat supply is quickly changed from low to high or *vice versa*, and the second known as the "step by step" system, which can lose or gain heat quickly, and the effect of a chain of time lags, which occurs with both systems, is dealt with diagramatically. A detailed description is also given of the working of a typical indicating pyrometer for automatic control and the methods adopted to achieve the closest and most accurate control are fully considered.—J. W. D.

A Pyrometer Controller. Anon. (*J. Sci. Instruments*, 1933, **10**, 22).—A note. Describes very briefly a pyrometer controller which can be used in connection with either thermocouples or resistance thermometers. A photograph is shown, but no details are given.—W. H.-R.

On the Passage of Mercury through Narrow Capillaries. H. Ebert and W. Ende (*Z. tech. Physik*, 1933, **14**, 64–67).—The irregular movement of mercury in locally constricted capillaries of maximum thermometers is attributed to the presence of impurities in the metal.—J. W.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 266–270.)

Metal Mixing by Analysis. Wesley Lambert (*Met. Ind.* (*Lond.*), 1933, **42**, 441–442).—The method of calculating the constitution of the charge from a knowledge of the weight and composition of the material available, when using scrap or scrap and new metal is described and illustrated with an example.
—J. H. W.

Ferrous and Non-Ferrous Metals in the Foundry. W. Rosenhain (*Proc. Inst. Brit. Found.*, 1931–1932, **25**, 183–201; discussion, 201–213).—See this *J.*, 1932, **50**, 769.—S. G.

Gas Contents of Aluminium Casting Alloys. H. Nipper (*Z. Metallkunde*, 1933, **25**, 65–67).—The influence of a large number of factors (such as quality of the metal, flux, melting temperature, mechanical and chemical treatment of the molten metal, casting temperature, kind of mould, casting method, &c.) on the gas content and mechanical properties of aluminium and Silumin castings has been investigated by density measurements, gas removal, and tensile tests. For the results, which are not given in detail, the original paper must be consulted.—M. H.

High-Strength Sand-Casting Aluminium Alloys. W. C. Devereux (*Proc. Inst. Brit. Found.*, 1931–1932, **25**, 517–551; discussion, 551–559).—See this *J.*, 1932, **50**, 124.—S. G.

Carbon and Nitrogen in Aluminium. Takayasu Harada (*Suiyô-Kwaishi*, 1928, **5**, (7), 571–578; *Japanese J. Eng. Abs.*, 1932, **8**, 85).—[In Japanese.]

H. carried out experiments on the determination of carbon and nitrogen in certain kinds of commercial aluminium, and on the behaviour of these non-metallic elements on melting aluminium. The product of carbon and nitrogen goes into slags and does not adversely affect or combine with the metal. Nitrogen does not affect the metal, if pure, when melted at temperatures up to 1400° C.—S. G.

Pressure Casting of Brass. P. Weiss and R. Wartena (*Rev. Fonderie moderne*, 1931, **25**, 331–333, 345–346).—Discussion of a paper published in *De Gieterei* (*Den Haag*), **1931**, March. The technique of pressure casting in chill moulds is described and its application to aluminium and brass discussed. Both these metals have relatively high melting points, and the former has the property of absorbing iron at high temperatures and of forming alloys with nearly all other metals. The moulds are therefore usually made of special chromium, vanadium, or chrome-nickel steel, made in one piece. The method of casting is based on a goose-neck delivery and a special melting crucible, which may be either tilting or fixed. The casting machine, which resembles a hydraulic press, and its mode of action are described.—J. H. W.

An Investigation of Core Oils. Carl H. Casberg and Carl E. Schubert (*Univ. Illinois Bull., Eng. Exper. Sta.*, No. **221**, 1931, 1–22).—Tests with numerous core oils show that the tensile strength of the cores has no definite relation to the sp. gr., percentage of ash, flash-point, or fire point of the oil. The initial tensile strength (L) of baked cores made by standard methods of mixing and ramming and with standard baking time and temperature is proportional to the saponification (S) and iodine (I) values of the core oil, thus $L/S=0{\cdot}77$ and $L/I=0{\cdot}90$. The water absorbed by the cores divided by the percentage loss in strength thereby produced in all cases gave a value of 0·00037.—A. R. P.

Pure Rubberized Oil as a Substitute for Linseed Oil in Foundry Core Binders. L. Wilson Greene and J. M. Faraday Leaper (*Oil and Soap*, 1933, **10**, (1), 28–39; *C. Abs.*, 1933, **27**, 1597).—Laboratory tests indicate that rubberized oil from *Hevea brasiliensis* may be used as a substitute for linseed oil in core binders. The high acidity of rubberized oil apparently has no deleterious effect on its core-binding properties.—S. G.

Introduction to the Study of Moulding and Casting. J. Pillon (*Proc. Inst. Brit. Found.*, 1931–1932, **25**, 307–376; discussion, 376–381).—French exchange paper.—S. G.

Sand Testing in the Foundry. W. Y. Buchanan (*Proc. Inst. Brit. Found.* 1931–1932, **25**, 560–600; discussion, 600–607).—See this *J.*, 1932, **50**, 391.
—S. G.

