# METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

1932 SEPTEMBER Part 9

## I.—PROPERTIES OF METALS

(Continued from pp. 465–471.)

**Dependence of Crystal Plasticity on Temperature. III.—Aluminium.** W. Boas and E. Schmid (*Mitt. Material., Sonderheft* **19**, 1932, 25–29).—See this *J.*, 1931, **47**, 577.—J. W.

**On the Recrystallization of Aluminium Sheet.** E. Schmid and G. Wassermann (*Mitt. Material., Sonderheft* **19**, 1932, 32–33).—See this *J.*, 1931, **47**, 417. —J. W.

**Beryllium and its Alloys.** H. Fischer and G. Masing (*Naturwiss.*, 1931, **19**, 590–595).—A summarized report on the most important properties of beryllium and age-hardenable beryllium alloys.—J. W.

**Beryllium.** Alfred Stock (*Met. Ind.* (*Lond.*), 1932, **40**, 661–664; **41**, 9–10). —A slightly condensed report of a paper read before the Electrochemical Society. See *J.*, this volume, p. 337.—J. H. W.

**On the Breaking Strength and Cleavability of Bismuth and Antimony Crystals.** G. Wassermann (*Z. Krist.*, 1930, **75**, 369–378, and *Mitt. Material., Sonderheft* **18**, 1931, 35–38).—The crystals were prepared by allowing the liquid metal to solidify slowly in evacuated glass tubes and then dissolving the glass in hydrofluoric acid. The hexagonal basal plane in all cases was in the vicinity of the axis of the rod, and therefore in shear tests direct shear did not occur along this plane, but irregular twinning took place locally; no translation was observed. Cleavage fracture ensued always along a rhombohedral cleavage plane, but was much less marked in the twinning zone where the rhombohedral plane met the basal plane. The mean value obtained for the shear strength of bismuth was about 690 grm./mm.$^2$ for the rhombohedral plane, compared with 300 grm./mm.$^2$ for the basal plane (cf. this *J.*, 1926, **35**, 461). Apparently the cleavability along various planes of a crystal is generally better the lower the critical normal stress. With antimony, twinning is more marked and more regular, and the shear condition of the rhombohedral plane cannot be quantitatively determined. Mügge's statements on the elements of twinning with antimony and bismuth have been confirmed.—J. W.

**The Phenomenon of "Frictional Oxidation" of Copper.** M. Fink and U. Hofmann (*Z. Metallkunde*, 1932, **24**, 49–54).—Wear tests with cold-worked electrolytic copper in the Amsler machine in air and oxygen-free nitrogen have proved that friction in air is to a great extent due to the formation of a thin layer of dust which consists of copper and cuprous oxide coated with copper oxide. The formation of ripples in the samples tested is also due to the action of oxygen, as they are not formed if oxygen is absent; ripples formed in a test in air or oxygen disappear if the test is continued in a nitrogen atmosphere. The practical importance of frictional oxidation and its relations to fatigue fracture are discussed.—M. H.

**Properties of Copper and Some of its Important Industrial Alloys at Elevated Temperatures.** W. B. Price (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 340–350).—See this *J.*, 1931, **47**, 425, and following abstract.—S. G.

**Discussion of W. B. Price's Paper on "Properties of Copper and Some of its Important Industrial Alloys at Elevated Temperatures."** W. H. Bassett. J. W. Bolton and F. H. Hehemann. J. J. Kanter. A. E. White and C. L.

Clark (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 351–367).—Cf. preceding abstract. W. H. B. contributes results obtained by himself and others on various copper alloys at elevated temperatures. Copper is not recommended, as it begins to anneal at 150° C. The discussion is illustrated by a number of curves. J. W. B. and F. H. H. observe that inclusion of flow test data would obviate possibilities of reaching incorrect conclusions from short test data. The presence of large percentages of tin is believed to be detrimental to creep resistance. The reason is the presence of considerable δ-eutectoid in the higher tin alloys. High-zinc copper-base alloys have poor creep resistance. J. J. K. also notes that yellow brass is much inferior as regards creep to copper–tin and copper–aluminium alloys. A. E. W. and C. L. C., referring to creep tests, point out the close dependence of creep characteristics on the recrystallization temperature. Copper alloys containing 70% or more of copper are able to maintain good creep resistance at somewhat higher temperatures than those containing 60% of copper. These contributors suggest that before any copper alloys of these types are subjected to high temperatures, the lowest recrystallization temperature of the alloy should be determined, and if it is found to be below the required operating temperature, the composition should be so amended that the recrystallization temperature will be raised the necessary amount.—W. A. C. N.

**Preparation of Pure Magnesium by Distillation and Sublimation.** J. Hérenguel and G. Chaudron (*Chim. et Ind.*, **1932**, Special No. (March), 348–350, and *Compt. rend.*, 1931, **193**, 771–773).—See *J.*, this volume, p. 67.—S. G.

**Contributions to the Physics and Metallography of Magnesium. I.—Physical Anisotropy of Magnesium Crystals. II.—Plastic Deformation of Magnesium Crystals. III.—On Mixed Crystal Formation in Magnesium.** E. Schmid (*Mitt. Material., Sonderheft* **19**, 1932, 16–25).—See *J.*, this volume, p. 2.—J. W.

**Adherence and Nature of the Hydrogen Absorbed by the Metals of the Platinum Group.** Erich Müller and Kurt Schwabe (*Z. physikal. Chem.*, 1931, [*A*], **154**, 143–166).—All the metals of the platinum group absorb large quantities of hydrogen. At very low pressures, the hydrogen is removed completely from palladium, partly from platinum, but not at all from rhodium, ruthenium, iridium, or osmium. That part of the hydrogen the absorption of which depends on pressure is bound by the molecules in the interior of the metal, but that part, the absorption of which is independent of pressure, is bound by the atoms at the surface.—B. Bl.

**The Supercooling of Tin and Resistivity Lag in the Solid-to-Liquid Transformation.** W. B. Pietenpol and H. Artis Miley (*J. Colo.-Wyo. Acad. Sci.*, 1930, **1**, (2), 39; *C. Abs.*, 1932, **26**, 3417).—Cf. *Phys. Rev.*, 1929, [ii], **33**, 294 (this *J.*, 1929, **41**, 427), and *Phys. Rev.*, 1929, [ii], 34, 1588–1600 (this *J.*, 1930, **43**, 406). An abstract. Tin can be supercooled approximately 9°. There is a lag in resistivity after supercooling has taken place and the metal changes from the liquid to the solid state.—S. G.

**Atomic Heat of Zinc and Tin near Absolute Zero.** W. H. Keesom (*Pontificia Acad. Sci. Nuncius radiophonicus*, **1932**, (10), 5–6; *C. Abs.*, 1932, **26**, 3432).—The atomic heat of zinc at 1·32° K. is 0·00025 cal. The atomic heat of tin varies greatly at 3·7° K.—S. G.

**Investigations on the Fatigue of Metals.** R. Cazaud (*Chim. et Ind.*, **1932**, Special No. (March), 390–392; *C. Abs.*, 1932, **26**, 3464).—The following method was used for determining the fatigue of metals under alternating stresses: a frustro-conical test-piece is encased in a mandrel rotating at 3000 r.p.m. and supporting a weight at its small end; the degree of fatigue, which is practically constant through the central portion of the test-piece, is calculated by the formula for cantilever deflection; the test is repeated on a number of test-pieces with successively decreasing loads, the total number of alternating stresses required to break the test-piece being noted in each case. The maximum load, in kg./mm.$^2$, which does not break the piece after 100,000,000 alternations, is the practical fatigue limit. Examples are given of the results obtained with this test on extra-mild steel, semi-hard annealed steel, alloy steels, aluminium and its alloys, and magnesium alloys. The test closely simulates actual working conditions, particularly those prevailing in aeroplane parts, and furnishes data that are valuable in the design and construction of machine parts.—S. G.

**On the Dependence of the Plasticity of Crystals on Temperature.** E. Schmid (*Mitt. Material., Sonderheft* **18**, 1931, 23–25, and *III. International Kongr. tech. Mechanik, Stockholm*, **1930**, 249).—A summarized report in which the important conclusion is reached that the very low values of the critical shear stress and normal stress of single crystals of metals compared with those which would be expected from the lattice theory cannot be explained by the thermal movement of the atoms. On the other hand, the strong dependence of the hardening coeff. on the temperature and velocity can be explained only by a superimposing of a thermal recovery process with a finite velocity on the athermal basic process observed at low temperatures. (Cf. Schmid and collaborators, this *J.*, 1930, **43**, 425, 525; 1931, **47**, 26, 68.)—J. W.

**Influence of Cold-Stretching on the Plasticity (of Metals) at Elevated Temperatures.** E. Schmid and G. Wassermann (*Mitt. Material., Sonderheft* **19**, 1932, 33–35).—See *J.*, this volume, p. 150.—J. W.

**On the Plastic Behaviour of Metals.** W. Prager (*Naturwiss.*, 1931, **19**, 581–585).—A review of the present position of the plasticity theory and its experimental proof.—J. W.

**German Metal Plastics during Three Hundred Years.** W. Pinder (*Stahl u. Eisen*, 1932, **52**, 257–262).—A short historical review.—J. W.

**Restoration of the Recrystallization Power [of Metals] by Bending Back [Deformed Specimens].** P. Beck and M. Polanyi (*Z. Elektrochem.*, 1931, **37**, S. 521–524; and *Mitt. Material., Sonderheft* **19**, 1932, 30–32).—See this *J.*, 1931, **47**, 514.—J. W.

**Report of Joint Research Committee [of A.S.T.M. and A.S.M.E.] on Effect of Temperature on the Properties of Metals.** H. J. French and N. L. Mochel (*Amer. Soc. Test. Mat. Preprint*, **1932**, 1–22).—A scheme is outlined for securing the active co-operation of various groups interested in certain features of metal practice under one directing organization. The work so far done is concerned solely with steels.—W. A. C. N.

**Trends in Engineering Requirements for Metals for the Power-Plant Industry.** H. J. Kerr (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 15–19; discussion, 20–29).—See this *J.*, 1931, **47**, 423.—S. G.

**Metallurgical Requirements for High-Temperature Steam Piping.** F. W. Martin (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 49–57; discussion, 58–65).—See this *J.*, 1931, **47**, 423.—S. G.

**Needs of the Oil Industry for Metals at High Temperatures.** E. S. Dixon (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 66–84; discussion, 85–99).—See this *J.*, 1931, **47**, 423.—S. G.

**Corrosion and Other Problems in the Use of Metals at High Temperatures in the Chemical Industries.** F. H. Rhodes (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 100–108; discussion, 109–111).—See this *J.*, 1931, **47**, 423.—S. G.

**Engineering Requirements and Trends for Metals in the Ferrous Metal Industries.** J. C. Woodson (*Symposium on Effect of Temperature on the

*Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 112–139; discussion, 140–150).—See this *J.*, 1931, **47**, 424.—S. G.

**Engineering Requirements and Trends for Metals in the Non-Ferrous Roasting, Smelting, and Refining Industry.** R. E. Brown (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 151–168).—See this *J.*, 1931, **47**, 424.—S. G.

**Engineering Requirements in the Automotive Industry for Metals Operating at High Temperatures.** A. L. Boegehold and J. B. Johnson (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 169–193).—See this *J.*, 1931, **47**, 424, and following abstract.—S. G.

**Discussion on A. L. Boegehold and J. B. Johnson's Paper on "Engineering Requirements in the Automotive Industry for Metals Operating at High Temperatures."** H. N. McQuaid. C. F. Smart. S. D. Heron. A. J. Field (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 194–200).—Cf. preceding abstract. H. N. McQ. considers that a cast iron containing aluminium which has been nitrided should be good for Diesel engine cylinder liners, pistons, inserted valve-seats, &c. He recommends chromium plating on crankshafts, pistons, &c. C. F. S. discusses the relative wearing properties of cast-iron and aluminium pistons. Electroplating the skirt of cast-iron pistons with tin of about 0·001 in. thickness reduces frictional loss and permits of smaller clearances. S. D. H. recommends cobalt–chromium steel for exhaust valves and guides to give good wearing properties, although it tends to rust rather quickly. A. J. F. mentions the R.R.50 aluminium alloy containing copper 1·3; silicon 2·2; nickel 1·3; iron 1·0; magnesium 0·1, and titanium 0·1%, for use in crankcases, cylinder jackets, and heads. Due to piston and rod expansion, when these are made of aluminium, some difficulty may be experienced in starting up a Diesel engine when it is hot, owing to greater compression.
—W. A. C. N.

**Use of Metals at Elevated Temperatures in the Ceramic Industry.** Clyde E. Williams (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 201–216; discussion, 217).—See this *J.*, 1931, **47**, 425.—S. G.

**The Trend of Progress in Great Britain on the Engineering Use of Metals at Elevated Temperatures.** R. W. Bailey, J. H. S. Dickenson, N. P. Inglis, and J. L. Pearson (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 218–236).—See this *J.*, 1931, **47**, 425, and following abstract.—S. G.

**Discussion on R. W. Bailey, J. H. S. Dickenson, N. P. Inglis, and J. L. Pearson's Paper on "The Trend of Progress in Great Britain on the Engineering Use of Metals at Elevated Temperatures."** J. J. Kanter. F. L. Everett. L. W. Clark (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 237–244).—Cf. preceding abstract. J. J. K. affirms that rapid primary creep occurs, in tension or in shear, before any approximations to a constant rate of creep are obtained. This primary creep often results in greater total deformation than can be tolerated. He suggests that when considering very minute plastic changes "total creep" should be used instead of "rate of creep." In general, the total creep stress which limits creep to a chosen tolerance is lower than one chosen on a "rate of creep" basis. F. L. E. details torsion experiments in creep, in which thin tube specimens are subjected to twist within a furnace and the creep due to shear is measured by a Martens mirror instrument. These torsion creep tests give data for small creep rates directly, and thus save the extrapolation which is necessary in tension creep studies. L. W. C. cites results which show that up to about 800° F. (427° C.) the characteristics of the torsion and tensile tests are almost identical; beyond this temperature they differ appreciably.—W. A. C. N.

**The Mechanical Properties of Metals at Elevated Temperatures.** Pierre Chevenard (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 245–268; discussion, 269–270).—See this *J.*, 1931, **47**, 425.—S. G.

**Properties of the Rare Metals for High-Temperature Service.** W. H. Swanger (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 610–622).—See this *J.*, 1931, **47**, 426, and following abstract.—S. G.

**Discussion on W. H. Swanger's Paper on "Properties of the Rare Metals for High-Temperature Service."** E. M. Wise. F. E. Carter (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 623–630).—Cf. preceding abstract. E. M. W. gives an excellent summary of uses to which the rare metals are put at the present time. Silver, as well as platinum and platinum alloys, is used for electrical contacts. Other avenues of employment which are considered are electrical temperature-measuring devices, vacuum-tube amplifier filaments, high-temperature oxidation catalysts. Many gold and platinum group alloys form extensive series of solid solutions at high temperatures which suffer transformations at lower temperatures and thus offer a convenient means of precipitation hardening. F. E. C. summarizes data on the volatilization of the platinum metals.—W. A. C. N.

**Effect of Low Temperatures on Metals and Alloys.** H. W. Russell (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 658–680; discussion, 681–682).—See this *J.*, 1931, **47**, 426.—S. G.

**Thermal Expansion of Metals.** Norman L. Mochel (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 683–718).—See this *J.*, 1931, **47**, 426, and following abstract.—S. G.

**Discussion of N. L. Mochel's Paper on "Thermal Expansion of Metals."** R. S. Moulton (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 719–724).—Cf. preceding abstract. R. S. M. discusses the practical point of the effect of fires on metals and alloys employed in structures, and the consequent stability or instability of the latter.—W. A. C. N.

**Note on Applications of Data on the Thermal Conductivity of Metals.** M. S. Van Dusen (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 725–729).—See this *J.*, 1931, **47**, 427, and following abstract.—S. G.

**Discussion on M. S. Van Dusen's "Note on Applications of Data on the Thermal Conductivity of Metals."** W. H. Swanger (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 730–733).—Cf. preceding abstract. W. H. S. briefly describes a method for determining thermal conductivity on cylinders 2 cm. in diam., such that cast or wrought specimens may be used. Commercial malleable nickel is used as a reference basis; its conductivity has been determined in absolute values by comparison in the same apparatus with pure lead. The apparatus permits the determination of the effect of temperature on the thermal conductivity over a wide range. Curves to demonstrate this are included. In general, the thermal conductivity of the pure or nominally pure metals decreases with increase in temperature. In the case of nickel the conductivity decreased up to 370° C., and above that temperature there was a slight increase. It is noteworthy that the magnetic transformation point of nickel occurs at 360°–380° C.—W. A. C. N.

**Supplementary Bibliography on Effect of Temperature on Properties of Metals.** Lois F. McCombs (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, 1931, 735–791).—See this *J.*, 1931, 47, 427.—S. G.

**The Changes in the Electrical Conductivity of Ferromagnetic Materials in Magnetic Fields.** O. Stierstadt (*Z. tech. Physik*, 1932, 13, 65–71, 105–111, 161–165).—A summarized report on the laws governing the change of resistance of iron and nickel in longitudinal and transverse magnetic fields. Explanations of the effects observed are given. The sign of the change is determined not by the direction of the field but by its strength and by the temperature at which the test is made.—J. W.