Moulding Sands. G. Tarocchi (*Fonderia*, 1932, **9**, 436–445).—A detailed study of the preparation and properties of foundry sands.—G. G.

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

(Continued from p. 270.)

The Buying and Selling of Old Gold. C. M. Hoke (*Met. Ind.* (*N.Y.*), 1933, **31**, 55–57).—Hints on the best methods of disposal of precious metal scrap in the U.S.A.—A. R. P.

On the Production of Iron-Poor Remelted Zinc. Edmund R. Thews and W. E. Herrmann (*Met. Ind.* (*Lond.*), 1933, **42**, 465–467).—Removing iron in remelting commercial scrap zinc presents practical difficulties. Previous to melting, mechanical ferrous impurities should be removed as far as economically possible. Reverberatory furnaces are recommended for remelting scrap comparatively poor in iron. Melting pot furnaces appear superior for handling large quantities of commercial zinc scrap containing 0·10–0·15% of iron. The reasons for these conclusions are discussed in detail.—J. H. W.

XV.—FURNACES AND FUELS

(Continued from pp. 271–273.)

1-Ton Crucible Melting Plant. Anon. (*Met. Ind.* (*Lond.*), 1933, **42**, 429).—A description is given of the construction and performance of 2 brass and bronze oil-fired crucible furnaces, claimed to be the largest tilting furnaces ever constructed.—J. H. W.

Photo-Electric Control of Gas Furnaces. Anon. (*Machinery* (*Lond.*), 1933, **41**, 463).—A note. In a recent furnace installation, a photo-cell operating through a relay shuts off the main gas supply if the flame becomes extinguished.—J. C. C.

A New Application of the Surface Combustion Principle. The "Degussa" High Temperature Furnace. Anon. (*Gas World* (*Indust. Gas Suppt.*), 1933, **5**, (2), 15).—A gas-fired surface combustion furnace, operated with gas at ordinary pressure and capable of attaining temperatures up to 2000° C., is described. A model for laboratory work is also available.—J. S. G. T.

XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 273–276.)

Inoculated Dinas Bricks. B. Pines (*Stal* (*Steel*), **1931**, (3–4), 75–83).—[In Russian.] X-ray examination of various quartz minerals used in the manufacture of dinas bricks leads to the conclusion that the different modifications of silica present in naturally occurring quartzes alter the direction of the transformations in the brick during firing, since they form centres of crystallization for these modifications. The best type of dinas brick is considered to be that with a tridymite–cristoballite structure obtained by firing in a manner which avoids the intermediate amorphous modification. Results of works' tests on the manufacture of bricks from charges inoculated with nuclei of the desired modification are given.—D. N. S.

Alumina as a Strong Fire-Resisting Material. H. Gerdien (*Z. Elektrochem.*, 1933, **39**, 13–20).—The refractory properties of alumina are described in the light of tests at various temperatures and in contact with various corrosive acids, metals, metallic oxides and salts, and it is shown that this material has a high resistance to corrosion under severe conditions of testing.—J. H. W.

Examination of Refractories. C. Meurice (*Ing. Chim.*, 1931, **15**, 97–114).—A review of the properties and constitution of refractories, dealing with the materials as regards structure, stability on heating, heat resistance, and resistance to the corroding action of products of combustion and molten materials. The properties and dilatation characteristics of the different forms of silica and alumino-silicates are described. From the dilatation curve the form in which the silica is present can be determined and useful practical indications obtained. Tests of heat resistance by determination of deformation under load are described; the appearance of a liquid phase can be clearly indicated.—R. G.

Further Contribution on the New Refractory "Siemensit." Hans Hirsch (*Tonind. Zeit.*, 1932, **56**, 1147–1149).—Characteristic results of the following tests are described: examination of structure, elastic properties, heat conductivity, refractoriness, softening under pressure, change of volume, resistance to sudden temperature changes, resistance to slags, especially basic and acid open-hearth steel slags, brown coal ash containing gypsum, crude glass mixtures rich in alkali, and fused sodium sulphate.—B. Bl.

On the New Refractory "Siemensit." Werner Hansen (*Tonind. Zeit.*, 1933, **57**, 209–210).—The stability of Siemensit in contact with lime and dolomite at 1200°–1400° C. has been investigated.—B. Bl.

"Sinterkorund" as a Refractory for Apparatus of High Chemical and Thermal Resistance. Hans Kohl (*Tonind. Zeit.*, 1932, **56**, 1266–1267, 1279–1280).—Sinterkorund consists of 99·8% alumina, 0·2% of silica, and traces of ferric oxide. After firing at 1800° C., it is completely crystalline, has *d* 8·78, and melts at 2050° C.; it is gas-tight up to 1720° C. and will withstand a load of 2 kg./cm.^{2} without deformation up to 1730° C. It has a high heat conductivity (at 17° C. 16·8 kg.-cal./m./hr./° C.) and is therefore very resistant to rapid temperature changes. The sp. electrical resistance at 800° C. is $0{\cdot}35 \times 10^9$ ohm/cm., and the sp. heat 0·2796 (0°–1500° C.). Crucibles and dishes of sintered corundum are resistant to alkalis, high-pressure steam, chlorine, molten glass and slags, molten metals, fused litharge, and iron oxides. Many uses for the material in the chemical and motor industries are indicated.—B. Bl.