**Phenomena in Oxide-Coated Filaments. II.—Origin of Enhanced Emission.** J. A. Becker and R. W. Sears (*Bell Telephone System Tech. Publ.*, B-646, 1932, 1–21).—Reprinted from *Phys. Rev.*, 1931, [ii], 38, 2193–2213; see *J.*, this volume, p. 220.—S. G.

## II.—PROPERTIES OF ALLOYS

(Continued from pp. 471–478.)

**A Study of Certain Light Alloys of Aluminium and "Aluminium-Bronze" [for Coinage].** Camille Matignon (*Chim. et Ind.*, 1932, 27, 1259–1273).—This is the first part of a report, presented to the French Minister of Finance by a committee of experts, on the scientific aspects of aluminium alloys and bronze as token monetary media. The features dealt with are—resistance to wear, chemical resistance and hardness. The aluminium used contained aluminium 99·6, silicon 0·19, iron 0·16, sodium 0·04%. The alloy "R.4" contained aluminium 95, copper 4·5, silver 0·5%, together with small percentages of impurities. "A.5" contained aluminium 90, copper 5, silver 5%. Comparisons are made with silver alloys that have been used in coinage. In a second group of trials a number of complex aluminium alloys were tried. Coinage bronze wears less than silver, which in turn is more resistant than R.4 and A.5. Aluminium abrades much more than "R.4" and "A.5." To brine, "A.5," "R.4," and aluminium are increasingly resistant in this order. "Aluminium–bronze" (aluminium 9%) resists wear better than ordinary coinage bronze. Alloys containing 5–10% manganese are very resistant to salt solutions. Aluminium alloys containing 5% silver are readily attacked in the same medium.—W. A. C. N.

**The Mechanical Properties of Aluminium and Magnesium Alloys at Elevated Temperatures.** R. L. Templin and D. A. Paul (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, 1931, 290–313).—See this *J.*, 1931, 47, 428, and following abstract.—S. G.

**Discussion on R. L. Templin and D. A. Paul's Paper on "The Mechanical Properties of Aluminium and Magnesium Alloys at Elevated Temperatures."** J. A. Gann (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, 1931, 314–315).—Cf. preceding abstract. J. A. G. records supplementary data on 2 additional extruded Dow metal alloys and on 3 cast Dow metal alloys. The following general conclusions are reached: (1) great similarity exists between the curves showing the effect of elevated temperatures on the tensile properties of aluminium and magnesium alloys; (2) wrought alloys of both types are more susceptible than the cast alloys to changes produced by elevated temperatures; (3) the aluminium alloys have somewhat better tensile values than the magnesium alloys in the temperature range 300°–600° F. (150°–315° C.); (4) differences in tensile properties at room temperature and at elevated temperature, due to alloy composition, heat-treatment, and mechanical working, largely disappear as the temperature is raised still further. At temperatures of 700°–800° F. (370°–425° C.) alloys of aluminium and magnesium possess approximately the same tensile strength irrespective of prior treatment.—W. A. C. N.

**Investigation of Elastic and Plastic Deformation of Duralumin Sheets during Bending.** I. G. Schulgin (*Trans. Central Aero-Hydrodynamic Inst.* No. **114**, 1932, 1–36; *U.S.S.R. Supreme Council Nat. Econ. All-Union Association of Aircraft Industry*, 1932, 1–36).—[In Russian, with English summary.] The investigation was carried out in great detail in order to determine the different factors (such as elasticity and plasticity of the material, thickness of plates, radius of the bends, length of ageing period between thermal treatment and the tests, and the number of bends) which influence the results of bending stresses. It is stated that no accurate and systematic data have hitherto been published on this subject, which is of great importance in aircraft construction, since reduction of the radius of the bend enables a much narrower and flatter riveting seam to be obtained, which results in a firmer join and a reduction in weight. The investigations were carried out according to the following scheme: (1) chemical composition; (2) determination of the methods of testing; (3) determination of the bending radii for sheets of different thicknesses; (4) determination of the elasticity and plasticity of Duralumin sheets during the ageing process (*a*) on quenching from 500° C. after 0·5, 1, 3, and 6 hrs., 1 and 7 days; (*b*) on normalizing at 350°, 400°, and 425° C. for 2 hrs., 1 and 7 days; (5) macro- and micrographic analysis. The chemical composition of individual samples varied very slightly, the average being: copper 4·40, magnesium 0·60, manganese 0·5, silicon 0·20, iron 0·40%, the rest aluminium. Seven specimens of sheet, labelled Mark 1–7, varying in thickness ($\delta$) from 4·08 to 0·58 mm., were tested, 5 sets of curvatures being tried (Table II). The following conclusions were reached: (1) the angle of bend of Duralumin sheets alters when once the load is removed owing to the elasticity of the material. The change may be one of increase or of decrease, depending on the initial radius of curvature and thickness of the sheet, thus: (*a*) if the bend originally obtained has a large radius of curvature, then for each given sheet thickness there may be a decrease in the angle if the final radius of curvature is small and an increase if it is large, whilst, ultimately, constancy is attained when the ratio of the radius of curvature ($r$) to the sheet thickness ($\delta$) attains a certain value ($\delta = 3{\cdot}2$ mm., $\frac{r}{\delta} = 2{\cdot}6$; $\delta = 2{\cdot}1$ mm., $\frac{r}{\delta} \simeq 3{\cdot}5$; $\delta = 1{\cdot}5$ mm., $\frac{r}{\delta} = 4{\cdot}1$; $\delta = 1{\cdot}0$ mm., $\frac{r}{\delta} = 5{\cdot}0$; $\delta = 0{\cdot}8$ mm., $\frac{r}{\delta} = 5{\cdot}5$; $\delta = 0{\cdot}5$ mm., $\frac{r}{\delta} = 6{\cdot}5$). (*b*) if the initial angle of bend has a small radius of curvature, then the final angle increases by 3° if the test is carried out 3 hrs. after quenching and by 5° after 24 hrs.; (2) no evidence has been obtained of elastic residual action in sections after bending at various times (up to 7 days) after quenching; (3) sheets which have been quenched from 500° C. in water and tested once 3 and 6 hrs. later developed cracks for the following values of $\delta$ and $r$: $\delta = 4$ mm., $r \simeq 4{\cdot}5$ mm.; $\delta = 3{\cdot}2$, $r = 3{\cdot}5$; $\delta = 2{\cdot}1$, $r = 2{\cdot}5$; $\delta = 1{\cdot}5$, $r = 2{\cdot}0$; $\delta = 1{\cdot}0$, $r = 1{\cdot}2$; $\delta = 0{\cdot}8$, $r = 1{\cdot}0$; $\delta = 0{\cdot}5$, $r = 0{\cdot}6$; (4) if the tests are carried out in 2 stages, separated by several hours, the cracks developed at values of $r$ greater than given in (3); (5) the cracks form, in general, at an angle of 45° to the radius of curvature; (6) the following values of $r$ are considered to be permissible in practice: $\delta = 4{\cdot}0$ mm., $r = 8{\cdot}3$ mm.; $\delta = 3{\cdot}0$, $r = 6{\cdot}0$; $\delta = 2{\cdot}0$, $r = 4{\cdot}0$; $\delta = 1{\cdot}5$, $r = 3{\cdot}0$; $\delta = 1{\cdot}0$, $r = 2{\cdot}0$; $\delta = 0{\cdot}8$, $r = 1{\cdot}6$; $\delta = 0{\cdot}5$, $r = 1{\cdot}0$. The numerical data are collected in tabular form as an appendix.—M. Z.

**The Manufacture and Properties of " Y " Alloy.** Anon. (*Z. ges. Giesserei-Praxis: Das Metall*, 1932, **53**, 282–283).—The manufacture and properties of " Y "-alloy are described in some detail.—J. H. W.

**The Light Aluminium Alloys.** Anon. (*Nickel Bulletin*, 1932, **7**, 145–152).—The composition and principal physical and mechanical properties of the " Y " and "R.R." alloys and numerous examples of their applications in the construction of internal combustion engines are given.—J. H. W.

**["4S"] Aluminium–Manganese–Magnesium Alloy.** Douglas B. Hobbs (*Met. Ind.* (*Lond.*), 1932, **41**, 126).—The mechanical properties of "4S," an aluminium alloy containing manganese 1% and magnesium 1%, are as follows:

| Temper. | Tensile Strength. Tons/in.$^2$. | Yield-Point. Tons/in.$^2$. | Elongation. % on 2 in. | Brinell Hardness.* | Shore Hardness.† | Shear Strength. Tons/in.$^2$. | Minimum Bend Diameter.‡ |
|---|---|---|---|---|---|---|---|
| Annealed | 11·6 | 4·5 | 20 | 45 | 14 | 7·1 | 0 × T |
| ¼ Hard | 13·8 | 11·1 | 6 | 55 | 21 | 7·6 | 1 × T |
| ½ Hard | 15·6 | 13·8 | 5 | 65 | 23 | 8·5 | 2 × T |
| ¾ Hard | 17·4 | 15·6 | 3 | 73 | 26 | 9·4 | 4 × T |
| Hard | 18·7 | 17·0 | 3 | 80 | 30 | 9·8 | Difficult |

* 500 kg. load with 10 mm. ball. † Magnifier hammer. ‡ Diameter over which specimen will bend 180° without fracture, T = thickness.

This alloy is intermediate in its properties between common and strong aluminium alloys and has high corrosion resistance.—J. H. W.

**Birmabright Aluminium Alloy.** Anon. (*Machinery* (*Lond.*), 1931, **39**, 135).—An account of the general properties of Birmabright. See also this *J.*, 1931, **47**, 649, and this volume, p. 349.—J. C. C.

**"M.V.C." [Aluminium] Alloy.** Anon. (*Machinery* (*Lond.*), 1931, **38**, 810; and *Mech. World*, 1932, **91**, 469–470).—See *J.*, this volume, pp. 12, 223.—J. C. C.

**[Cromal.]** Anon. (*Indust. Australian*, 1932, **87**, 140).—See this *J.*, 1931, **47**, 479.—P. M. C. R.

**Beryllium Alloys and Their Properties.** Anon. (*Helios* (*Fachzeit.*), 1932, **38**, (14), 111).—A review.—v. G.

**[Contribution] to the Knowledge of the Binary System Iron–Chromium.** F. Wever and W. Jellinghaus (*Mitt. K.-W.-Inst. Eisenforschung*, 1931, **13**, 143–147; and (summary) *Metallurgist* (Suppt. to *Engineer*), 1931, **7**, 139–140).—As is the case with the iron–vanadium system (*J.*, 1931, **47**, 79, 522), the iron–chromium system forms a continuous series of solid solutions at high temperatures, but below about 920° C. the compound FeCr is formed very slowly and forms solid solutions with excess iron or chromium. Its structure is not definitely known, but appears to be analogous with that of FeV. The limits of solid solubility at 600° C. are 46–52 atomic-% chromium.—J. W.

**Stellite and its Applications.** Anon. (*Machinery* (*Lond.*), 1931, **39**, 169–171, 204–205).—Stellite is an alloy of cobalt 45–50, chromium 25–30, tungsten 15–20, and carbon 2·5–2·75%, which is cast in special moulds after precautions to ensure removal of dissolved gas. It retains its hardness even after heating to 1000° C. and, unlike tungsten carbide, can be welded. For cutting tools, Stellite may be used as tips which are brazed to shanks, as blades fitted into slots in milling or boring heads, or as plain cast bars. "Stelliting" is the operation of depositing a layer of the alloy on steel or cast iron by means of an oxy-acetylene torch, electric arc, or atomic hydrogen electric arc, so as to form a hard, wear-resisting surface. An account of the physical and chemical properties of Stellite is given, together with typical examples of Stellite cutting tools and Stellited press tools and machine parts.—J. C. C.

**Beryllium "Bronzes."** Anon. (*Cuivre et Laiton*, 1931, **4**, 337–340).—Discusses the chemical and physical characteristics of beryllium, the rôle of the latter as a deoxidizer in the founding of copper, its behaviour in this connection, the useful alloys of copper and beryllium, their preparation, thermal treatment, general characteristics, and application.—W. A. C. N.

**The New Metal—Beryllium. Its Applications in the Copper Industry.** Anon. (*Cuivre et Laiton*, 1929, **22**, (23), 15).—Alloys of beryllium with copper, nickel, and iron are discussed. Beryllium results, in the case of its alloy with copper, in a completely deoxidized material. Usually the beryllium is added in the form of a 10% alloy with copper.—W. A. C. N.

[**New Copper–Beryllium Alloy.**] Anon. (*Indust. Australian*, 1932, 87, 140).—From *Moniteur Officiel du Commerce et de l'Industrie*. The presence of important beryl deposits in New England and some of the Western States has rendered possible the commercial production of a new copper–beryllium alloy of high electrical conductivity, which is very hard and highly resistant to corrosion. The analysis of the alloy is not given.—P. M. C. R.

**Cupro-Nickel.** Anon. (*Cuivre et Laiton*, 1930, **3**, 87–89, 109–110, 137–138, 163.)—(I.) A review of the physico-chemical and physical properties of the alloys of this series. Curves are given showing the sequence of melting points and the variation of the magnetic transformation points as functions of composition. Curves are also given of temperature coeff. of resistivity and electro-thermic power. (II.) The mechanical properties are studied. (III.) Details are given of manufacture—melting, deoxidation, and rolling. (IV.) Industrial applications are discussed. Alloys containing 15–25% nickel, those containing up to 30%, and up to 40% nickel are considered separately.
—W. A. C. N.

**Effect of Antimony on the Mechanical Properties of a Bearing Bronze (Cu 80 : Sn 10 : Pb 10).** C. E. Eggenschwiler (*U.S. Bur. Stand. J. Research*, 1932, **8**, 625–634; *Research Paper* No. 442).—A study was made of the effect of additions of antimony (from 0% to 0·58%) on the Brinell hardness, structure, Izod impact value, deformation under pounding, and broaching properties of a bearing bronze containing copper 80, tin 10, and lead 10%. In general, increasing the antimony content from 0 to 0·58% had no effect on the broaching properties nor on the distribution of the lead particles throughout the copper–tin matrix. There was a slight tendency towards an increased size of the areas of the hard $\delta$-constituent with the higher antimony content. Additions of antimony lowered the Izod impact value. The deformation under pounding was markedly lowered with the first addition of antimony, reaching a minimum at 0·2% antimony. Higher antimony additions tended to increase the deformation. The addition of antimony up to about 0·2% slightly increased the Brinell hardness of the alloy, but further additions of antimony, up to 0·58%, caused little or no further change in hardness.—S. G.

**On the Physical Properties of an 87 : 8 : 5 Cu–Zn–Sn Bronze.** G. Blusich (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 269).—[In Italian.] For the study of the mechanical properties and metallographic features of the bronze in relation to the section of the casting, 8 ingots, of various sections, were cast in sand and in permanent moulds. The results clearly show that the bronze is very sensitive to the effect of large sections.—G. G.

**High-Resistance Bronzes and Brasses.** E. G. Shumovskii (*Trans. Central Board Labour Metal Ind. U.S.S.R.*, 1930, **1**, 52–63; *C. Abs.*, 1932, **26**, 3470).—[In Russian.] Investigations showed that for correct mechanical properties no bronze should contain more than 13% tin. A brass with zinc 37–38, nickel 5, manganese 1·75, and iron 1·25% was found to have high resistance.—S. G.

**Misleading Composition.** Léon Guillet (*Cuivre et Laiton*, 1929, **2**, (21), 9–10).—A discussion of the equivalent values of third metals when added to brass, in their effects in replacing zinc and yet producing similar metallographic structures. Mathematical examples illustrative of the principles involved are included. It is shown how the quantities of the added elements necessary to produce certain structures equivalent to those of normal brasses may be calculated.—W. A. C. N.

**Special Brasses.** L. Guillet (*Cuivre et Laiton*, 1929, **2**, (18), 7–10).—Cf. *J.*, this volume, p. 349. Three different ways in which the additional elements which go to form special brasses exist in the alloys are : (1) the element retains its identity; (2) it forms a special constituent; (3) it enters into solution in one or other of the normal constituents of brass. The first condition is illustrated by the case of lead, the second by tin or phosphorus, and the third by aluminium.—W. A. C. N.

**The Principal Types of Special Brasses—The Principal Coefficients of Equivalence.** Léon Guillet (*Cuivre et Laiton*, 1929, 2, (23), 11–12).—A review of the effect of small additions of various elements with their respective coeffs. of equivalence.—W. A. C. N.

**Aluminium as an Impurity in Industrial Brass Alloys.** Gerhard Wolf (*Met. Ind.* (*Lond.*), 1932, 41, 27–28).—Practically all the mechanical disadvantages of aluminium in brass are due to aluminium oxide. The presence of this oxide may be due to the introduction of brass scrap containing it or to the oxidation of metallic aluminium in the melt by other oxides, by the furnace atmosphere, or by air during pouring. The methods of preventing the formation of this oxide or of removing it when it has formed are described.—J. H. W.

**Aluminium–Brass.** Anon. (*Met. Ind.* (*Lond.*), 1932, 41, 98).—A short note. An improved method of casting employed by I.C.I. Metals, Ltd., enables aluminium–brass to be poured into the mould without splashing or turbulence, thus ensuring sound castings. It is claimed that aluminium does not increase the tendency of brass to season-crack and that the addition of aluminium considerably improves the resistance of brass to corrosion. Alumbro, an alloy containing 76 : 22 : 2 copper–zinc–aluminium, is recommended for the construction of condenser tubes. See following abstract.—J. H. W.