An Insulating Refractory for Heating Furnaces. Anon. (*Iron Age*, 1933, **131**, 433).—Describes a new insulating refractory said to combine low thermal conductivity and heat-storage capacity with refractoriness and light weight.
—J. H. W.

Insulating Materials and Their Utility. C. Stanley Read (*Refractories J.*, 1933, **9**, 69–71).—The requirements for good insulation and the manner in which these requirements can be satisfied by insulating materials are discussed.
—J. H. W.

XVII.—HEAT-TREATMENT

(Continued from p. 276.)

On a Rational Terminology in the Field of Heat-Treatment of Alloys. A. A. Botchvar (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), 1931, (9), 19–23).—[In Russian.] It is proposed that the terms used in describing certain heat-treatment processes should be reviewed, since many do not fully express the essential nature of the process. Examples of such terms are: "quenching," "annealing," "normalizing." Two variants of a new terminology are suggested.—D. N. S.

The Formation of Blisters during the Heat-Treatment of Age-Hardenable Aluminium Alloys. P. Brenner, F. Sauerwald, and W. Gatzek (*Z. Metallkunde*, 1933, **25**, 77–80).—The influence has been investigated of the composition, annealing medium (air, salt bath, vacuum), temperature and duration, and surface condition of the sheets on the formation of blisters in various aluminium alloys containing magnesium, copper, silicon, and manganese as well as the usual iron content. The results (illustrated by numerous photographs) indicate that the formation of blisters depends on exterior influence as well as the nature and amount of alloying elements. Hints are given for avoiding blisters, *e.g.* by annealing in an electric furnace instead of the usual salt-bath. Detailed results will be published in the Jahrbuch 1933 of the Deutsche Versuchsanstalt für Luftfahrt.—M. H.

Short-Time Annealing of Aluminium Sheet and Strip in Continuous Electric Annealing Furnaces. H. Masukowitz (*Met. Ind.* (*Lond.*), 1933, **42**, 425–427).—Abstract from *Z. Metallkunde*, 1932, **24**, 236–239; see *J.*, this volume, p. 47.
—J. H. W.

Ageing of Zinc Die-Casting Alloys. Anon. (*Machinist* (*Eur. Edn.*), 1933, **77**, 213E).—The physical characteristics which must be known for the use of zinc-base alloys for die-castings are tabulated for the Zamak alloy No. 3. Ageing treatments are: (1) heat to 70° C. for 10 hrs., 85° C. for 8½ hrs., or 100° C. for 6 hrs. and cool in the furnace; (2) heat to 70° C. for 12 hrs., 85° C. for 8½ hrs., or 100° C. for 6 hrs., and cool in air.—J. H. W.

XVIII.—WORKING

(Continued from pp. 276–278.)

The Energy Absorbed in the Cold-Working of Metals. Walter Rosenhain and V. H. Stott (*Proc. Roy. Soc.*, 1933, [A], **140**, 9–25).—Apparatus for measuring the work done and the heat produced when a considerable length of wire is drawn through a die enclosed in a calorimeter is described. The process is continuous in operation and is characterized by a much larger expenditure of energy per unit mass of metal than has been the case with previous processes. In the case of annealed aluminium wire the energy absorbed by the wire amounted to 0·47 joule per grm. of metal, equivalent to 1·2% of the total work done, *viz.* 38 joules per grm., including friction in the die. The corresponding figures for annealed and hard copper were: annealed; 0·96 joule/grm.; 3·1%; 31 joules/grm.; hard, 0·12 joules/grm.; 0·5%; 24·5 joules/grm. These values are less than those obtained by Farren and Taylor (see this *J.*, 1925, **33**, 322), but confirm their results approximately.—J. S. G. T.

Machines for the Hot-Pressing of Non-Ferrous Metals. O. Kühner (*Z. Metallkunde*, 1933, **25**, 88–93).—A detailed description of the construction and operation of various types of hot-pressing machines (friction spindle press, eccentric press, knee lever press with pressure regulator) made by a German manufacturer.—M. H.

On the Problem of Working Magnesium Alloys under Pressure. R. Barbanel (*Legkie Metally* (*Light Metals*), **1932**, (2), 40–47).—[In Russian.] Works' practice in the drawing and extrusion of tubes of a magnesium alloy containing aluminium 4, manganese 0·3, and silicon 0·02% (introduced during casting) is described. The alloy was poured into tubular moulds, having an external diameter of 175 mm. and an internal diameter of 76 mm., with a length 350–400 mm. and a weight of 14 kg. The optimum conditions for extrusion were: temperature 350°–370° C., pressure 140 kg., rate 0·03–0·05 m./second, wax being used as lubricant. By extrusion matrices for drawing with an external diameter of 94 mm. and an internal diameter of 74 mm. were obtained. Wall thicknesses of 3–5 mm. could also be obtained. Drawing was carried out at 250° C. with a reduction of 5–7% at each pass, and a normalizing treatment at 350°–400° C. after each reduction.—D. N. S.