**Aluminium–Brass.** W. W. Wood (*Met. Ind.* (*Lond.*), 1932, 41, 137).—A letter stating that the aluminium–brass (described in the preceding abstract) has been given no name by the patentees, the British Non-Ferrous Metals Research Association, Alumbro referring to condenser tubes of this alloy manufactured by I.C.I. Metals, Ltd.—J. H. W.

**Aluminium–Brasses.** Léon Guillet (*Cuivre et Laiton*, 1930, 3, 31).—The addition of aluminium to brass confers a " fictitious " composition, in that the microscopical appearance does not coincide with what would be expected from the composition. Equivalence values are explained and calculated. The mechanical properties of certain industrial alloys are examined and tabulated. —W. A. C. N.

**Brass Containing Cadmium.** Léon Guillet (*Cuivre et Laiton*, 1930, 3, 57–59).—In a brass containing 70% copper, up to 1·5% cadmium does not materially affect the mechanical properties. In brass containing more than that amount those properties are not so good. With 4% cadmium the strength is practically nil. These results confirm those obtained microscopically. Above 1·5% cadmium the compound $Cu_2Cd$ appears and increases the brittleness. In a brass containing 60% copper the permissible maximum of cadmium content is 1%. Similar conditions obtain in a brass containing 55% copper. The various results are tabulated. Particular attention should be paid to the amount of cadmium which may be added as an impurity in the zinc. —W. A. C. N.

**The Lead–Brasses and their Identification.** Léon Guillet (*Cuivre et Laiton*, 1930, 3, 131).—Analytical and micrographical methods are available for identification purposes. The Erichsen test is suitable for detecting the presence of lead by alteration in mechanical properties.—W. A. C. N.

**The Ternary Alloys of Copper, Zinc, and Nickel.** Anon. (*Cuivre et Laiton*, 1930, 3, 216–217, 237–238, 267–268).—The triangular diagram is employed to explain the ranges of the useful alloys. The significance of equivalence values is also explained diagrammatically. The metallurgical and physical properties of the most important of the alloys are discussed.—W. A. C. N.

**Special Brasses—Brasses Containing Silicon.** Léon Guillet (*Cuivre et Laiton*, 1930, 3, 311–312).—A brief discussion of the compositions of silicon brasses which are found to be beneficial, and of the physical and mechanical properties of these alloys. In general, silicon is stated to be less favourable than some other materials for modifying the qualities of the brasses.—W. N.

**Tombasil—a New Alloy of Silicon, Zinc, and Copper.** E. Vaders (*Cuivre et Laiton*, 1931, 4, 469–483).—Cf. this *J.*, 1930, **44**, 363; 1931, **47**, 519). Silicon does not reduce the conductivity of copper as quickly as some of the other elements. The silicon–zinc–copper alloys are very susceptible to heat-treatment. The solubility diagram is fully discussed and photomicrographs are included to illustrate various phases. The content of silicon in general does not exceed 6%. A section is devoted to the physical and mechanical properties of these alloys and afterwards to their practical application. The density of the alloy containing copper 75·16 and silicon 3·72% is 7·85; that containing copper 67·16 and silicon 1·71% is 7·98. The alloys work well when hot, and, generally speaking, the presence of silicon improves their working properties.—W. N.

**Special Brasses—Tin–Brasses.** Léon Guillet (*Cuivre et Laiton*, 1930, 3, 259–260).—A *resumé* of the constitution and physical properties of the important tin–brasses.—W. A. C. N.

**Properties and Some Applications of Tungum Alloy.** Anon. (*Metallurgia*, 1932, **6**, 99–100).—A recent addition to the anti-corrosive alloys is a copper-base alloy known as Tungum. It has a tensile strength " as cast " of 24 tons/in.$^2$, and can be rolled, forged, drawn, or extruded within the range 700°–750° C., when its strength increases to more than 30 tons/in.$^2$. Its properties are also improved by heat-treatment and its strength at elevated temperatures is satisfactory. It offers a very good resistance to the effect of various corrosive media, particularly to acid corrosion, and in the presence of sea-water the alloy is electro-negative to zinc, iron, steel, lead, tin, and antimony. It is stated that it can be used with advantage in parts subjected to reversal of stress, that tubes of Tungum show no tendency to season-cracking, that it can be satisfactorily plated with chromium, and that it brazes, welds, and machines easily. —J. W. D.

**Production and Treatment of White Gold Alloys.** Werner Fröhlich (*Met. Ind.* (*Lond.*), 1932, **41**, 28–29).—The two chief groups of " white gold " alloys are the gold–nickel–zinc and the gold–palladium alloys. Of these, the latter have the more satisfactory working properties, but are more expensive. The quality and properties of the gold–nickel–zinc alloys depend on the composition, the melting process, and the heat-treatment. The alloys of lowest melting point of this group contain nickel 15–20 and zinc 10%, and melt at 1700°–1750° F. (925°–955° C.). The nickel is first melted under boric acid and the gold gradually added. The melt is then cooled to 2000°–1950° F. (1095°–1065° C.) and deoxidized with magnesium ribbon or wire. Zinc should never be added previous to this deoxidation. After adding the zinc the melt is stirred with a carbon rod and another piece of magnesium added. Copper is sometimes added to decrease the hardness and brittleness, but it contaminates the etching solution used in jewellery. Tin, from white gold scrap, should be avoided. For homogeneity of structure the alloy is remelted especially if only virgin metals have been used. Annealing should be at as low a temperature as possible and cooling-off effected gradually. Owing to their sensitiveness to oxidation, the alloys should always be heated under a layer of borax–boric acid paste made up with alcohol.—J. H. W.

**Fatigue Studies of Telephone Cable Sheath Alloys.—II.** J. R. Townsend and C. H. Greenall (*Bell Telephone System Tech. Publ.*, **B-669**, 1932, 1–9).—Reprinted from *Proc. Amer. Soc. Test. Mat.*, 1930, **30**, (II), 395–402. See this *J.*, 1930, **44**, 503.—S. G.

**Properties of Bearing Metals at Normal and Elevated Temperatures.** E. R. Darby (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, 1931, 316–331).—See this *J.*, 1931, **47**, 431, and following abstract.—S. G.

**Discussion on E. R. Darby's Paper on "Properties of Bearing Metals at Normal and Elevated Temperatures."** H. K. Herschman and J. L. Basil. R. J. Shoemaker (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 332–339).—Cf. preceding abstract. H. K. H. and J. L. B. affirm that D.'s statement that lead-base alloys are generally weaker and softer at elevated temperatures than tin-base alloys is not entirely supported by D.'s results or by data issued by the Bureau of Standards. The latter show that the Brinell hardness of the lead-base alloys containing 5% or more of tin equals or exceeds that of tin-base alloys up to 150° C., whilst the hardness of both series (except the alkali-hardened lead alloy) falls within a narrow range at 200° C. Lead-base alloys containing above 2% of tin are more resistant to pounding at 150° C. than the tin-base alloy. At 200° C. the lead-base alloys containing more than 5% tin are better than the tin-base alloy. Izod tests, however, appear to confirm Darby's results at elevated temperatures. Additional data, in the form of curves, are given showing the resistance to repeated pounding of white-metal bearing alloys at various temperatures. R. J. S. discusses "Bahnmetall" and "Frary" or "Ulco" metal. The former contains approx., lead 96–98, calcium 0·6, sodium 0·6, lithium 0·03, aluminium 0·10%. The latter contains small quantities of calcium and barium as hardeners. Both alloys dross excessively and are unstable on remelting. A third material containing the same quantity of lead as the above, but having calcium and tin as hardeners (Satco metal), has good high-temperature properties, is stable on remelting, does not dross excessively, and can be exposed to the air even at red heat without suffering injury. It is much used for linings for engine-truck and trailer brasses, passenger-car journals, and tender bearings. Compared with Babbitt metal it has higher transverse strength, is resistant to deformation, and has high melting and softening points.—W. A. C. N.

**Boroto Bearing Metal.** Anon. (*Machinery* (*Lond.*), **1931**, **39**, 111).—See *J.*, this volume, p. 17.—J. C. C.

**The Mercurides of Cerium, Lanthanum, Praseodymium, and Neodymium.** P. T. Daniltchenko (*Zhurnal Obschtchey Chimii* (*Journal of General Chemistry*), **1931**, [A], (163), (3/4), 467–474).—[In Russian.] Cf. *J. Soc. Phys.-Chim. russe*, **1929**, **61**, 172; **1930**, **62**, 975. On the analogy of magnesium, which forms a definite compound MgHg with mercury, the relations between mercury and the rare-earth metals were investigated. Cerium oxide if warmed with magnesium powder in a vacuum was vigorously reduced to a sintered mass of cerium metal, which on heating with mercury in a sealed tube for 40 hrs. at 400°–440° C., gave a grey, crystalline solid compound of density 12·54–12·69 of cerium and mercury of the formula $CeHg_4$. The same compound is obtained if liquid cerium amalgams (*i.e.* with a high mercury content) are distilled in a current of carbon dioxide. The compound oxidizes in air with incandescence, dissolves completely in nitric acid, and is slowly hydrolysed by boiling water. If heated to 470° C. it decomposes. Lanthanum under similar conditions gives a steel-grey crystalline compound, density 12·64–12·72, $LaHg_4$, which is very stable, being unaffected by heating to 350°–400° C. *in vacuo*. In other properties it is extremely similar to the corresponding cerium compound. Praseodymium and neodymium likewise form similar crystalline compounds which are somewhat less active to air, water, and various reagents than $CeHg_4$. The mixture of unseparated rare-earth metals known as "Mischmetall" gives, when amalgamated with mercury and distilled, also a crystalline powder, strongly resembling in its properties the compounds of the other metals, so that it is concluded that all the rare-earth metals form mercury compounds of the general type $MeHg_4$.—M. Z.

**The Effect of Temperature on Some Properties of Iron-Chromium-Nickel Alloys.** N. B. Pilling and Robert Worthington (*Symposium on Effect of Tem-

*perature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 495–500).—See this *J.*, 1931, **47**, 430, and following abstract.—S. G.

**Discussion on N. B. Pilling and Robert Worthington's Paper on "The Effect of Temperature on Some Properties of Iron–Chromium–Nickel Alloys."** B. J. Sayles (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 551–556).—Cf. preceding abstract. B. J. S. maintains that the quantities of the minor elements are equally, if not more, important than those of nickel and chromium in determining high-temperature behaviour.—W. A. C. N.

**Nickel and Nickel Alloys Other than the Nickel–Chromium–Iron Group.** C. A. Crawford and Robert Worthington (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 557–585).—See this *J.*, 1931, **47**, 426, and following abstract.—S. G.

**Discussion on C. A. Crawford and Robert Worthington's Paper on "Nickel and Nickel Alloys Other than the Nickel–Chromium–Iron Group."** W. B. Price (*Symposium on Effect of Temperature on the Properties of Metals. Held at Joint Meeting of Amer. Soc. Mech. Eng. and Amer. Soc. Test. Mat.*, **1931**, 586–588).—Cf preceding abstract. W. B. P. gives high-temperature data for so-called "Admiralty nickel" which contains copper 70, nickel 79, tin 1%. These indicate fairly good properties.

| Temperature, °C. | Tensile Strength. lb./in.$^2$. | Ultimate Strength. lb./in.$^2$. | Elongation. % on 2 in. | Proportional Limit. lb./in.$^2$. |
|---|---|---|---|---|
| 20° | 94,000 | 123,600 | 12·0 | 60,000 |
| 404° | 70,600 | 78,800 | 7·2 | 46,300 |
| 514° | 59,300 | 65,100 | 5·5 | 31,300 |
| 613° | 34,100 | 37,000 | 7·7 | 12,500 |

—W. A. C. N.

**Complex Nickel–Copper Alloys.** M. Ballay (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 239).—[In French.] See also *J.*, this volume, p. 77. The corrosion-resistance of copper–nickel alloys is very good, but the melting necessitates some care, as the metal must not remain too long at a high temperature before pouring. It is necessary to deoxidize and to remove the sulphur; the refining may be done with manganese or with magnesium; a flux consisting of borax and boric acid gives good results. Copper–nickel alloys may be classed in 3 groups: nickel 25–30%, nickel 45%, nickel 65–70%. The most used alloy is Monel metal, obtained direct from the Canadian ores. Where friction occurs, complex alloys with tin are to be preferred (*e.g.* Platnam, with nickel 54, copper 33, and tin 13%, having the same constitution as tin bronzes). B. also studied the structure and properties of nickel–copper–silicon alloys, which properties may be modified by heat-treatment, this being very marked in Monel metal containing 3% silicon. The alloys may be considerably softened by quenching, and again hardened by drawing at 600° C. The nickel–copper–silicon–tin alloys were also investigated. Silicon seems to decrease the solubility of tin in copper–nickel alloys in the solid state. The copper–nickel–aluminium alloys also show some important changes through heat-treatment, *e.g.* the alloy copper 83, nickel 15, aluminium 2%. These alloys appear to have very good mechanical properties and to be very resistant to sea-water corrosion.—G. G.

**The Properties of Copper–Nickel Alloys Containing Tin and Silicon Used for Steam Valves.** Léon Guillet, Auguste Le Thomas, and Marcel Ballay (*Compt. rend.*, **1932**, **194**, 2102–2105).—The construction of thermal equipment is frequently carried out in alloys of the type nickel 50, copper 34, tin 16%. These alloys, although generally suitable for the purpose, sometimes show anomalies, especially as regards hardness. It has been found that copper–nickel alloys containing up to 20% tin have a structural constitution analogous to that of ordinary bronzes containing the same quantities of tin—namely, (1) a solid solution of copper, nickel, and tin corresponding with the $\alpha$-constituent of bronzes, and (2) a much harder constituent corresponding with the $\delta$-constituent of bronzes, called here $\alpha$ and $D$, respectively. The $D$-constituent appears with tin more than 8%, giving hardnesses rather higher than those of the corresponding bronzes, but never as high as 300 (Brinell). The hardening effect of the tin in the 50% nickel alloys is more rapid than in the 70% alloys. The effect of silicon is very important, and has been studied for silicon contents below 5%. The hardness rises very rapidly with the silicon content, and micro-examination reveals no new constituent, but an increase in the proportion of the hard $D$ constituent. Hardnesses of 300 Brinell are readily obtained even with moderate tin content. The hardness of the 50% nickel alloys decreases progressively from 20° to 450° C. The coeff. of expansion in this temperature range is $17\text{–}18 \times 10^{-6}$, *i.e.* similar to that of the bronzes. For equivalent hardness, diminution of tin and increase of silicon improve the resistance to shock and decrease the tendency to pinhole. Two alloys emerge as being suitable for an extensive range of apparatus: (1) nickel 50, copper 39, tin 8, and silicon 3%, and (2) nickel 65, copper 27·5, tin 4, and silicon 3·5%. Their Brinell hardness is of the order of 350 at 20° C. and 315–320 at 450° C., and they have the same structure as ordinary 15% tin–bronzes.—J. H. W.

**Photoelectric and Thermoelectric Effects in Hydrogenized Palladium–Silver and Palladium–Gold Alloys.** Joseph Schniedermann (*Ann. Physik*, 1932, [v], **13**, 761–769).—The absorption of hydrogen by palladium during electrolysis decreases linearly with increasing gold or silver content and reaches zero at about 70% silver or 80% gold. The thermoelectric power of hydrogenized alloys against the corresponding pure alloy reaches a maximum at 40% of gold or silver. Hydrogen absorption increases the photoelectric effect in all cases.
—v. G.

**On Ferromagnetic Platinum–Chromium and Platinum–Iridium Alloys. (Preliminary Paper.)** Ernst Friederich (*Z. tech. Physik*, 1932, **13**, 59).—Alloys of platinum with about 10% of chromium are ferromagnetic.—J. W.

**Kinetics of the Dissolution of Dilute Sodium Amalgam.** Robert Livingston (*J. Physical Chem.*, 1932, **36**, 2099–3000).—A mechanism of the dissolution of dilute sodium amalgam in a solution of a weak acid, involving the rapid reversible decomposition of the compound $NaHg_2$, is given in order to interpret the experimental results of Brönsted and Kane, leading to the equation— $d(\Sigma Na)/dt = k(\Sigma Na)^{1/2}(A)$, where $(\Sigma Na)$ is the stoichiometric concentration of sodium in the amalgam, and $(A)$ the concentration of acid in the aqueous layer (see *J. Amer. Chem. Soc.*, 1931, **53**, 3624).—J. S. G. T.

**Volumetric and Dilatometric Investigations of Alloys.** M. G. Oknov (*Metallurg* (*The Metallurgist*), **1929**, (5), 1–9; *C. Abs.*, 1931, **25**, 4829).—[In Russian.] Experimental data obtained by volumetric and dilatometric methods were collected. The systems investigated, iron–carbon, copper–tin, copper–zinc, copper–antimony, copper–aluminium, and aluminium–zinc, were divided into 2 groups: (1) those for which the volumetric and dilatometric analyses agreed (copper–tin, copper–antimony, copper–50% zinc, aluminium–zinc) and (2) those for which they did not agree (iron–carbon, copper–aluminium, copper–75% zinc). The alloys in the first group remain after hardening in the same condition that they assumed at higher temperatures. For those of the second group the hardening is accompanied by certain auxiliary processes which are connected with a change in volume. Further investigations on the iron–carbon system indicate that in the hardening process a tetragonal lattice is formed which produces steel with a high sp. volume. Similar phenomena are assumed for the alloys of the second group.—S. G.

**Is a Change in Solid Solubility a Liability or an Asset?** E. M. Wise (*Min. and Met.*, 1931, 12, 270–272; *C. Abs.*, 1931, 25, 4829).—The iron–carbon system affords a most important example of the value of a change in solid solubility. By cooling at a sufficiently high rate an iron–carbon alloy containing carbon in solution, an alloy enormously supersaturated with respect to carbon can be secured. Variation with temperature of the solubility of tungsten plus carbon, of molybdenum, of beryllium or copper in iron offers a variety of precipitation hardening-alloys of decreasing order of utility. In addition to carbon, chromium, nitrogen, phosphorus, and perhaps oxygen are causes of temper brittleness. Aluminium lacks the allotropic transformation characteristics of iron and, therefore, the character of solvent undergoes no fundamental change with temperature. Intermetallic compounds such as $CuAl_2$, $Ag_2Al$, and $Mg_2Si$ show a marked change with temperature in the solubility in aluminium; because of increased dissociation at elevated temperatures, nickel-base alloys may be hardened by virtue of change in solubility of certain alloying elements therein. Copper behaves in a similar way to nickel and aluminium, being devoid of any useful allotropic transformation. Gold-base alloys of a wide range of composition are likewise amenable to precipitation hardening. Alloys of zinc, tin-base alloys, and extruded lead alloys are also considered.—S. G.

**Does a Mean Horizontal Portion Exist between Two Eutectic Points of Constitutional Diagrams of Binary Systems?** R. Kremann (*Z. physikal. Chem.*, 1931, [A], **154**, 136–142).—Note on Puschin and Rikovski's paper. Cf. this *J.*, 1931, **47**, 81.—B. Bl.

**Contributions to the Knowledge of the Thermodynamic Activities of Binary Alloys.** Carl Wagner and Günter Engelhardt (*Z. physikal. Chem.*, 1932, [A], **159**, 241–267).—Measurements have been made of the e.m.f. of cells of the type: molten alloy AB/molten salt of A or B/molten pure A or B, where A is bismuth and B is one of the following: lead, tin, thallium, or magnesium. From the results the activities, the distribution coeff., and the heats of mixing have been calculated and compared with the values obtained by others. The applicability of Van der Waals' equation is discussed for binary systems. Measurements with solid alloys of the systems silver–gold and copper–gold in molten electrolytes have been made at 400°–750° C. The values may be approximately regarded as equilibrium potentials.—B. Bl.

## III.—CORROSION AND PROTECTION

(Continued from pp. 479–484.)

### CORROSION

**Factors Affecting the Corrosion of Aluminium.** M. I. Makushenko (*Zvetnye Metally* (*The Non-Ferrous Metals*), 1930, 5, 348–364; *C. Abs.*, 1931, **25**, 4508).—[In Russian.] The corrosion of aluminium by moist air and natural water depends on external factors as well as on the physico-chemical properties of the metal. The chemical composition of the water is of the greatest importance; weakly alkaline water effects the quickest destruction of aluminium; hard, neutral spring water affects aluminium but slightly. Moistening the aluminium and drying in air produces a deep deterioration. Addition of sodium chloride or soda increases the corroding properties of water, and these compounds are the main cause of the rapid deterioration of aluminium. Oxalic has a stronger corroding action than acetic acid. Some foodstuffs, like boiled rice, after being kept for a long time in aluminium vessels, have a deep effect. A mixture of sulphuric and nitric acids in the presence of potassium bichromate corrodes away aluminium vessels completely. Of the technical impurities in aluminium, the resistance to corrosion is lowered most by copper, iron, and zinc. Non-metallic impurities likewise lower the resistance to corrosion, as do internal defects such as blow-holes, porosity, &c. Polishing has a favourable influence. Boiling with chromic acid is recommended as a quick protective method.—S. G.

**The Corrosive Effect of Gasolines and Motor Benzoles on Copper.** F. H. Garner and E. B. Evans (*J. Inst. Petrol. Technologists*, 1931, **17**, 451–463).—A summary is given of previously published work on the subject. An account follows of experimental work carried out with the object of selecting the most satisfactory test for detection and estimation of corrosive action. A convenient and accurate method for estimating "free sulphur" is described. Experiments showed that no relationship existed between the free and total sulphur contents of a number of fuels. Corrosion tests with strips of copper or with the copper dish showed general agreement between corrosion produced and free sulphur content of the fuel, but several pronounced discrepancies occurred. These are attributed by the authors to the presence of inhibitors or other substances modifying the course of the corrosion. The main conclusion is that determination of the total amount of corrosive material by a method such as that developed by the authors gives the most reliable means of estimating possibilities of corrosion in fuel systems. Fuels containing up to 0·5 mg. free sulphur in 100 ml. may be regarded as non-corrosive, those containing up to 1 mg. as reasonably good, and those containing much more than 1 mg. as liable to give rise to trouble.—H. S.

**Potential Measurements and Dissolution Tests with Tin–Copper and Zinc–Copper Alloys.** O. Bauer, O. Vollenbruck, and G. Schikorr (*Mitt. Material.*, *Sonderheft* 19, 1932, 3–15).—The following tests have been carried out with 17 tin–copper and 11 zinc–copper alloys: (1) potential measurements against the *N*-calomel electrode in 1% sodium chloride, *N*-hydrochloric acid, *N*-sulphuric acid, and *N*-sodium hydroxide solutions; (2) measurements of the rate of dissolution in the three last-named solutions. Copper-rich alloys of both systems show approximately the same potential as copper; the transition of the zinc- and tin-rich alloys to less noble potentials occurs suddenly at the phase limits. The behaviour in the dissolution tests is very complicated and markedly dependent on the rate of access of oxygen. The potential and rate of dissolution are both affected by oxide films, metal deposits, and dissolved metal. Free access of oxygen greatly intensifies the corrosion, as it acts as a depolarizer, but the rate of loss of weight is reduced when an oxide coating is formed. When oxygen is excluded, attack of copper and copper–zinc alloys by *N*-hydrochloric acid is inhibited. The dissolved constituents of the alloy must be individually determined in studying the corrosion not only of heterogeneous, but usually also of homogeneous alloys. Dissolved metal ions frequently accelerate corrosion, *e.g.* in the case of copper and brass in *N*-hydrochloric acid with free access of oxygen; in some cases, however, dissolved metal ions retard further corrosion.—J. W.

**Corrosion of Tin.** J. M. Bryan (*Dept. Sci. Indust. Res., Rep. Food Invest. Board*, **1930**, 107–109; *C. Abs.*, 1931, **25**, 4837).—When dissolved oxygen was completely removed from citric acid–sodium nitrate buffers by boiling *in vacuo* and passing in nitrogen freed from oxygen by the method of Kautsky and Thiele (*Z. anorg. Chem.*, 1926, **152**, 342–346) corrosion of tin did not occur appreciably at any H-ion concentration. With air present, corrosion was maximum at about $p_H$ 3 in 10 days, and at about $p_H$ 2·5 in 28 days. More oxygen was absorbed than was necessary to account for the tin oxidized in solutions of low acidity. This is probably due to oxidation of the citrate ion.—S. G.

**The Relative Positions of the Tin and the Iron Couple.** T. N. Morris (*Dept. Sci. Indust. Res., Rep. Food Invest. Board*, **1930**, 105–107; *C. Abs.*, 1931, **25**, 4837).—The rate of corrosion of tinned iron at 25° C. in citric acid–sodium citrate buffers depends on the relative positions of the tin and iron in space. If the tin strip is vertically above the iron the corrosion of the iron is somewhat retarded; if the two are side by side the corrosion of both is more rapid. Both in the presence and absence of air the tin is maximally corroded at $p_H$ 4 to 5, and the iron at $p_H$ 2 to 3. In general, the amount of corrosion of the iron varies inversely with that of the tin.—S. G.

**Inhibitors and Accelerators.** T. N. Morris (*Dep. Sci. Indust. Res., Rep. Food Invest. Board,* **1930,** 119–126; *C. Abs.*, 1931, **25,** 4837).—Previous work on acceleration of corrosion of iron by sulphur dioxide and inhibition by sugars and by tin were extended to cover the effect of $p_H$. Gelatin (0·5%), tin salts (4 p.p.m.), sucrose, and crude beet sugar (25%) showed a maximum inhibiting effect at high acidity, and in the case of gelatin almost none at $p_H$ 5·5. The accelerating effect of 8 p.p.m. sulphur dioxide on corrosion in 0·5% citric acid occurs only on the acid side of $p_H$ 4 to 4·5; between this $p_H$ and neutrality sulphur dioxide actually inhibits. The presence of 25% sucrose does not alter the effect of sulphur dioxide. The corrosion of iron is increased 2 to 3 times by 8 p.p.m. sulphur dioxide at $p_H$ 2·4, and by a smaller amount at lower acidity, whilst the corrosion of tin is only slightly decreased under the same conditions. Hence the total corrosion of tinplate is increased by sulphur dioxide on the acid side of $p_H$ 5, but unaffected or slightly reduced at $p_H$ 6. The effect of sulphur dioxide in checking hydrogen swells of fruits of low acidity is in line with these facts.—S. G.

**The Generation of Hydrogen in Tins.** S. Schmidt-Nielsen and Arne Flood (*Kongl. Norske Videnskab. Selskab. Forh.* **B. 3,** (21), 1931, 82–85; *C. Abs.*, 1931, **25,** 4941).—Cans containing foods insufficiently sterilized or leaky may become filled with hydrogen gas under pressure resulting from the bacterial decomposition of the contained food. If the reaction of the contents is neutral some tin will dissolve during the first months, according to the amount of oxygen in the can. Later there is no rapid solution of tin and consequently no generation of hydrogen. Local corrosion of the tin coating of cans will take place if the contents are not sterile, causing swelling of the cans after 1 or 2 years. If the $p_H$ value is greater or less than 7, corrosion may take place without the action of micro-organisms, especially in the case of herrings. As soon as the tin coating is broken the generation of hydrogen will take place. Even if the tin coating is thick and largely free from impurities, hydrogen will be generated as soon as the oxygen is consumed, but in neutral and sterile content the amount generated is too small to be detected. Possibly the analysis of the gas in cans may be used as a measure of the sterility of the contents.—S. G.

**The Behaviour of Metals Towards Salts, Especially Ammonium Salts with and without the Presence of Ammonia. (A Contribution to the Corrosion Problem.)** (Frln.) Hildegard Ehrig (*Z. anorg. Chem.*, 1932, **204,** 385–397).—An investigation of the dissolution of several metals, especially cadmium, zinc, magnesium, and copper, in solutions of ammonia, ammonium nitrate, ammonium chloride, ammonium sulphate, &c., with and without addition of ammonia, and the associated chemical reactions.—M. H.

**Galvanic Corrosion. Possible Galvanic Effects in the Corrosion of Metals in Milk.** W. A. Wesley, H. A. Trebler, and F. L. LaQue (*Electrochem. Soc. Preprint,* **1932,** 267–283).—Nickel, copper, aluminium, chromium–nickel, and chromium–nickel–iron were coupled in hot, aerated, pasteurized milk. The resulting galvanic effects were given, in decreasing order of magnitude, by aluminium and nickel; aluminium and copper; nickel and copper; aluminium and chromium–nickel–iron. Negligibly small effects were shown by both nickel and copper coupled with chromium–nickel and chromium–nickel–iron, whilst no effects were observed when chromium–nickel was coupled with chromium–

nickel–iron. The two last-mentioned alloys, although having very low corrosion rates in milk, behaved quite differently from noble metals in affecting only slightly the corrosion of nickel or copper coupled with them. The possibility of galvanic corrosion due to a difference in temperature of identical metal surfaces exposed to the same solution, was investigated, and it was found that an appreciable current flowed on contact of two nickel specimens exposed to milk at different temperatures. The current resulted in increasing the rate of solution of the hotter electrode. It was found, however, that the galvanic effect of differential aeration was much more serious than that of temperature difference.—H. W. G. H.

**The Electrolytic Corrosion of Metals Used in the Brewery.** P. Schafmeister and W. Tofaute (*Z. ges. Brauwesen.*, 1932, **55**, 1–7, 9–11; *J. Inst. Brewing*, 1932, **38**, 214).—Strips of metal connected in couples by a milliammeter and suspended in beer for 95 hrs. generated currents which varied in strength according to the metallic combination. At the same time, corrosion of the metal acting as anode took place to a greater or less extent. The current strength gradually diminished with time except in the case where tinned iron was the anode in conjunction with a copper cathode. In all cases the actual loss of weight of the anodic strip was greater than was calculated from the strength of the current. This discrepancy was introduced by an additional amount of corrosion, termed "self-solution," which occurred when the metal strip was immersed in beer without contact with a second metal. If the corrosion due to "self-solution" was added to that calculated from the current strength, the value obtained agreed very closely with the actual amount of corrosion. Iron as the anode showed the greatest corrosion, which was chiefly due to "self-solution." Its corrosion was smallest in conjunction with aluminium as the cathode, but in contact with copper or $V_2A$, the Krupp chromium steel, it was rapidly attacked. Tinned iron showed no "self-solution," and the small total corrosion with a copper cathode was due to electrolytic action alone. The tin was slowly destroyed and the iron gradually exposed. Accordingly, the strength of the current increased owing to the formation of an iron–copper element to which was added the effect of local iron–tin elements. Eventually the strips acted as an iron–copper element with the usual high corrosion of the iron. Although aluminium had a low "self-solution," owing to the production of a protective film of oxide on its surface, strong electrolytic action and corrosion took place when it was in contact with copper or $V_2A$, which rendered its use dangerous from the electrolytic point of view. Copper anodes showed almost no corrosion even in contact with Krupp's steel. This latter alloy was unattacked in any of the combinations and was not corroded by disinfecting materials. It had formerly the objection, if retained at 600°–700° C., of showing crystalline disintegration owing to the formation of carbide. There was a danger of such disintegration during the welding of joints. However, varieties of the alloy have now been produced which do not have this defect.—S. G.

**Metals and Beer.** P. Petit (*Brass Malt.*, 1932, **22**, 49–53; *J. Inst. Brewing*, 1932, **38**, 380).—P. gives a *resumé* of the recent work of Schafmeister and Tofaute on the corrosion of metals in wort and beer (preceding abstract) and discusses the significance of their observations. The solubility of iron is sufficiently great to be troublesome in beer, particularly as its corrosion, unlike that of other metals, increases in rate with time. On this account the steel of filters should be coated with a resistant varnish or plated with copper or aluminium. P. has shown that as little as 0·2 mg. of iron or copper per litre of beer (approx. 1/70th grain per gall., or 1 part in 5 million) has a deleterious effect on head formation and retention, and the part that traces of these metals play in accelerating the coagulation of proteins is well known. It is impossible to avoid the introduction of traces of iron and copper in brewing materials, so that added care is needed to ensure that this minimum amount is not augmented at any stage, above all after refrigeration. The "break" in the copper and deposition on the coolers remove a part of the metals, particularly iron, but it is doubtful whether yeast has any such cleansing action where only small amounts of the metals are present. The possibility of trouble from the presence of iron or copper is naturally increased by a bad copper "break," by faulty flocculation of the yeast after fermentation, and by too short a period of storage. It is a reproach that brewers should still have to rely on the formation of scale as a protection against corrosion in copper vessels, and should still regard the formation of a deposit of a heterogeneous composition in a beer as inevitable. P. gives a warning, in conclusion, against the use of almost all antiseptics for cleaning copper, as their use greatly facilitates dissolution of the metal by beer.—S. G.

**Corrosion of Metals by Tan Liquors. I.—Introduction.** M. P. Balfe and H. Phillips (*J. Internat. Soc. Leather Trades Chem.*, 1932, **16**, 120–127; *C. Abs.*, 1932, **26**, 2685).—A general discussion of the resistance of metals to acid liquors.—S. G.

**Corrosion of Metals by Tan Liquors. II.—Corrosion of Metals and Alloys Submerged in Stationary Tan Liquors.** M. P. Balfe and H. Phillips (*J. Internat. Soc. Leather Trades Chem.*, 1932, **16**, 194–201; *C. Abs.*, 1932, **26**, 3137).—Cylinders of numerous metals and alloys were immersed in (1) a "tail suspender liquor," and (2) a "bleach" liquor, for 16 days at 18°–20° C., after which the liquors were analyzed for the metals concerned. Least corrosion was shown by iron–nickel–chromium alloys of the "stainless" steel type, which were better than the non-ferrous alloys tested. Procedures are given for determining in tan liquor small quantities of nickel (dimethylglyoxime method), aluminium ("aluminon"), zinc (nephelometric with $K_4Fe(CN)_6$), and chromium (diphenylsemicarbazide method).—S. G.