The Choice of Material for Stamps for Duralumin Stampings. S. I. Gubkin (*Niimash-Izvestia Nauchno-issledovatelskogo Instituta Mashinostroenia i Metalloobrabotki* (*Bulletin of the Scientific Research Institute of Machine Building and Metal Treatment*), **1932**, (3), 175–179).—[In Russian.] The adhesion of Duralumin stampings to the tool when stamping is carried out at above 400° C. is investigated. It is concluded that this is due to purely mechanical causes. The stamp should be constructed of alloy steel, which minimizes adhesion. The same result can be obtained by using a suitable lubricant.—N. A.

Striking a New Coinage. L. Golfier (*Aciers spéciaux*, 1933, **8**, 31–34).—The various processes in striking a new coinage from the casting of the bars to the final inspection are described and illustrated.—J. H. W.

Producing Aluminium Alloy Diaphragms. E. E. H. (*Machinery* (*Lond.*), 1932, **40**, 814–816).—Details are given of the methods of flattening, enamelling, forming, heat-treating, and cleaning aluminium alloy diaphragms used in sound-reproducing instruments. An alloy containing copper 0–0·05, manganese 1·25–2·0, iron 0–0·45, silicon 0·05–0·40% is used for simple flat diaphragms 0·02–0·03 in. thick, and Duralumin 0·001–0·003 in. thick for very light diaphragms of intricate contour. The thick diaphragms are flattened by heat-treatment at 225° C. ± 5° C. under pressure in a special fixture. Brief details are included of the use of nitro-fluoric acid solution for producing very thin Duralumin sheet by uniform chemical attack.—J. C. C.

XX.—JOINING

(Continued from pp. 280–281.)

Repairs of Aluminium Accessories by Means of a Patented Alloy. W. A. Lapidus (*Avtogenoe Delo* (*Autogenous Practice*), 1931, (1), 16–17).—[In Russian.] The solder (composition not stated) melts at about 200° C. and is used by the American Fix Co. of Cleveland for repairing aluminium accessories.—D. S.

The Autogenous Welding of Aluminium and Its Alloys. H. Bohner. H. Buchholz (*Z. Metallkunde*, 1933, **25**, 50–52, 64).—Cf. this *J.*, 1932, **50**, 257. Chiefly polemical. H. Bohner states that fine-grained welded joints can be produced by the use of a welding rod containing 0·15% titanium. The welding method has little influence on the tensile strength (18–24 kg./mm.^{2}) and elongation (2·5–6%) of alloys of the Lautal type; the breadth of the softened zone is 4 times as great with autogenous welding as with electric welding, whatever the thickness of the sheet. The bending strength of welded wires of aluminium–copper alloys is higher if the welding rod contains more aluminium than the alloy welded.—M. H.

Electric Welding of Sheet Aluminium by Means of a Carbon Arc. A. P. Goriatchev and R. R. Syromiatnikov (*Avtogenoe Delo* (*Autogenous Practice*), 1931, (6), 6–9).—[In Russian.] The welding of aluminium (containing silicon 0·21, iron 0·94, and copper 0·19%) with a positive carbon electrode, the metal forming the negative electrode, is described. The current used was 100–180 amp., the filler rod had the same composition as the metal and the flux was a mixture of sodium chloride 7·6, potassium chloride 66·1, and lithium chloride 27·3%. In the tensile test a work-hardened welded sheet fractures along or adjacent to the welded seam while a welded and normalized sheet fractures outside this zone. The hardness of the weld is 32·5 compared with 27 for the annealed sheet, but the weld is sufficiently elastic to bend double without fracture.—D. N. S.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from p. 282.)

Aluminium in Denture Construction. Anon. (*Brit. J. Dental Sci., Prosthetics Section*, 1930, **75**, 33–36).—Extracts from various sources. Aluminium dental bridges are used in Germany and the U.S.S.R. A Russian committee found such bridges to be harmless, and to produce no after-taste or irritation. —J. C. C.

Dry Kiln Doors of Aluminium. Anon. (*Railway Eng.*, 1931, **52**, 394).—A very brief note. Cf. this *J.*, 1932, **50**, 688.—H. F. G.

The Design and Construction of Metal Hulls for Boat Seaplanes. R. J. Moffett (*Engineering J.*, 1931, **14**, 609–615).—Aluminium alloys, notably Duralumin, are generally used, but owing to their relatively low corrosion-resistance, especially to salt-water, the use of "stainless" steel is increasing. Anodic treatment and gum-base paints are employed with some success, the best anti-corrosion surface being that of anodically treated and painted Alclad. Methods of working aluminium alloys are briefly noted.—H. F. G.

Light Metals in Transport Engineering. Freeman Horn (*Met. Ind.* (*Lond.*), 1933, **42**, 39–42).—A review of the applications of light metals in the construction of ground and aerial transport machines.—J. H. W.

The Use of Aluminium and Aluminium Alloys in 1933 Automobile Design. W. Tyson (*Aluminium Broadcast*, 1933, **4**, (2), 11–14).—A review.—J. C. C.