**Guarding Against Corrosion in Acetic Acid Equipment.** D. F. Othmer (*Chem. and Met. Eng.*, 1932, **39**, 136–139).—Different ranges of acetic acid concentration have widely different corrosive actions on metals, and the presence of even a fraction of 1% of other acids or their salts may increase the destructive action one hundredfold. The vinegar industry equipment involves the use of copper, brass, nickel, Monel metal, and tin, but, owing to severity of corrosion, in the case of copper and brass and high cost of the others, attention is being paid to high-chromium–nickel steels. Copper is the standard material for processing all strengths of acetic acid below the anhydrous grade in the wood distillation industry. The presence of formic acid in wood-distillation acids renders the use of aluminium prohibitory. Seamless copper tubing with cast copper, bronze, or other fittings, is used, as well as the compression fitting type, which utilizes soft copper tubing supplied in rolls. The ends are belled and joints formed by means of copper or bronze fittings. Deoxidized copper sheet and tubing are fabricated by welding to form distillation or other equipment, and pipe lines utilizing several miles of copper pipe are sometimes constructed in this way. Copper is used for strengths of acetic acid higher than that of vinegar or pyroligneous acid, and is satisfactory for all strengths and at all temperatures if the liquid be free from dissolved air or oxygen. Silver is even better than copper, and is relatively unaffected by the presence of oxygen. Even silver-plated copper vessels and tubing resist hot acid vapours mixed with air. Brass is sometimes used, but is not really satisfactory. Hot acids of 35–40% acid concentration have the most corrosive action on most metals, and such liquids, containing air in solution, have practically destroyed brass pipe lines in 2 weeks' service. "Aluminium–bronze" has been satisfactory for pipes and pumps, whilst lead has only a very limited application. Instances are given of the uses of tubing and vessels in which the inner metal is protected by another metal drawn tightly over it or actually bonded to it, *e.g.*

nickel over copper. Special uses are also found for silver, aluminium, and tantalum.—F. J.

**Report of Committee B–3 [of A.S.T.M.] on Corrosion of Non-Ferrous Metals and Alloys.** T. S. Fuller and Sam Tour (*Amer. Soc. Test. Mat. Preprint*, 1932, 1–25).—See also abstracts below of reports of sub-committees. This report is mainly concerned with a critical discussion of corrosion testing, and particularly of accelerated tests, the method of carrying them out, and the preparation of the specimens. Copper, nickel, aluminium, and zinc-base alloys are rubbed down on 0 and 00 Hubert papers, and cleaned from grease within 24 hrs. before the test is started. In the case of lead, the pieces are treated with ether to remove grease, and then with acetic acid to remove the oxide film. Copper and Admiralty bronze are best prepared by washing with water and then dipping in dilute sulphuric acid. Nickel specimens are also cleaned in 2·5% sulphuric acid. In any total immersion test of accelerated corrosion the principal factors to be controlled are: concentration, temperature and degree of motion of the solution, the duration of the test, method of aeration of the solution, cleanliness of the specimen, ratio of specimen size to volume of solution. A standard procedure for conducting the tests is detailed. An alternative immersion test consists essentially in dipping the specimen in and out of the solution at a definite rate. This is more applicable when the actual conditions of service are similar. So far the results have been rather widely divergent. In addition to factors already mentioned, the drying of the specimens after they leave the solutions is very important. A rate of one cycle per minute is suggested. The apparatus and the procedure are discussed. The Committee is not in a position to recommend the salt-spray test for testing and rating metals, but it is described and discussed. It is considered that the accelerated electrolytic test cannot be expected to agree in its results with other tests. A large number of photomicrographs illustrate the text.—W. A. C. N.

**Report of Sub-Committee VI [of Committee B–3 of A.S.T.M.] on Atmospheric Corrosion. Atmospheric Corrosion Test Programme.** W. H. Finkeldey (*Amer. Soc. Test. Mat. Preprint*, **1932**, 26–42).—Cf. preceding abstract. It is proposed to continue the exposure tests for approximately 25 years. The amount of corrosion has been measured by determining (1) the change in weight, and (2) the loss in strength and ductility of the specimens. The general procedure in the tests is described, and sketches and illustrations are included showing the construction of the exposure racks.—W. A. C. N.

**Report of Sub-Committee VII [of Committee B–3 of A.S.T.M.] on Liquid Corrosion.** R. J. McKay and H. E. Searle (*Amer. Soc. Test. Mat. Preprint*, **1932**, 43–47).—Cf. abstracts above. A summary of the work in hand. The specimens are placed in racks in various corroding media that are contained in vessels normally used from day to day. Sulphuric and hydrochloric acids and caustic soda are the principal agents employed.—W. A. C. N.

**Report of Sub-Committee VIII [of Committee B–3 of A.S.T.M.] on Galvanic and Electrolytic Corrosion.** C. L. Hippensteel (*Amer. Soc. Test. Mat. Preprint*, **1932**, 48–51).—Cf. abstracts above. Couple combinations of the following metals are being subjected to outdoor exposure—aluminium, copper, mild steel, tin, zinc, nickel, and lead. Each specimen consists of a standard tension test-piece.—W. A. C. N.

## *PROTECTION*

**Protection of Metals Against Corrosion.** J. Cournot (*Ann. Brass. Dist.*, 1932, **30**, 125–128, 139–143; *J. Inst. Brewing*, 1932, **38**, 381).—In a few special cases corrosion may be prevented by treating the corroding agent, and this applies to steam boilers, &c., where the gaseous and encrusting materials are eliminated by treatment of the water. On the other hand, the difficulty may be got over by using non-corroding metals such as rustless steels, but in the majority of cases the metal which is being corroded is directly treated. Protection may be obtained by electrochemical methods in which metallic elements are placed in contact with the protected metal, so creating a galvanic current which immunizes the metal. Thus aluminium or Duralumin in sea-water with zinc or cadmium rivets are not attacked, but rapidly corrode with copper rivets. If both copper and cadmium rivets are placed on the aluminium plate, the action of the one annuls the other, and good effects have been secured with cadmium-plated rivets. Corrosion is usually prevented by protecting the surface, which must be first prepared and films removed by treatment with abrasives and various solvents or by immersion of the metal as anode in an acid bath or as cathode in an alkaline bath. Immersion in baths of molten zinc, cadmium, or aluminium is being replaced by spraying with these metals, and effective protection is obtained provided that the protected metals are not subjected to high temperatures. There has been an increase in cementation methods where the protecting solid, liquid, or gas penetrates into the treated metal and forms a resistant alloy. Thus, the cementation of iron alloys by aluminium confers on them a remarkable resistance to corrosion owing to the formation of a skin of aluminium oxide on the surface. The cementation of iron by zinc is ineffective, but the use of silicon may have a future, whilst cementation of copper and its alloys by zinc, aluminium, and tin is being investigated. Similarly, the problem of cementation of aluminium and the light alloys has not yet been solved, owing to the surface film of oxide checking the penetrating material. The deposition of protective coatings by electrolytic action is the most important method, and much recent work has been done to revise the technical details so that adherence, opacity, &c., of the coatings might be improved. Improved nickel-plating has been rendered possible by depositing the nickel from the bath at high temperatures, and an opaque coating of remarkable quality can now be rapidly obtained. The quality of cobalt plating is as high as that of nickel, but is more expensive. The cadmium-plating of aluminium exposed to sea-water is very effective, the film being very opaque and markedly adherent. It has a resistance to corrosion 3 times that of zinc, and can, in addition, be used to protect iron and the ferrous alloys. Chromium plating is effective, but the technical difficulties are great and to obtain reliable results the methods must be carefully followed.—S. G.

**Report of Committee A–5 [of A.S.T.M.] on Corrosion of Iron and Steel.** J. H. Gibboney and James Aston (*Amer. Soc. Test. Mat. Preprint*, **1932**, 1–5).—Contains summarized records of the proceedings of the various sub-committees. Many specimens which have been under observation for some years were again inspected and any failures noted. The study on wire products has been completed and tentative revision of some of the standards is recommended. The work on field tests of metallic coatings indicates that the durability of a zinc coating is substantially proportional to the weight of the coating, and also that the relative resistance to corrosion of zinc and iron varies in different locations, depending on the impurities in the air. 7000 test-pieces having electroplated coatings have been exposed. The investigations on embrittlement lead to the conclusion that in many instances it can, by suitable treatment of the article, be avoided. A guide for safeguarding against injurious embrittlement of hot galvanized products has been prepared. See following abstracts. —W. A. C. N.

**Report of Sub-Committee VI [of Committee A–5 of A.S.T.M.] on Specifications for Metallic-Coated Products.** F. F. Farnsworth (*Amer. Soc. Test. Mat. Preprint*, **1932**, 12–17, 31–56).—Cf. preceding abstract. Tentative revisions in 6 standard specifications are noted. In addition to general changes which are common to all the specifications, the specific changes in the individual specifications are reviewed. The resistivity of copper-bearing and non-copper-bearing steels is now scheduled. If the gauge of the wire at any point is not within standard limits the whole coil may be rejected. The zinc coating must remain adherent when the tie wire is wrapped at a rate of not more than 15 turns per minute in a closed helix at least twice about a cylindrical mandrel having a diameter equivalent to the nominal diameter of the tie wire under test. The zinc coating must adhere firmly to the wire and must not flake. The wire shall withstand without fracture not fewer than 35 twists in a length equivalent to 100 diameters. The minimum weight of coating for the three sizes of barbed wire made has been reduced from 0·35 oz. to 0·30 oz. No progress is reported on the development of specifications for plated coatings on iron and steel.—W. A. C. N.

**Report of Sub-Committee VIII [of Committee A–5 of A.S.T.M.] on Field Tests of Metallic Coatings.** R. F. Passano (*Amer. Soc. Test. Mat. Preprint*, **1932**, 18–25).—Cf. abstracts above. In the section dealing with galvanized sheets it is shown that there is considerable irregularity in the period within which the coatings fail, depending on the situation at which the tests were made. It is also shown from comparative tests on coated and uncoated sheets that the relative resistance to corrosion of zinc and iron varies at different locations, depending on the nature of the impurities in the air. The specimens which have been electroplated instead of galvanized consist of panels of steel covered with nickel, chromium, zinc, or cadmium, with or without intermediate layers. 7000 of these panels have been prepared, and the tests will occupy several years. Tests on wire and wire products are also contemplated.—W. A. C. N.

**[Report of] Sub-Committee X [of Committee A–5 of A.S.T.M.] on Embrittlement Investigation.** V. F. Hammel and C. S. Trewin (*Amer. Soc. Test. Mat. Preprint*, **1932**, 26–30).—Cf. preceding abstracts. Certain recommendations are made, although they are not fully understood, for the prevention of embrittlement in galvanized steel products. A guide is proposed for safeguarding against these injurious properties. In this it is noted that complete or partial embrittlement manifests itself at points which have been cold-worked. The important factors in embrittlement are summarized as follows: (1) the reduction of the ductility of the foundation steel on cold-working; (2) pickling roughens the surface and results in hydrogen absorption. Increasing the temperature of pickling increases the resulting embrittlement. Ageing in service or heating to 300° F. (149° C.) brings about a complete recovery from the effect of hydrogen; (3) low temperatures involve an increased tendency towards brittleness. Open-hearth steels alone should be used in galvanizing if it is to be preceded by cold-working without an intermediate annealing. Specifications for the manufacture of this open-hearth steel are quoted. In a second appendix is given the recommended practice for detecting embrittlement of hot-galvanized angles. The test consists of a species of bending test in which the piece rests across two supports at a predetermined distance apart. The load is applied midway between these and directly over a hole similar to that used in the fabricated parts and drilled through the deeper face of the angle. The test length is measured along the edge of the vertical leg of the angle (*i.e.* below the hole). When measured under the stated conditions the elongation on a 2-in. length should not be less than 5%. If it is less than this the average reduction in thickness, measured at specified points plus the percentage elongation, shall not be less than 10.—W. A. C. N.

**Sodium Silicate Inhibits Corrosion of [Aluminium] Collapsible Tubes by Soap.** Anon. (*Sci. Amer.*, 1930, **143**, 478–479; *Ceram. Abs.*, 1931, **10**, 232).—Additions of less than 0·5% of sodium silicate to shaving soap will stop the corrosive action of the soap on collapsible aluminium tubes. Another inhibiting effect of sodium silicate is its power to impart resistance to acid corrosion to such materials as Portland cement or ordinary red brick. The surface is coated with a dilute solution of sodium silicate which penetrates the pores and results in increased resistance to corrosion, abrasion, and penetration of oil and water.—S. G.

**Application of Aluminium Coatings for the Protection of Iron Against Oxidation at High Temperature.** N. N. Muratch (*Zvetnye Metally* (*The Non-Ferrous Metals*), 1930, 5, 1347–1352 and (abstract) *Light Metals Research*, 1931, 1, (13), 8; *C. Abs.*, 1931, 25, 4502).—[In Russian.] M. studied the painting of iron surfaces with aluminium powder. The surface to be protected must first be cleaned and freed from oxide. The paint is made by mixing 3 parts aluminium, 5 parts rosin, and 5 parts petroleum tar, the organic matter being added to prevent oxidation of the aluminium before it melts. The paint is heated to 200°–350° C. and applied to the surface which has also been heated to 200°–300° C. Two coats should preferably be applied successively. The metal is then gradually heated to 700°–800° C.; the aluminium diffuses into the iron with formation of a solid solution. The iron thus protected resists heating up to 900° C.—S. G.

**Alumilite Process.** Ralph E. Petit (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, 19, (4), 6–7).—A description is given of a method of anodically oxidizing aluminium and of the properties of the film produced, but, as no details are given of the nature of the bath, the article is of little practical interest. —A. R. P.

**Lead Coating in Field.** Anon. (*Chem. and Met. Eng.*, 1932, 39, 104).—Homogeneous lead coatings, produced by the new "Leadhesion" process, are said to be especially applicable to large equipment, moving parts such as agitators, and to apparatus for particularly severe service. It is suitable for the handling of large and small work in the field as readily as in the shop.—F. J.

**Nickel-Clad Steel Plate for Equipment.** Erle G. Hill (*Chem. and Met. Eng.*, 1932, 39, 268).—Cf. *J.*, this volume, p. 85. Formerly "Nickel-Clad" steel plates had a brown nickel oxide surface as the result of open rolling at high temperatures. Although this oxide itself has excellent corrosion-resisting properties, there is a market for "Nickel-Clad" having a bright finish. So good is the bond between nickel and steel that the methods usually followed in fabricating equipment from steel plate can be employed with "Nickel-Clad" in such cold-working operations as shearing, punching, bending, flanging, and forming, and in hot-working operations such as spinning, flanging, and die-pressing. In hot-working, care must be taken to avoid high sulphur in furnace-gases, as nickel is embrittled thereby, undergoing intercrystalline attack.—F. J.

**The Determination of the Porosity of Tin Coatings on Steel.** D. J. Macnaughtan, S. G. Clarke, and J. C. Prytherch (*Met. Ind.* (*Lond.*), 1932, 40, 671). —Abstract of a paper read before the Iron and Steel Institute. See *J.*, this volume, p. 356.—J. H. W.

**Coating of Iron with Titanium.** A. Travers (*Chim. et Ind.*, 1932, Special No. (March), 345–347; *C. Abs.*, 1932, 26, 3470).—Iron cannot be coated with titanium by $TiCl_4$ vapours alone, even at 1400° C. In the presence of commercial electrolytic hydrogen above 1000° C. there was formed a very thin, adherent yellow coating of TiN because of the presence of small amounts of nitrogen in the hydrogen; even after the hydrogen was passed over Maquenne's calcium–magnesium mixture, there still appeared a few yellowish specks, indicating the presence of traces of nitrogen. The reaction is suggested as a very sensitive test for the detection of nitrogen. In the presence of hydrogen purified over calcium–magnesium, $TiCl_4$ gave a blackish-grey coating of titanium. The TiN coating withstood the action of the atmosphere of the laboratory for 2 years without apparent change; it resists the action of artificial sea-water, even in the presence of $H_2O_2$; the action of mineral acids and of air at high temperature (1000° C.) is practically negligible. The titanium coating merely retards corrosion of the iron. *Electrodeposition of titanium* may be obtained by means of complex organic $Ti^{V}$ salts, provided that the concentration is 35 grm. titanium per litre or more, giving a continuous, adherent deposit not more than 0·005–0·006 mm. thick, which merely retards slightly the corrosion of the iron. —S. G.

## IV.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

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(Continued from pp. 485–487.)

**Discussion on [the Paper by L. H. De Wald on] Some Important Factors Controlling the Crystal Macrostructure of Copper Wire-Bars.** W. A. Scheuch. D. K. Crampton. C. S. Harloff. C. H. Schneider. W. H. Peirce. L. H. De Wald (*Amer. Inst. Min. Met. Eng. Tech. Publ.*, No **485**, 1932, 1–15).—Cf. this *J.*, 1931, **47**, 581. D. K. C. obtained similar results to De W. using phosphorus-deoxidized copper and vertically-cast round billets. Round billets cast to produce large radial grains have greater soundness and density than those with fine macrostructure. They also require less power and less time for piercing. C. S. H. considers that all factors operating during casting are interdependent and must be carefully balanced. C. H. S. says that an important feature is the relationship of the weight of the mould to the weight of the metal it contains, and that it is the most important method of controlling crystal size. Usually it is found in the casting of wire-bars that both fine and coarse structures occur in the same bar—the finer furthest away from the pouring point. It is not possible to establish a link between the crystal structure and the fine-wire-drawing quality of such bars. W. H. P., on the other hand, considers that de Wald's results confirm his own. In addition, he quotes an experiment in which the mould was partly lined with a Portland cement–sand mixture. The deduction from the structures obtained when casting copper in this composite mould is that a fine structure is the product of uniform cooling conditions during setting, whilst a coarse structure is produced only when there is a sharp temperature difference between the outside and inside of the bar. De W., in replying to the discussion, mentions that he prefers a chemical or rapid optical means of determining oxygen during refining under normal conditions rather than placing reliance wholly on the contour of the surface of the bar. —W. A. C. N.

**Black Magnetic Rouge Polishes Rapidly and Without Flow.** Welton J. Crook and W. R. Philbrook (*Metal Progress*, 1932, **21**, (5), 72–74).—"Black magnetic rouge," obtained by precipitation and containing 99% $Fe_2O_3$, is found to be cheap, uniform in quality, free from the tendency to form gritty carbonate deposits, and very rapid in action, whilst applicable to comparatively soft materials as well as to hardened steels. A disadvantage is the dirty and adherent character of the powder.—P. M. C. R.

**On the Chemistry of Alloys.** A. Westgren (*Forschungen und Fortschritte*, 1932, [8], (1), 8–9).—A summary of a lecture. See *J.*, this volume, p. 352.—J. W.

**On the Structure of Extremely Thin Crystal Films.** F. Kirchner (*Naturwiss.*, 1932, **20**, 123–124).—A short preliminary report. Electronic interferences in very thin crystalline films obtained by sublimation show that random orientation of the crystals occurs generally only when these are very small; in other cases the film has a fibrous structure with a certain amount of scattering or a completely oriented structure. Examples quoted are cadmium iodide and bismuth.—J. W.

**On the Structure of the Surface of Cut Metal Crystals.** W. Boas and E. Schmid (*Naturwiss.*, 1932, **20**, 416–419).—Laue reflexion diagrams of cut and polished crystals of aluminium, copper, zinc, cadmium, and antimony that have been previously etched to varying depths show that in all cases there is a finely crystalline surface layer followed by a thicker deformed transition layer above the core of undistorted crystal. The relative thicknesses of these layers depend on the structure and orientation of the original crystal. The better the possibilities of translation, as determined by the crystal structure and orientation of the cut plane, the smaller the depth of penetration of the distortion. —J. W.

**Röntgenographic Determination of the Solubility of Magnesium in Aluminium.** E. Schmid and G. Siebel (*Mitt. Material., Sonderheft* **19,** 1932, 44–47).—See *J.*, this volume, p. 12.—J. W.

**On the Rolling Texture of Cadmium.** E. Schmid and G. Wassermann (*Mitt. Material., Sonderheft* **19,** 1932, 35–36).—See *J.*, this volume, p. 35.—J. W.

**X-Ray Investigation of the Gold–Platinum System.** W. Stenzel and J. Weerts (*Mitt. Material., Sonderheft* **19,** 1932, 51–54).—See *J.*, this volume, p. 86.—J. W.

**The Lattice Constants of Silver–Palladium and Gold–Palladium Alloys.** W. Stenzel and J. Weerts (*Mitt. Material., Sonderheft* **19,** 1932, 47–51).—See *J.*, this volume, p. 86.—J. W.

## V.—ANALYSIS

(Continued from pp. 487–488.)

**Quantitative Analysis of Alloys without Destroying the Samples.** A. Glazunov (*Chim. et Ind.*, **1932,** Special No. (March), 332–333; *C. Abs.*, 1932, **26,** 3456).—A brief discussion of the possibility of applying spot tests to the surface of alloys. The results of nearly 100,000 preliminary tests indicate that reliable results can be obtained, but the reagents, operating conditions, &c., must be investigated for every alloy.—S. G.

**Testing Precious Metals with the Touchstone.** C. M. Hoke (*Brass World*, 1932, **28,** 92–93).—Explains the principles of touchstone testing of precious metals and describes the preparation of the aqua regia, precautions to be taken in testing green gold, and the testing of silver articles.—J. H. W.

**Testing Precious Metals with the Touchstone. II.—Platinum and its Alloys.** C. M. Hoke (*Brass World*, 1932, **28,** 112–114).—The methods of differentiating between Pt and its alloys and other metals resembling them are described. The touchstone test for these alloys is similar to that for Au, except that the needles are made of Pt, Ir–Pt, and Pt–Pd, and aqua regia on a hot touchstone is used. By using a spot plate instead of a touchstone and adding a solution of $SnCl_2$ to the acid-treated streak, Au, Pt, and Pd can be detected in the presence of one another, and by comparison with standard solutions, their relative proportions can be approximately estimated.—J. H. W.

**A Colorimetric Method for the Determination and Detection of Small Quantities of Lead.** Edward W. Krans and J. B. Ficklen (*J. Indust. Hygiene*, 1931, **13,** 140–143).—The method depends on the precipitation of the Pb as $PbCrO_4$, dissolution of the precipitate in HCl, addition of *s*-diphenylcarbazide, and comparison of the colour produced with that produced under similar conditions by a standard Pb solution—A. R. P.

**Quantitative Analysis of Lead in its Compounds and Alloys by the Adsorption Method.** A. Schachkeldian (*Zhurnal Prikladnoi Chimii* (*Journal of Applied Chemistry*), 1931, [B], **4,** (7/8), 1087–1095).—[In Russian.] The adsorption method of titrating Pb is based on the formation of an electrically charged colloidal complex of Pb which adsorbs and changes the colour of an organic indicator. Thus if $0{\cdot}1N$-$(NH_4)_2CrO_4$ solution is titrated with $0{\cdot}1N$-$Pb(NO_3)_2$ in the presence of bromothymol blue, Congo red, methyl red, or fluorescein as indicator, a colloidal suspension of $PbCrO_4$ is obtained in which $CrO_4''$ ions are adsorbed as long as any are present. When the equivalent point is passed, the excess $Pb^{\cdot\cdot}$ ions in their turn are adsorbed by the colloid, which then acquires a positive charge and adsorbs the anion of the indicator, which thus sharply changes colour. A detailed investigation of the optimum conditions and technique for several modifications of the above method of titration has been carried out. In pure solutions Pb can be determined over the range $0{\cdot}1$–$0{\cdot}0003N$. Nitrates raise the lower limit to $0{\cdot}003N$, whilst acetates, oxalates, and tartrates render estimation impossible. The method is applicable to the analysis of Pb paints and alloys. Alloys are dissolved in $HNO_3$, the Pb is precipitated with $Na_2CO_3$, the basic $PbCO_3$ redissolved in dilute $HNO_3$, and the solution, after neutralization with $NH_4OH$, titrated with $(NH_4)_2CrO_4$, using Congo-red as indicator.—M. Z.

**An Electro-Colorimetric Method of Determining Small Quantities of Manganese.** K. A. Nenadkevitch (*Dokladi Akademii Nauk S.S.S.R.* (*Reports of the Academy of Sciences of U.S.S.R.*), **1931**, [A], (6), 153–159).—[In Russian.] The Mn is oxidized anodically instead of with $K_2S_2O_8$. The nitrate or sulphate solution (50 c.c.) containing 5 c.c. of $HNO_3$ (*d* 1·4) is placed in the anode tube, which is connected to the cathode tube by a glass tube fitted with a stopcock; both tubes contain Pt electrodes between which a current of 0·2 amp. is passed to oxidize the Mn to $HMnO_4$.—N. A.

**Analysis of Amalgams.** Al. Ionesco-Matiu and C. Popesco (*Chim. et Ind.*, **1932**, Special No. (March), 162–163; *C. Abs.*, 1932, **26**, 3456).—I.-M.'s mercurimetric method can be used for detecting Hg in Cu, Zn, and complex (Pb–Sn–Bi) amalgams.—S. G.

**A Study of the Potassium Dithio-Oxalate Colorimetric Method for the Determination of Nickel.** John H. Yoe and Floyd H. Wirsing (*J. Amer. Chem. Soc.*, 1932, **54**, 1866–1876).—The reaction is suitable for colorimetric analysis, and will detect 1 part of Ni in 125 million parts of solution. Suitable conditions are described. Many metallic ions interfere, especially Fe and Co.—R. G.

**A New Gravimetric Method for the Estimation of Nickel, Cobalt, and Cadmium.** Pulin Bihari Sarkar and Benoy Krishna Datta-Ray (*J. Indian Chem. Soc.*, 1930, **7**, 251–258; *Brit. Chem. Soc.*, **1930**, [A], 882).—The insoluble hydrazine-thiocyanate compounds, $M(SCN)_2,2N_2H_4$, of bivalent metals may be employed for the determination of Co, Cd, and Ni when present alone.—S. G.

**Determination of Nickel and Chromium in their Alloys and in Cast Iron.** V. Pestelli (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 329–337).—[In Italian.] The determination of the constituents of Ni–Cr, Ni–Cr–Fe, and Ni–Cr cast-iron alloys is discussed.—G. G.

**Contribution to the Rapid Analysis of Phosphorus in Bronzes.** G. Blasich and G. Pepino (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 277).—[In Italian.] Rooney's method (*J.*, 1918, **20**, 108) is modified as follows: The alloy (1–2 grm.) is boiled with 30 c.c. of $HNO_3$ (*d* 1·20) and 10 c.c. of HCl (*d* 1·19) until brown fumes are no longer evolved, 25 c.c. of boiling $H_2O$ are added, followed by 15–20 c.c. of 4% $KMnO_4$, the precipitate of $MnO_2$ is redissolved with $NH_4Cl$ and the P precipitated with 40 c.c. of 35% $NH_4NO_3$ and $NH_4Cl$ at 40°–50° C. The precipitate is collected, washed, and titrated in the usual way.—G. G.

**On the Analysis of the Platinum Metals. III.—The Colorimetric Estimation of Ruthenium.** O. E. Zviagintzev (*Zhurnal Prikladnoi Chimii* (*Journal of Applied Chemistry*), 1931, [B], **4**, (7/8), 1085–1088).—[In Russian.] Former methods of estimating Ru in mixtures containing Os and Ir are criticized. A colorimetric method based on the property of Ru to give a deep brown complex $H_2RuCl_5$ in HCl solution, whereas the Os complex is colourless, is described. The colour of the HCl solution of the metals after addition of a little KCl is compared with that of a standard $H_2RuCl_5$ solution. The results obtained are not very accurate and more than 2% Cr interferes by masking the colour.—M. Z.

**The Separation and Determination of the Alkali Metals Using Perchloric Acid. IV.—The Perchlorate–Chloroplatinate Method for the Determination of Potassium in the Presence of Sodium.** G. Frederick Smith and A. C. Shead (*J. Amer. Chem. Soc.*, 1932, **54**, 1722–1730).—K and Na in perchlorate solution in 50% $C_2H_5OH$ may be precipitated by alcoholic chloroplatinic acid and K separated quantitatively as chloroplatinate.—R. G.

**Estimation of Silicon in Aluminium and its Alloys.** Halvard Dale (*Met. Ind.* (*Lond.*), 1932, **40**, 550).—A letter on an article by W. R. Gamble (see *J.*, this volume, p. 443). The use of Pt apparatus and of NaOH of the grade "extra pure, from sodium" is recommended. Organic acids should not be present, and solutions of samples of high Si content must be sufficiently diluted. The presence of $PO_4'''$, $AsO_4'''$, and $Fe^{\cdot\cdot\cdot}$ may require modifications to be made.—J. H. W.

**Colorimetric Estimation of Silicon in Aluminium.** W. R. Gamble (*Met. Ind.* (*Lond.*), 1932, **41**, 41).—A letter replying to Dale (see preceding abstract). For routine tests, platinum apparatus is considered unnecessary, as is also special grade NaOH if allowance is made for $SiO_2$ in the reagent. G. claims that organic acids, $AsO_4'''$, and $PO_4'''$ are rarely, if ever, present, and that he has recorded the action of $Fe^{\cdot\cdot\cdot}$. For alloys, the use of the standard silicic acid disc in the Hellige Comparator is recommended as avoiding the presence of coloured solutions and the making-up of picric acid standards (see *J.*, this volume, p. 443).—J. H. W.

**On the Question of the Volumetric Determination of Thallium.** A. J. Bogorodsky and M. W. Troitzky (*Zhurnal Obstchey Chimii* (*Journal of General Chemistry*), 1931, [A], **1**, (7), 895–899.—[In Russian.] The work of earlier investigators is briefly summarized, with the conclusion that no satisfactory method exists. The solubility of TlI in pure $H_2O$ and in solutions of KI was determined to ascertain whether $Tl^{\cdot}$ can be determined iodometrically. As TlI is almost entirely insoluble, a method of analysis has been developed based on the quantitative precipitation of TlI from solutions containing the $Tl^{\cdot}$ ion with a known excess of KI, treatment of the TlI filtrate with an excess of acidified $KIO_3$ solution, removal of the liberated $I_2$ by boiling, and titration of the excess $KIO_3$. An accuracy of 0·2–0·4% is obtained.—M. Z.

**The Argentometric Determination of Thallium.** M. W. Troitzky (*Zhurnal Obstchey Chimii* (*Journal of General Chemistry*), 1931, [A], **1**, (8/9), 1083–1085).—[In Russian.] Macro- and micro-methods for the determination of Tl are developed based on the reduction of AgCl by $Tl^{\cdot}$ salts (both soluble and insoluble). The $Tl^{\cdot}$ solution is boiled with excess of AgCl in alkaline solution, the precipitate of $Tl_2O_3$, aq. and Ag collected and dissolved in $HNO_3$, and an aliquot part of the solution titrated with $0{\cdot}1N$-$NH_4CNS$. For micro-analysis not more than 5 c.c. are used, the solids are separated by centrifuging; and the Ag is titrated with $0{\cdot}01N$-$NH_4CNS$ using a micro-burette. The results are accurate to 0·5% in the first, and to 1% in the second method.—M. Z.

**Estimation of Thallium by the Hypoiodite Method.** M. W. Troitzky (*Zhurnal Obstchey Chimii* (*Journal of General Chemistry*), 1931, [A], **1**, (8/9), 1086–1088).—[In Russian.] $I_2$ in an alkaline solution of KI (*i.e.* KOI) quantitatively oxidizes univalent Tl, provided a certain minimum excess is added to overcome the effect of secondary reactions. On completion of the oxidation reaction the precipitated $Tl_2O_3$ is removed, and the excess of $I_2$ (liberated by acidification) titrated with $Na_2S_2O_3$.—M. Z.

**On the Volumetric Determination of Tin in White Metals.** T. Lombardo (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 285–297 and *Metallurgia italiana*, 1932, **24**, 10–20).—[In Italian.] The effects of Sb, Cu, Pb, As, on the volumetric determination of Sn in the analysis of white metals are shown diagrammatically, and in numerous tables. It is concluded that Sb facilitates the reduction of Sn by Pb and by Armco Fe and that Cu has no effect unless the amount present exceeds 23% of the Sn. Pb up to 38% of the Sn, as well as As, is inert. The Sn results, in Pb-base alloys, are about 0·26% low.—G. G.

**A Gravimetric Method for the Separation and Determination of Titanium.** Hal Trueman Beans and Dorothea R. Mossman (*J. Amer. Chem. Soc.*, 1932, **54**, 1905–1911).—The Ti is precipitated as double iodate $Ti(IO_3)_4.3KIO_3$, by slightly acid ($HNO_3$)$KIO_3$. The precipitate is dissolved in HCl, reduced by $SO_2$, and the Ti precipitated by $NH_4OH$, ignited, and weighed as $TiO_2$. The method separates Ti from many of the elements occurring with it in ores, notably Al. A procedure for the separation of small amounts of Zr from Ti is described.
—R. G.

**A Colorimetric Method for the Determination of Vanadium with Phosphotungstic Acid.** A. P. Vinogradov (*Dokladi Akademii Nauk S.S.S.R.* (*Reports of the Academy of Sciences of U.S.S.R.*), **1931**, [A], (10), 249–252).—[In Russian.] The substance is heated with 10 c.c. of $HNO_3$ (*d* 1·2), chlorides are removed with $AgNO_3$, a slight excess of 7–8% $KMnO_4$ is added, and the excess destroyed by boiling with a few drops of 1–3% $H_2O_2$. After cooling, 10 c.c. of 0·25% $H_3PO_4$ are added to the solution, which is then diluted to 80–90 c.c., treated with 10 c.c. of 5–10% phosphotungstic acid solution, and diluted to exactly 100 c.c. The colour produced is compared with that produced under similar conditions by a standard V solution containing 2·3 grm. $NH_4VO_3$ and 20 c.c. of $HNO_3$ (*d* 1·2) per l.—N. A.

**The Potentiometric Estimation of Zinc in Non-Ferrous Alloys.** W. F. Stefanovsky (*Zhurnal Obstchey Chimii* (*Journal of General Chemistry*), 1931, [A], **1**, (8/9), 991–994).—[In Russian.] The potentiometric titration of Zn is critically reviewed. Titration of $Zn(NO_3)_2$ even in the presence of small quantities of other salts such as $KNO_3$ and $NH_4NO_3$ is accurate to 0·2–0·3%, so that the method is applicable to the determination of Zn in alloys. The $HNO_3$ solution of the alloy is evaporated to a syrupy consistency, the Sb and Sn being removed. Cu and Pb are determined in the filtrate electrolytically, any Fe is precipitated with $NH_4OH$, and the Zn titrated electrometrically with 0·1*N*- or 0·25*N*-$K_4Fe(CN)_6$ solution, using a Pt electrode and $K_4Fe(CN)_6$ as indicator. The method is suitable for the analysis of brass, bronze, solder, &c.—M. Z.