Aluminium and the Car. Anon. (*Met. Ind.* (*Lond.*), 1932, **41**, 400).—A brief description of the applications of special aluminium alloys for use in the manufacture of motor-car parts.—J. H. W.

An Aluminium Coating that is Useful in Electrical Engineering. R. E. Pettit (*Elect. Manufacturing*, 1932, **10**, (3), 22–23; *C.Abs.*, 1933, **27**, 353).—An artificially-formed coating of Al_2O_3 is an effective insulation material for electrical machinery and equipment. By the Alumilite process this is produced by making the aluminium article the anode in a bath of sulphuric acid with certain organic and inorganic modifiers (not described in this article).
—S. G.

On the Use of Aluminium Windings in the Rotors of Turbo Generators. E. G. Komar (*Elektrichestvo* (*Electricity*), **1931**, (15), 854–858).—[In Russian.] A review of the present-day aspects of the problem and an attempt to examine it theoretically.—N. A.

Characteristics of the General Electric Photoflash Lamp. W. E. Forsythe and M. A. Easley (*J. Opt. Soc. Amer.*, 1931, **21**, 685–689).—Aluminium foil in slight excess of oxygen is flashed in a closed bulb by application of a suitable voltage. The light emitted is about 166,000 candles, or the equivalent of 470 five hundred watt incandescent lamps in maximum output, with an efficiency of about 32 lumens per watt.—R. G.

Aluminium Webs. L. R. (*Anzeiger Berg-, Hütten- u. Masch.*, 1932, **54**, (11), 6).—The webs are made from strips of aluminium, 0·3 mm. wide, cemented together with a film of cellulose hydrate.—B. Bl.

Aluminium Paste. —— (*Drugs, Oils, Paints*, 1932, **47**, 622; *Res. Assoc. Brit. Paint Manuf. Rev.*, 1932, (30), 306).—A heavy paste of very fine high-grade aluminium flake in neutral oils which will not under normal conditions dry out or harden when mixed with varnish is claimed to produce a smooth solid surface resembling a plated finish.—S. G.

Aluminium Paints as a Means of Excluding Damp and of Improving Damp Rooms. W. Stümer (*Bautenschutz*, 1931, **2**, 95–96; *Building Sci. Abs.*, 1931, [N.S.], **4**, 422).—The properties and uses of aluminium paints are discussed. Such paints are particularly suitable for painting bituminous coatings. Aluminium paints on wood are highly moisture-resistant, and surfaces so painted are little affected by frequent washing. The metallic constituent of such paints is non-poisonous. The metallic nature of the coating prevents the penetration of micro-organisms. The light-reflecting value is high—60 to 70% of incident light. A single coating is usually sufficient for maximum reflection and covering power. Their high reflectivity makes such paints of value in covering roofs in tropical countries, whilst the coatings are also little affected by smoke and are not discoloured by sulphuretted hydrogen. Practically all surfaces may be painted, provided that the most suitable vehicle is used, *e.g.* an oil for external walls, a quick-drying lacquer for interior walls, and the best stand oil for wooden walls or beams.—S. G.

Aluminium Paint on Creosoted Wood. Anon. (*Wood Preserving News*, **1930**, Dec.; *Building Sci. Abs.*, 1931, [N.S.], **4**, 92.)—A report is given of an investigation of the usefulness of certain paints when applied to creosoted wood. The paints studied were: (1) a white cellulose paint; (2) a green lead paint; (3) a green zinc paint; and (4) an aluminium paint. One coat of each was applied to creosoted poles set up in the ground and allowed to dry out for 3 weeks before painting. After exposure to the weather for 2 years it was found that whereas the cellulose, lead, and zinc coatings had failed as regards retention of their colours and had in the main assumed the colour of the creosote, the aluminium paint had fully retained its colour. The vehicle was a hard, dry, long oil varnish type containing 50% by weight of non-volatile oils and gums. The major portion of the vehicle consisted of heat-treated China wood oil and the remainder of heat-treated linseed oil. Aluminium powder was added in the

proportion of 2½ lb. per gall. on the job as required. This paint dries hard in 12 hrs.—S. G.

The Relationship between Radiant Energy and Paint. F. C. Atwood (*Amer. Paint J. Convention Daily*, 1932, **16**, (53B), 8; *Amer. Paint Varnish Manuf. Circ.*, No. **423**, 1932; *Paint Varnish Prodn. Manager*, 1932, **8**, (6), Sect II, 10–13; *Res. Assoc. Brit. Paint Manuf. Rev.*, 1932, (**30**), 304).—The vehicle in an aluminium paint may reduce the value of aluminium powder as heat insulator by as much as 50%. White pigments reflect 90% of visible spectral energy and are, therefore, the most effective non-absorbers for solar radiation. Hence, white paints are better than aluminium paints for coating petrol tanks, &c., exposed to the sun. For hot-water radiators the colour of the pigment is unimportant, as all ordinary pigments are good absorbents and good radiators of long-wave heat energy. An aluminium or other polished metal coating would, however, be definitely unsuitable for use on a radiator, because such a surface has a low radiation coeff. for long-wave heat energy.
—S. G.

The Compounding of Aluminium Powder with Rubber. W. D. Guppy (*India Rubber Inst. Trans.*, 1932, **8**, 131–135; *C. Abs.*, 1933, **27**, 440).—Experiments show that powdered aluminium does not influence the time of curing to obtain a maximum tensile product. With increasing proportions of aluminium, the elongation at rupture and the tensile strength diminish, and the stiffness increases progressively. The most marked effect of powdered aluminium (in proportions about 50% by weight of the rubber) is to reduce the elongation at small stresses. At higher stresses, the extensibility increases very rapidly, and the remaining part of the stress-strain curve runs almost parallel to that of the base mixture. Vulcanizates containing aluminium have a tendency to tear readily along a plane parallel to the surface formed by the plates of the mould used for vulcanization, because of orientation of the aluminium particles. Several accelerated base mixtures were used in the experiments. Judging by inorganic sulphide in the vulcanizates, there is no chemical reaction between aluminium and sulphur during vulcanization. The experimental results are tabulated.—S. G.

The Use of Beryllium in Industry. —— (*Totchnaia Industria*, **1931**, Oct., and *Technique moderne*, 1932, **24**, 594).—The production and properties of the metal and its effects when added in small amounts to copper, bronze, and steel are discussed. The prices and annual production of the metal for the years 1923–1929 are given.—H. W. G. H.

Report of Committee A–10 [of A.S.T.M.] on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys. Jerome Strauss and H. D. Newell (*Proc. Amer. Soc. Test. Mat.*, 1932, **32**, (I), 136–137).—A progress report.
—S. G.

Report of Committee B–1 [of A.S.T.M.] on Copper Wire. J. A. Capp (*Proc. Amer. Soc. Test. Mat.*, 1932, **32**, (I), 193–197).—See this *J.*, 1932, **50**, 497.
—S. G.

Report of Committee B–5 [of A.S.T.M.] on Copper and Copper Alloys, Cast and Wrought. C. H. Mathewson and D. K. Crampton (*Proc. Amer. Soc. Test. Mat.*, 1932, **32**, (I), 255–263).—See this *J.*, 1932, **50**, 497.—S. G.

Uses of Copper in Buildings. I.—Copper Roofs. H. N. Bassett (*Carpenter and Builder*, 1932, **110**, 508; *Building Sci. Abs.*, 1932, [N.S.], **5**, 129).—B. briefly considers the use and methods of laying copper roofs. Copper may be used for all sizes and shapes of roof, whether sloping, vertical or flat, and may be laid on all kinds of support, *e.g.* wood or concrete. It is essential that no other metal than copper be used for nails or rivets, in order to obviate the danger of electrolytic corrosion. Jointing by brazing or soldering is to be avoided; welding with copper may be used, but so far as possible joints should be made by folding or riveting. A sheet of tarred felt should be placed under

the copper to prevent wear by friction with uneven surfaces below. Provision should be made for expansion under the heat of the sun in view of the relatively high coeff. of expansion of copper. Copper sheets or tiles should not be attached directly to the supports, but should be held in place by copper clips nailed or rivetted to the supports with copper nails or rivets. Joints should be so made that water will flow away. Holes made for fixing the sheets or clips should be covered by a fold either of the clip or of the sheet. Edges should be doubled to afford additional stiffness to prevent wind lifting a sheet or tile or causing it to whip. It is pointed out that no very special skill is required for the fixing of copper roofing. As regards cost, the first cost of the copper roof is higher than that of a tiled roof but its durability is also greater. —S. G.

Heat Emission from Iron and Copper Pipe. F. C. Houghten and C. Gutberlet (*Heating, Piping and Air Conditioning*, 1932, **4**, (1), 47–52; *Building Sci. Abs.*, 1932, [N.S.], **5**, 71).—An illustrated description is given of an investigation carried out at the research laboratory of the American Society of Heating and Ventilating Engineers with a view to determine the heat emission from copper steam and hot-water pipes of the dimensions commonly used in heating systems. It was found that the heat loss from bare copper piping is about 54% of that from bare, black iron pipes of the same nominal size, and 203% of the loss from insulated iron piping. Heat loss is approximately equal for vertical and horizontal pipes of the same size and material.—S. G.

Adoption of Air-Conditioning by Many Leading Railroads Provides Added Incentive to Public for Increased Summer Passenger Travel. Anon. (*Bull. Copper and Brass Res. Assoc.*, 1932, (**71**), 2–3).—The use of copper and brass in air-conditioning plant used on American trains is referred to.—J. S. G. T.

Artificially-Cooled Air, Major Factor in New American Liners' Challenge for Supremacy of Seas. Tons of Copper Alloys Used. Anon. (*Bull. Copper and Brass Res. Assoc.*, 1932, (**71**), 4–5).—The use of copper, brass, and bronze for air-conditioning plant used in American liners recently constructed, is referred to.—J. S. G. T.