**A New Method of Volumetric Estimation of Zinc in Zinc White Pigment and in Technical Zinc Chloride.** I. Tananaev (*Zhurnal Prikladnoi Chimii* (*Journal of Applied Chemistry*), 1931, [B], 4, (5), 686–695).—[In Russian.] Repetition of the work of Kolthoff and of Cony and Cady on the determination of Zn with $K_4Fe(CN)_6$ has shown that the results are unreliable unless exactly the same conditions are used as for the standardization of the $K_4Fe(CN)_6$ solution. It is proposed, therefore, to add an excess of $K_4Fe(CN)_6$ solution to the Zn salt solution and titrate back with standard $KMnO_4$, using an organic indicator (methyl violet or indigo). The method is accurate to within 0·1% and is independent of the concentrations of the Zn or $K_4Fe(CN)_6$ solutions. A bibliography is appended.—M. Z.

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

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

(Continued from p. 489.)

**A New Dark Field Microscope Illuminator for Opaque Objects Producing Annular, Cross Fire, and Indirect Illumination.** John J. Gerlach (*Rev. Sci. Instruments*, 1931, 2, 412–415).—A dark field illuminator, employing an annular prism surrounding the object and from which a wide-angled cone of light is incident on the object to be illumined in a very nearly horizontal direction, is described.—J. S. G. T.

**The Lateral Chromatic Aberration of Apochromatic Microscope Systems.** I. C. Gardner and F. A. Case (*Rev. Sci. Instruments*, 1931, 2, 416–426).—Methods for the measurement of the lateral chromatic aberration and distortion of microscope objectives and eyepieces are described. Results of measurements on 20 apochromatic objectives and 10 compensating eyepieces indicate that the latter do not, in general, entirely compensate the chromatic aberration of the former, and that the complete system is usually under-corrected. The bearing of this result on the performance of the system in photomicrographic work by a three-colour process and in the direct visual examination of objects is discussed.—J. S. G. T.

**Vickers Projection Microscope.** Anon. (*Machinery* (*Lond.*), 1931, **38**, 709–710).—An illustrated description of the Vickers projection microscope.—J. C.

**Apparatus for Measuring the Thermal Conductivity of Metals in the Form of Wire or Ribbons.** Pierre Vernotte (*Chim. et Ind.*, **1932**, Special No. (March), 393–396; *C. Abs.*, 1932, 26, 3465).—The principle of the method is: a wire is soldered at one end to a massive furnace heated to a uniform known temperature, $W_1$, which is transmitted to the soldered end of the wire; heat is conducted along the wire and is distributed into the surrounding atmosphere by convection; the wire acquires a mean temperature $V_1$ and the law of distribution of temperatures through the length of the wire is deduced from $V_1$ and $W_1$. The theory of this method is explained mathematically, and the construction and operation of the instrument are described. In practice, the wire may be soldered, whilst under tension in the cold, at both ends, and the deflection due to expansion on heating is measured.—S. G.

**Speeds Up Precision Weighing.** Anon. (*Eng. and Min. J.*, 1932, **133**, 354).—Note on a new assay balance which permits about 100 weighings in ½ hr. An index lever is rotated until the balance pointer comes to zero. The index pointer then indicates the weight of the sample, the value being read directly in mg. on a dial.—R. Gr.

**A Thermostat Regulator.** Elliot Q. Adams (*Rev. Sci. Instruments*, 1932, **2**, 187–188).—An electric thermostatic regulator employing a tungsten–mercury contact in hydrogen, and which has maintained the temperature of a 50-litre water-bath constant to within ± 0·002° C. for 1 hr., or, employing an auxiliary heater, constant to within ± 0·001° C. for 3 hrs., is described.—J. S. G. T.

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## VII.—PHYSICAL AND MECHANICAL TESTING AND RADIOLOGY

(Continued from pp. 490–492.)

**Report of Committee E-1 [of A.S.T.M.] on Methods of Testing.** W. H. Fulweiler and E. Hess (*Amer. Soc. Test. Mat. Preprint*, **1932**, 1–9).—A complete index to methods of testing adopted by the Society has been issued. Progress is reported in testing under the following headings—mechanical, tension, compression, ductility, hardness, cupping, impact. Comments are also made on speed of testing, elastic strength, calibration of testing machines, and on consistency, plasticity, &c. Work has been commenced on the standardization of sieves. A special committee has been set up to deal with the presentation of data.—W. A. C. N.

**The Exhibit of Testing Apparatus and Machines held in Connection with the 34th Annual Meeting of the A.S.T.M.** H. V. Cadwell (*Rev. Sci. Instruments*, 1931, **2**, 665–737).—Exhibits of testing apparatus shown at the 34th annual meeting of the American Society for Testing Materials, are briefly described. They include level bars, gauge markers, extensometers, hardness testers, strain gauges, hydraulic testing machines, metallurgical microscope outfits, recording potentiometers, melting-point apparatus, microscope illuminators, bimetallic thermo-regulators, double microscope for creep measurements on metals, repeated torsion machine, scleroscopes, durometers and elastometers, Schopper testing and impact machines, fatigue testing machines, torsion strength tester for wires, and visual gauge-testing machines.—J. T.

**Some Principles of Testing.**—H. W. Rosenhain (*Metallurgist* (Suppt. to *Engineer*), 1932, **8**, 71–72).—Cf. *J.*, this volume, p. 368. A continuation of the discussion of testing applied to engineering materials referring to aspects which have been brought into special importance as the result of metallurgical developments, such as heat-treatment, and " notch-brittleness." Tests which bear no obvious relation to service conditions may be of practical importance, and there is thus little justification for tests resembling service use alone, as these may be misleading. Model tests are discussed.—R. G.

**Test Results and Service Values of Materials.** H. F. Moore (*Met. Ind.* (*Lond.*), 1932, **40**, 419–422).—Abstract of a paper presented at a joint meeting of the

American Society for Testing Materials in the New York Metropolitan District and the Iron and Steel Division, Institute of Metals Division, and the New York Section of the American Institute of Mining and Metallurgical Engineers, with the co-operation of the New York Section, American Welding Society.—J. H. W.

**Dynamic Testing of Materials.** A. Esau (*Forschungen und Fortschritte*, 1931, 7, 377–378).—A short summarized report, especially on short-time testing, in which the damping is measured.—J. W.

**Investigation of the Endurance of Metallic Constructional Materials with the High-Frequency Tensile-Compression Machine of Schenck.** K. Memmler and K. Laute ((*Mitt. Material., Sonderheft* 15, 1931, 39–70, and *Forschungsarbeiten*, 1929, No. 329).—The construction and operation of the machine are described in detail. The results obtained in tests on steels, nickel, copper, Lautal, Scleron, and Elektron using test-pieces of drawn round rods after various mechanical and thermal treatments are described, using a frequency of 500 periods/second. The relation between the static and dynamic tensile strengths of the sheets was 0·5–0·7, whereas in the case of the non-ferrous metals it was 0·35 (average). Only after $10^8$ alternations (or $10^7$ for steels) is the alternating stress required to produce fracture independent of number of vibrations; in this region endurance-hardening of non-ferrous metals takes place, and this effect, which is very marked with annealed metals, outweighs the effect of fatigue. Usually hardening by endurance loading and by static loading mutually affect one another relatively slightly, only the first part of the static tensile curve being modified by previous endurance loading. Short-time dynamic tests on non-ferrous metals were hitherto unsatisfactory in all respects. The effects of damping and surface faults of all kinds and the phenomena of fracture are briefly discussed.—J. W.

**Adhesion and Fatigue of Thin Coatings of White Metal Deposited on Mild Steel Surfaces.** T. E. Stanton (*Aircraft Eng.*, 1932, 4, 135).—Abstract of a report (*Aeronaut. Res. Cttee. R. and M.*, No. **1424**, 1930) on adhesion and fatigue of coatings of white metal. Tests were made on steel rings lined with white metal. Bending stresses were applied at the rate of 3000 cycles/minute. No frictional resistance was introduced by the conditions employed in the fatigue tests, but special tests were made to determine coeffs. of friction of the various bearings. In addition to rings lined with white metal, similar rings lined with lead bronze were subjected to tests. With samples representing the best practice, complete destruction of adhesion between white metal and steel was effected only when the stress was a large fraction of the limiting fatigue stress of the steel and the number of repetitions of the order of 15 millions. Lead–bronze bearings gave good results under very severe conditions of loading.—H. S.

**The Elastic Limit of Metals.** Pierre Vernotte (*Chim. et Ind.*, 1932, 27, 765–769).—An attempt to elucidate the various theories which have been put forward on this subject. It is emphasized that extreme caution should be exercised in the interpretation of tests and results. The trials should be of a simple character and should produce in reality the conclusions which are in fact required. Indirect methods which give data in a short time are to be distrusted in favour of more lengthy methods which are accurate and more conclusive.
—W. A. C. N.

**The Creep Strength of Metallic Working Materials at Elevated Temperatures and the Arbitrary Effect Thereon of Heat-Treatment.** W. Rohn (*Z. Metallkunde*, 1932, 24, 127–131).—The value of short-time creep tests (40–60 hrs.) and long-time creep tests (1000–5000 hrs.) is discussed and a method for the determination of creep strength (creep limit) and rate of creep at elevated temperatures is described (cf. this *J.*, 1930, 44, 597). Creep limit–temperature curves are given for iron, nickel, and a number of more or less complex alloys containing chiefly nickel, iron, and chromium. The creep limit of iron and nickel increases with rise of previous annealing temperature from 750° and 1250° C. The same is true, but to a much larger extent, for a nickel–iron–chromium alloy containing molybdenum and manganese after annealing at 1150° and 1250° C., *i.e.* far above the recrystallization temperature.—M. H.

**Resistance to Abrasion in Relation to Hardness.** S. A. Main (*Proc. Inst. Mech. Eng.*, 1931, **121**, 523–532).—The unsatisfactory position of our knowledge of abrasion, and of abrasion testing is explained and discussed. Hardness is frequently taken as a measure of resistance to abrasion, but the important property is not the initial hardness of the material, but its hardness after the deformation which it suffers under the particular conditions of abrasion. The remarkable properties of manganese steel in rails are due to its property of work-hardening to a greater extent for a given deformation than other materials, and of bearing a greater extension than other steels, but if used for grinding soft materials which do not deform it, manganese steel does not give a markedly higher life ratio than other steels. The diamond pyramid, Herbert pendulum, and scleroscope methods are more suitable for this kind of testing than the normal Brinell test, since they give smaller indentations, and enable the acquired hardness near the surface to be measured. There is much need for a study of the mechanism by which the metallic particles are torn away.
—W. H.-R.

**Some Tests on the Stability of Thin Strip Material under Shearing Forces in the Plane of the Strip.** H. J. Gough and H. L. Cox (*Proc. Roy. Soc.*, 1932, [A], **137**, 145–157).—The use of metal construction for aeroplanes has resulted in a need for some simple test of thin sheet metal which will serve to discriminate between desirable and undesirable properties of the metal. This paper describes the results of tests on the buckling of long strips of material under shearing forces applied along the edges of the strip. The test was designed originally as an acceptance test for thin strip material; attention is here paid only to theoretical aspects of the test. The buckling load of an infinitely long strip has been determined theoretically by Southwell and Skan, and it is here shown that if the effect of initial departures from planity of the strip be taken into account, the buckling loads determined by experiment agree with the theoretical values. This agreement has been demonstrated by plotting the depth of the waves produced against the shear load and by determining the buckling load on the assumption that these quantities fulfil the hyperbolic relation predicted by theory.—J. S. G. T.

**Tests on Thin Sheet Metal.** C. Norman Fletcher (*Mech. World*, 1932, **91**, 553–554).—The Erichsen test on sheet metal gives useful information, but in practice does not afford conclusive evidence of the suitability of the material for a given press operation. T. Y. Olsen suggested that this was because the test was incomplete, as it altogether neglected to take into account the pressure required to produce the cup. He therefore designed a machine in which the pressure required in the test was indicated by means of a pressure gauge in communication with an enclosed liquid which shared the pressure. The pressure was applied mechanically through a worm-gear with ball-thrust and the depth of cup before fracture was recorded on a dial-indicator. Power-driven improved models of this machine are illustrated and described. The smaller model tests sheet up to $\frac{1}{16}$ in. thick, up to a pressure of 12,000 lb., whilst the larger model tests sheet up to $\frac{1}{4}$ in. thick, up to a pressure of 35,000 lb. The load applied is read from one of three rods which support the upper part of the machine containing the particular die in use, by means of a strain-gauge. Two standard testing procedures have been developed and are in regular use on production work; these are described. Another sheet-testing machine designed by C. E. Williams is illustrated and described. The sheet metal specimen is cupped, but the pressure is applied dynamically, and a stress–strain diagram showing the relation between depth of cup and the necessary pressure is drawn automatically.—F. J.

**Routine Testing of Thin Sheet Metals.** P. M. (*Machinery* (*Lond.*), 1931, **38**, 717–719).—The application of tensile, bend, hardness, and ductility (cupping) tests to the testing of thin metal sheet is reviewed, and the limitations of the various test methods are indicated.—J. C. C.

**The Testing of Weld-Seams.** H. Schmuckler (*Autogene Metallbearbeitung*, 1931, **24**, 231–234).—After a brief consideration of some other methods, a full description is given of the test devised by S. in which a place in the seam is milled out by a conical cutter. Visual examination, with or without suitable etching shows up defects in the weld. The test is said to be effective, quick, and cheap. It may be considered almost non-destructive.—H. W. G. H.

**Giving the Weld a Chance.** [**Testing of Welds.**] G. E. Thornton (*J. Amer. Welding Soc.*, 1932, **11**, (2), 9–10).—The specimen for the cantilever rotating beam test is machined so that the stress per unit of cross-section is the same at any point in its length.—H. W. G. H.

**Modern Methods of Testing Welds.** Anon. (*Mech. World*, 1932, **91**, 31).—The recent and rapid extension of welding due to increased facilities and improved technique, has brought in its train a demand for efficient non-destructive tests. The more important of these are briefly discussed, viz.: use of water, oil, and air under pressure, electromagnetic and magnetic devices, stethoscope device, X-ray and $\gamma$-ray inspection.—F. J.

## *RADIOLOGY*

**Testing of Welds by X-Rays.** R. A. Stephen (*Mech. World*, 1932, **91**, 529–530).—Amongst the non-destructive tests at present available, that of X-ray examination is deemed the best. Some tests recently made with a mobile shock-proof X-ray apparatus are described. A thin plate of iron, having holes drilled in it of varying depths, is placed on top of the weld submitted for test and both are radiographed together. Those portions of the X-ray " beam " passing through the holes, of varying depth, give disc images of varying intensity, which can be compared with any flaws present in the weld to give an approximate idea of the dimension of such flaws in the direction of the incident " beam." X-ray examination is so little removed, as an operation, from ordinary camera photography that, with proper equipment, no experienced engineer or metallurgist need be deterred from its use.—F. J.

**X-Rays for the Detection of Faulty Welds.** Anon. (*Welder*, 1932, **3**, (28), 26–29).—Describes the mobile plant installed by Babcock and Wilcox, Ltd. The " Metalix " tube is connected by insulated cables, capable of withstanding 100 kv., to the H.-T. generator. The anode cable is water-cooled and both are sheathed by an earthed metallic braiding. Specimen radiographs of welds are illustrated. By comparison with a stepped piece of metal, radiographed alongside the weld, the difference in thickness of two places in the latter can easily be fixed by comparing their density in the point with the corresponding densities on the scale.—H. W. G. H.

**Welding and X-Rays.** Anon. (*Mech. World*, 1932, **91**, 310).—Brief editorial note on the possible utilization of X-rays for testing welded work.—F. J.

**X-Ray Diffraction Patterns.** Anon. (*Welding Eng.*, 1932, **17**, (4), 35–37).—Describes the use of X-rays for determining the effects of different welding methods, filler rods, and of working or annealing, on the crystal structure of welds and the neighbouring metal.—H. W. G. H.

**An X-Ray Testing Unit.** Anon. (*Marine Eng.*, 1932, **55**, 206–207).—A description of a new portable industrial X-ray unit which combines electrical safety with protection against unwanted radiation. The apparatus incorporates a shockproof X-ray tube, and by the use of special fast intensifying screens, and by forced water cooling of the anode which permits of an increase in the energy input to the X-ray tube, the time of exposure necessary is comparatively short. The apparatus is compact, being fitted with a control table and a suitable encased H.T. generator, and is mounted on a small trailer.—J. W. D.

## VIII.—PYROMETRY

(Continued from p. 492.)

**Subsidiary Heat Transference the Origin of Serious Errors in Pyrometry.** —— Veron (*Science et Industrie*, 1932, 16, 181–186).—Industrial pyrometric methods are broadly classified and the errors specially affecting each group are indicated, with suggestions for their reduction or elimination, as follows: (1) the pyrometry of liquids by contact with a " witness body " is vitiated by radiation from walls, by the conductivity of the rod, and occasionally by evaporation or condensation on the " witness "; (2) the pyrometry of solids by analogous methods is vitiated by air-gaps and by variations in the state of the surface of the solid; (3) pyrometric methods based on the reception and calibration of radiations from the body under consideration are vitiated by additional radiations both from other solids and from intervening gases. The conditions of flow of liquid bodies are specially studied in their relation to temperature measurement, with a view to correct certain misconceptions. From an analysis of ideal pyrometric conditions, V. derives a general expression, his interpretation of which indicates the relative importance of time factor, of mass, surface area, conductivity, and specific heats of body and pyrometer, and the ranges of temperature concerned. The methods here employed are applied to the groups already indicated, with special discussion of industrial conditions, *e.g.* of blowers and of boiler practice.—P. M. C. R.