New Adler Planetarium Replete with Copper Alloys Inside and Out. Anon. (*Bull. Copper and Brass Res. Assoc.*, 1932, (**71**), 7).—About 15,000 lb. of copper sheet in addition to brass and bronze has been used in the building of the Adler planetarium erected recently in Chicago.—J. S. G. T.

Metal Supplants Masonry in Modern Construction. T. E. Orr (*Daily Metal Reporter*, 1931, **31**, (72), 3–4).—From an address on "Copper for Vertical Surfaces" before the New York States Sheet Metal Contractors' Association. The use of such rustproof materials as copper and its alloys for vertical surfaces in the U.S.A. and Germany is reviewed.—P. M. C. R.

Copper Alloys and Corrosion. —— Ballay (*Usine*, 1931, **40**, (47), 25–27).—Abstract of a paper presented to the Salon Nautique. See this *J.*, 1932, **50**, 183.—H. W. G. H.

The Fischer Bow-Collector. Anon. (*Tram. and Rail. World*, 1931, **69**, 14–15).—Many tramway systems now substitute the bow-collector for the trolley-pole and wheel. The collector consists of a steel plate, pivoted in gun-metal bearings, the wear on the trolley-wire being reduced by two long copper strips riveted to the edge of the plate. This combination has been found to give longer life of both plate and wire than if brass or copper plating is used. The plate, which maintains contact by a system of springs, provides lubrication by suitable grease-filler grooving.—P. M. C. R.

Tentative Specifications for Insulated Wire and Cable: 30 per Cent. Hevea Rubber (D 27–31 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, 1932, 960–976).—See this *J.*, 1932, **50**, 105–106.—S. G.

Tentative Specifications for Magnesium-Base Alloy Castings (B 80–31 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, 1932, 302–304).—See this *J.*, 1932, **50**, 106–107.—S. G.

XXIV.—BOOK REVIEWS

(Continued from pp. 286–288.)

Man and Metals. A History of Mining in Relation to the Development of Civilization. By T. A. Rickard. In two volumes. Med. 8vo. Pp. xiii + 1068, with 108 illustrations. 1932. New York: McGraw-Hill Book Co., Inc. ($10.00); London: McGraw-Hill Publishing Co., Ltd. (50*s*. net).

It has been known to many metallurgists for some time that Mr. Rickard had in preparation an extensive work on the history of mining and metallurgy, and those who were aware of his wide knowledge and literary skill have looked forward with interest to its appearance. They will not be disappointed, for this important work not only brings together a great mass of historical material, but also presents it in such a way as to be eminently readable and attractive. The author has not been content to collect facts concerning the mining, smelting, and exploitation of metals, but has delved deeply into the records of the social reactions of mining on society and government, so that his work has a sociological value above that of a mere technical record. The very large number of references collected at the end of each chapter shows how thoroughly the field has been surveyed, but the literary quality of the narrative prevents the dullness which so often characterizes learned historical treatises. Some space might have been saved, and incidentally the cost reduced, by shortening those chapters which deal with matters not metallurgical, such as that on man before metals, and the accounts of the general history of Egypt and other Eastern countries, which are readily available in other works. No doubt the author wished to present his picture of the relations between Man and Metals with as complete a background as possible, but the reader who has good general histories at hand would prefer to see some of the subjects on which Mr. Rickard has exceptional knowledge treated in a rather fuller manner.

On controversial questions, such as the origin of bronze, the early tin trade with Britain, and the date of the introduction of iron smelting, the author's careful discussion of the evidence is most valuable, and his views deserve every consideration. Bronze still remains a mystery, and although it seems natural to assume that it was preceded by a prolonged use of copper, it remains a remarkable fact that some of the earliest Sumerian objects are of bronze. A vivid account is given of the part that the search for precious metals played in the history of the classical peoples and again in Europe and America down to our own times, and the story is full of meaning for the moralist as well as for the social historian. The use of slave labour in the mines, and the persecution and even extermination of cultured races by conquerors thirsting for gold, form shameful chapters in the history of civilization, whilst the wild gambling of the nineteenth century "gold rushes" is scarcely more creditable.

It is with the mining and smelting of metals that the author is concerned, and the treatment of the metal after extraction is considered only incidentally; consequently, the great modern developments of metallurgy receive little attention, and it is essentially as a study of the part played by metals in the evolution of mankind that this work will have permanent value, although no metallurgist can glance at it without lighting on some matter of interest, however little he may formerly have considered the social aspect of his science.—C. H. DESCH.

Ternäre Systeme. Elementare Einführung in die Theorie der Dreistofflegierungen. Von G. Masing. Med. 8vo. Pp. viii + 164, with 166 illustrations. 1933. Leipzig: Akademische Verlagsgesellschaft m.b.H. (Brosch., M. 8.30; kart, M. 9.60.)

This book is intended to introduce the reader to the more simple kinds of equilibrium diagrams met with in the study of ternary alloys. After a brief introduction to the Phase Rule, the methods of representing the compositions and phase boundaries of ternary alloys are described. The reader is then led systematically through a series of hypothetical ternary systems of increasing complexity. These begin with the simple case in which the three components *A*, *B*, and *C* form neither solid solutions nor compounds, and proceed to the opposite extreme, in which all three components are completely miscible in the solid state, and then to more complex combinations involving partial solid solubility, peritectic reactions, intermetallic compounds, and the formation of two immiscible liquids. The necessity for continual reference from the text to the diagrams makes the reading far from easy, but the general arrangement of this part of the book is admirable, and the student who works patiently through the whole series of examples will acquire a very useful knowledge of ternary diagrams, and will learn to avoid some mistakes which are easily made.

The book is illustrated by numerous figures of isothermal and vertical sections through the three dimensional ternary diagrams, and these are very clear and satisfactory. Minor misprints occur in the titles or lettering of Figures 82, 124, 128, 129, 134, and 135. In Figures 83, 86, 116 and 119, English readers may be puzzled by the use of a German type of w which

somewhat resembles an m and is different from the ordinary w used in the text. The author is less fortunate with the perspective drawings of the three-dimensional diagrams; in some cases these do not show the shapes clearly, and could be improved by better drawing, and methods of shading.

The concluding chapters deal with the diagrams for ternary alloys of aluminium, iron, and silicon, of copper, zinc, and tin, and with the different modifications of iron in ternary alloys. The change from hypothetical to actual ternary systems is very welcome, and prevents the book from being too abstract. Readers will probably criticize the choice of the particular diagrams which the author has selected from the different investigations, but actual examples are undoubtedly desirable, although in some parts the author has been compelled to "simplify" the complex binary diagrams considerably so that his description of the ternary diagram is in the nature of a preliminary sketch with many details to be filled in. The preliminary sketches must, however, be made sometime, and we are glad to see a beginning.

In the opinion of the reviewer, the great defect of the book is the entire absence of any real description of the underlying assumptions. In view of the fact that the whole book depends on an absolute acceptance of the Phase Rule, we had expected at least some indication of the assumptions and limitations involved. At the beginning, the author raises our hopes by showing how in the case of hydrogen, oxygen, and water, we may have a system of one, two, or three components according to the conditions, but he is silent as to how this is to help us in our study of alloys, particularly where the solid state is concerned; in fact, apart from a short description of crystal lattices on p. 121, the only reference to equilibrium between phases is ten lines in the proof of the Phase Rule on pp. 7–8, where it is stated that if two phases are in equilibrium, the concentrations of the components are not independent, but are connected by a distribution law. This method of proving the Phase Rule does not seem so satisfactory as that of Gibbs, and when presented so briefly may easily confuse the student, who may ask, for example, what kind of distribution law holds when a compound is formed in the solid but has no existence in the liquid or vapour states. The reviewer feels that the student reader may easily be left in a state of uncertain confusion. Thus at the beginning of the fourth chapter, dealing with binary compounds, the reader is told that it is "perhaps more correct not to speak of a compound, but of an intermediate crystal phase without a considerable range of solid solubility, since the laws of heterogeneous equilibria state nothing about the molecular condition of the phases." This is a very dangerous statement to leave without further amplification, for the truth is, of course, that whilst the fundamental laws of thermodynamics are universal, their application to chemical equilibria can be made only by introducing explicit assumptions. It may, of course, be argued that discussions of this nature lie outside an elementary book, but in this case the limitations involved should be stated frankly, and the examples confined to simple systems. If complex equilibria such as these between the α, β, γ, and δ phases in brass or bronze are to be considered, the student should not be left with the impression that the fundamental theory is necessarily as simple as in the elementary cases. We may hope therefore that, in later editions, the author will not shirk these difficulties, but will discuss the underlying assumptions of the theory just as clearly as he has explained the detailed application of the Phase Rule to the different systems.—W. HUME-ROTHERY.

Plastic Working of Metals and Power Press Operations. By E. V. Crane. Med. 8vo. Pp. xi + 326, with 254 illustrations. 1932. New York: John Wiley and Sons, Inc. ($4.00); London: Chapman and Hall, Ltd. (25*s*. net.)

In this book the author attempts to deal in some three hundred odd pages with a dozen branches of the subject, the chapter headings being: "Mass Production"; "Essential Metallurgy"; "Shearing Metal in Dies"; "The Shearing Group of Press Operations"; "Bending Operations"; "Expanding, Contracting, and Curling"; "Cold-Working of Plastic Metals"; "The Drawing Group of Press Operations"; "Drawing Speed, Lubrication, Annealing"; "Cold Operations of the Squeezing Group"; "Extrusion"; and "Hot-Press Forging." As a result it has been impossible to give more than a cursory review of some of the processes, extrusion for example being disposed of in a dozen pages. The mechanical and metallurgical problems involved in the various processes are frequently considered together in the same chapter, a feature which interferes to some extent with the pleasure of reading the book, and gives the impression of its being a compilation of a number of separately written articles instead of an orderly development of the subject inferred from the title. There are more than 250 figures, many being blocks of plant, but they are badly reproduced and do not add to the attractiveness of the book.

The book contains much useful information, but the contents are not likely to satisfy anyone specially interested in the subject, and for this reason one of the most valuable additions that might have been made would have been a bibliography of literature, including German and French, where fuller information on the various processes could be found.

—H. W. BROWNSDON.