**Causes of the Destruction of Precious Metal Thermocouples.** Otto Feussner (*Helios*, 1932, 38, 119).—A reply to Hütter (see this *J.*, 1931, 47, 220). F. maintains that the accuracy and life of precious metal thermocouples under exacting conditions exceed those of base-metal couples.—v. G.

**Construction of Thermo-Elements by Electrodeposition.** H. Kersten and Roland Schaffert (*Rev. Sci. Instruments*, 1932, 3, 189–195).—A method of joining electrodeposited metals by electrodeposition, utilizing the fact that most metals plated on polished stainless steel can be peeled off easily, is described. Particulars of the baths, current density, and temperature necessary for the production of thermo-junctions comprising combinations of the metals, iron, cobalt, nickel, copper, silver, cadmium, and brass, are given. —J. S. G. T.

**Note on Copper-Constantan Thermocouple Calibration below 0° C.** R. Wiebe and M. J. Brevoort (*Rev. Sci. Instruments*, 1931, 2, 450–457).—Calibration of copper–Constantan thermocouples between 0° C. and − 193° C. can be accomplished with an accuracy of 0·05° C. by determining experimentally the e.m.f. of the couple at −78·50° C. (the normal sublimation temperature of carbon dioxide), and at − 182·97° C. (the normal boiling point of oxygen). The deviations, $d$, of these readings from the e.m.f.'s of the standard couple, $e$, are given by $d = ae + be^2$. Values of $a$ and $b$ being determined from the experimental results referred to, the deviation at any other temperature down to − 193° C. can be calculated. Extrapolation of these results down to − 220° C. is only a close approximation, the possible error being of the order 0·2° C.—J. S. G. T.

**Tellurium–Bismuth Vacuum Radiation Thermocouple.** C. Hawley Cartwright (*Rev. Sci. Instruments*, 1932, 3, 73–79).—A simple method of constructing delicate radiation thermocouples with gold leaf receivers is described in detail. A tellurium wire $\frac{1}{4}$ mm. long can easily be welded to the receiver by a condenser discharge. The thermoelectric power of β-tellurium against bismuth is 600 $\mu v/°$ C. Thermocouples of these metals are about three times as sensitive as those made with bismuth alloy wires.—J. S. G. T.

**Notes on Radiation Thermopiles.** John Strong (*Rev. Sci. Instruments*, 1932, 3, 65–69).—A design of thermopile in which two junctions give maximum sensitivity is described. Junctions are welded in position by a condenser discharge. Taylor process wires of composition bismuth + 10% tin and bismuth + 3% antimony are particularly easily soldered at any time if "deglassed" and kept beneath benzene. Silver films of any desired thickness can be prepared by distillation of silver *in vacuo* and deposition on a copper sheet, from which the film may be removed after annealing.—J. S. G. T.

**A New Pyrometer at the Koltchugin Works.** M. Blokov (*Opyt Predpriatie* (*Experience of Undertakings*), 1931, (3), 39–40).—[In Russian.] A new type of pyrometer based on a Constantan–copper thermocouple developed by I. M. Mikhailov is described. The copper–Constantan (50 : 50 copper–nickel) thermocouple has a 5–6 greater thermoelectric effect than a platinum/platinum–rhodium couple, and is substantially free from secondary electrical effects. Its resistance, also, does not alter appreciably with rise of temperature, nor does it undergo structural changes at high temperatures. It can be used with great accuracy to measure temperatures of 1000° C. (provided that it is protected from atmospheric oxygen) and lasts about 2 weeks in continuous service.—M. Z.

## IX.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Continued from pp. 492–495.)

### ELECTRODEPOSITION

**Influence of Temperature on the Crystal Structure of Electrodeposited Antimony.** H. Kersten (*Physics*, 1932, 2, 276–279).—"Explosive" antimony is shown, by X-ray analysis, to be amorphous before exploding and crystalline afterwards. Antimony, electrodeposited from an aqueous solution of antimony trichloride containing hydrochloric acid, is amorphous when deposited below 25° C.; between 25° and 30° C. it changes to the crystalline form; between 30° and 70° C. the crystalline structure is nearly constant; structural changes occur between 70° and 100° C.—J. S. G. T.

**The Electrodeposition of Cadmium from Cadmium Sulphate Solutions. I.—The Effect of $p_H$, Current Density, and Temperature on the Crystal Size of the Deposit, the Current Efficiency, and the Electrode Efficiency Ratios.** S. Wernick (*Electrochem. Soc. Preprint*, 1932, Sept., 75–86).—The electrodeposition of cadmium from cadmium sulphate solutions was studied with the object of determining the effect of variation of $p_H$ of the solution, current density, and temperature of the electrolyte on the crystal structure and grain-size of the deposit and on the anode and cathode efficiencies and the electrode efficiency ratio. The $p_H$ of a simple solution of cadmium sulphate rises rapidly with progressive deposition and requires to be buffered in order to maintain a uniform $p_H$. At the same time, the crystal structure of the deposit becomes progressively less granular, but subsequently (at a $p_H$ above 6), more crystalline, dark, and less adherent. An optimum range of $p_H$ is approximately 5–5·7. The effect of aluminium sulphate, sodium acetate, boric acid, and sodium chloride as buffering agents was examined. The best buffer within the desired range of $p_H$ was a mixture of boric acid and sodium chloride. Cadmium sulphate solution with this buffer was adopted as a standard electrolyte. Increasing current density has only a small effect on anode and cathode efficiency, the variation being 1·6% and 1·4%, respectively, and the electrical efficiency ratio is also little affected. There is, however, a marked effect on the grain-size of the deposit, which consists of large crystal aggregates at low current density and is relatively fine-grained and also more adherent at higher current density. "Treeing" occurs when the current density exceeds 4·5 amp./dm.$^2$. Increasing temperature has a relatively more marked effect on the electrode efficiencies than current density. The anode efficiency rises notably at the higher temperatures examined, and the cathode efficiency decreases somewhat, resulting in a progressive increase in the electrical efficiency ratio. The effect on the deposit is at first in the direction of refinement of the grain size, but at higher temperatures a coarser, crystalline structure develops. It is concluded that temperatures in excess of 40°–50° C. are undesirable in depositing cadmium from cadmium sulphate solutions. The "structureless" type of deposit obtainable from cadmium cyanide solutions is unobtainable from cadmium sulphate solutions in the absence of an "addition agent."—S. G.

**[Cadmium-]Plating Before Forming.** J. S. Hoffman (*Amer. Machinist (Eur. Edn.)*, 1932, **76**, 755).—A short note. Flat blanked pieces are cadmium-plated before forming. This allows more efficient cleaning and gives a lower percentage of faulty plating than plating after forming.—J. H. W.

**Chromium Plating in the Automotive Industry. Deposition of Chromium upon Articles Made from Sheet Zinc in the Automotive Products Industry.** Charles H. Proctor (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (6), 28–34).—For chromium plating sheet-zinc automobile hub caps preliminary coatings of copper and nickel are recommended; although the copper may be dispensed with, better adherence is obtained by its use. The copper bath contains 1·5 oz. sodium cyanide, 1 oz. copper cyanide, 0·02 oz. sodium thiosulphate, 4 oz. trisodium phosphate, and 0·5 oz. potassium hydroxide per gall.; it is used at 75°–80° C. with a current density of 70 amp./ft.$^2$ and operates as a combined electrolytic cleaner and copper-plating bath. The nickel bath contains 12 oz. nickel sulphate, 2 oz. nickel chloride, 2 oz. boric acid, and 12 oz. magnesium sulphate per gall., with sufficient citric acid to reduce the $p_H$ from 6·9 to 6·0; plating is carried out at 20°–30° C. with a current density of 8–9 amp./ft.$^2$ The chromium bath contains 25 oz. chromic acid and 0·75 oz. zinc sulphate crystals per gall.; it is used at 140 amp./ft.$^2$ at 45° C.—A. R. P.

**Some Production Methods Used in Chromium Plating.** Burton G. Daw (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (6), 23–27).—Practical hints on chromium plating automobile parts.—A. R. P.

**Chromium Plating of Aluminium.** Anon. (*Machinery (Lond.)*, 1931, **39**, 272).—Brief details, abstracted from *Manchester Guardian Commercial*, of the methods developed by W. Blum and G. E. Renfro for depositing chromium direct on aluminium.—J. C. C.

**Chromium Plating Applied to Steel Mill Rolls.** N. H. McKay (*Iron Age*, 1932, **130**, 2–3).—A description is given of chromium plating steel rolls to produce mirror strips with finishing rolls and to prevent the corrosion of the steel by hot tin and drosses in tin pot rolls, and for reclaiming roll necks that have been accidentally machined undersize.—J. H. W.

**Chromium Plating of Steel for Wear Resistance.** A. Willink (*Metal Cleaning and Finishing*, 1932, **4**, 231–232, 239).—See *J.*, this volume, p. 96.—S. G.

**Chromium Plating Prolongs Life of Steel Dies in Electrical Porcelain Plant.** Anon. (*Ceram. Ind.*, 1930, **15**, 414; *Ceram. Abs.*, 1930, **9**, 1072).—Chromium plating has made possible an increase of 4 or 5 times the former life of steel dies by allowing the use of alloy steels which, without the chromium plate to protect them from abrasion by the silicates, were too costly. The accuracy of dimensions of the insulators is increased and the cost of steel die upkeep and loss of time from repairs reduced by the use of chromium-plated alloy steel dies. Some plants are doing plating under licence from the process patentees, whilst others send the dies to chromium-plating plants.—S. G.

**Chromium-Plated Glass Moulds.** C. J. Stahl (*Glas-Ind.*, 1929, **37**, 191–193; *Ceram. Abs.*, 1930, **9**, 661).—The properties of chromium are discussed. Various different metals used for moulds are enumerated and their qualities compared with chromium-plated iron moulds. The details of chromium-plating methods and technique are presented.—S. G.

**Chrome Plating.** W. Birett (*Glas-Ind.*, 1929, **37**, 205–206; *Ceram. Abs.*, 1930, **9**, 661).—Chromium plate, its use on glass moulds, and details of the process used in chromium plating are discussed. The advantages of chromium-plated moulds are enumerated.—S. G.

**Depositing Chromium on Electric Appliances.** F. A. Maurer (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (5), 21–26).—Electric irons are first copper-plated in a cyanide bath, then nickel plated, and finally chromium plated. Brief working details of the processes involved are given.—A. R. P.

**Grinding and Polishing in Chromium Plating.** Anon. (*Metallwaren Ind. u. Galvano-Tech.*, 1932, **30**, 153–154).—A review of methods used in America for preparing articles for chromium-plating and for buffing the plated articles.
—A. R. P.

**Preparing Surfaces for Chromium Plating.** W. E. W. (*Machinery* (*Lond.*), 1931, **38**, 839); also A. E. (*ibid.*, 1931, **39**, 238).—Workshop notes on methods of polishing before chromium plating in order to ensure a brilliant finish.—J. C.

**Automatic Chromium Plating Equipment.** R. J. Piersol (*Metal Cleaning and Finishing*, 1932, **4**, 201–204; *C. Abs.*, 1932, **26**, 3442).—A discussion of details of construction.—S. G.

**Installation of the Chromium-Plating Unit.** R. J. Piersol (*Metal Cleaning and Finishing*, 1932, **4**, 147–150; *C. Abs.*, 1932, **26**, 2925).—A discussion of important engineering problems and constructional details involved in the installation of a chromium-plating unit.—S. G.

**Design of the Chromium-Plating Unit.** R. J. Piersol (*Metal Cleaning and Finishing*, 1932, **4**, 35–38, 81–82, 95–96).—S. G.

**Properties which Characterize Chromium Plating.** R. J. Piersol (*Iron Age*, 1932, **129**, 1344–1345, 1381).—The distinctive characteristics of chromium plate, such as wide range of abrasive hardness, distinctive crystalline structure, relatively low brittleness, high and constant coeff. of reflection, high temperature resistance, and low coeff. of friction, are discussed, and the manner in which difficulties due to porosity and lack of adhesion to the base metal have been overcome, is described.—J. H. W.

**Gold Solutions for Production Work.** J. L. Merigold (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (5), 26–32).—Recipes are given for the preparation of gold-plating baths to deposit fine gold and various gold–copper and gold–cadmium alloys to produce deposits of the various carat golds in shades of red, yellow, green, rose, purple, brown, grey, and white.—A. R. P.

**Rapid Nickel-Plating. A Comparison of Present-Day Practice in the United States and in Europe.** C. H. Eldridge (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (3), 21–29).—Modern practice in France, England, and the U.S.A. is reviewed.—A. R. P.

**The Control of Electroplating Solutions. XIII.—The Nickel Solution.** Samuel Field (*Met. Ind.* (*Lond.*), 1932, **41**, 109–111).—Cf. this *J.*, 1931, **47**, 666; and this volume, pp. 250, 450. The dimethylglyoxime and cyanide methods of determining the nickel in a nickel-plating solution, the estimation of ammonium compounds and of chlorides are described.—J. H. W.

**Hot Nickel Solutions and Low $p_H$.** Alex. Regmunt (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (5), 15–21).—Practical notes on the nickel-plating of bumper bars. After cleaning in a hot electrolytic cleaner the bars are rinsed, immersed in 2–3$N$-hydrochloric acid for 30 seconds, rinsed in a water-spray, and plated for 4 minutes at 50 amp./ft.$^2$ in a nickel bath at 115°–125° F. (46°–52° C.). The work is washed in water and copper-plated for 6 minutes at 50 amp./ft.$^2$, again washed, then dried and buffed. The final nickel coating is applied at 35 amp./ft.$^2$ for 11½ minutes at 115° F. (46° C.). The nickel bath contains 45 oz. of sulphate (21·5% nickel), 3–4 oz. of nickel chloride, and 4 oz. of boric acid per gall., and the tanks are provided with steam coils and air-agitation. The copper bath contains 28 oz. of sulphate crystals and 11 oz. of sulphuric acid per gall.—A. R. P.

**Pitting in Nickel Solutions.** W. M. Phillips (*Monthly Rev. Amer. Electroplaters' Soc.*, 1932, **19**, (4), 9–11).—Pitting is generally due to the presence of suspended particles of insoluble material which may be extraneous matter or derived by hydrolysis of impurities in the bath, *e.g.*, ferric sulphate or cupric sulphate. Troubles due to impurities of the latter type are obviated by using a low $p_H$ bath, but filtration alone will remedy defects caused by dust particles. —A. R. P.

**[Nickel-]Plated Aluminium Die-Castings.** A. Eyles (*Amer. Machinist* (*Eur. Edn.*), 1932, **76**, 251E–252E).—Ensuring the adherence of nickel plate to aluminium is a matter of considerable difficulty. Cleaning before plating is important, and is best done by the trichlorethylene (degreasing) process or electrolytically in a 10% solution of sodium carbonate. After rinsing in a hot solution of hydrochloric acid (sp. gr. 1·18) 1 litre, ferrous chloride solution 3 litres, and water 100 litres, the articles can be nickel-plated in baths at medium or high current densities. A useful solution is nickel sulphate 16 oz., sodium sulphate 26 oz., ammonium chloride 2 oz., and boric acid 2 oz./gal. The baths should be worked at 90°–95° F. (32°–35° C.) at a current density of 15 amp./ft.$^2$, the $p_H$ value being 5·8–6·0. Magnesium sulphate gives a better buffing deposit, but sodium sulphate has better throwing power.—J. H. W.

**Spotting on Electrodeposited Silver Coatings.** K. W. Frölich (*Mitt. Forschungsinst. Edelmet. Schwäb, Gmünd.*, 1931, **4**, 91–98).—See article by H. Moser, K. W. Frölich, and E. Raub, *Z. angew. Chem.*, 1931, **44**, 97 (this *J.*, 1931, **47**, 445).—A. R. P.

**Zinc Plating for Appearance.** E. E. H. (*Machinery* (*Lond.*), 1931, **39**, 183–184).—A review of the causes of the discoloration of zinc deposits. General darkness, intensifying during storage, is characteristic of work from cyanide vats, and is due to the retention of traces of cyanide. A sulphate bath is recommended. Irregular staining can usually be ascribed to impurities in the baths, derived from incomplete washing between operations or otherwise. A case of "hair-like" stains was traced to sulphates (and, to a less extent, chlorides) in the wash water. It was overcome by introducing a final dip in distilled water contained in an enamelled tank, and changed twice daily. —J. C. C.

**Testing of Zinc Salts for Plating Baths and Determination of the Zinc Content of [Sulphate] Baths.** A. Wogrinz (*Metallwaren Ind. u. Galvano-Tech.*, 1932, **30**, 154–155).—Precipitation of the neutral solution with sodium sulphide followed by washing of the precipitate with 2% sodium acetate solution, dissolution in iodine and sulphuric acid, and titration of the excess iodine is recommended.—A. R. P.

**Electrodeposited Metal Foils.** H. Kersten (*Rev. Sci. Instruments*, 1931, **2**, 649–653).—Suitable baths, current density, temperature, &c., for the electrodeposition of thin films of cobalt, nickel, copper, silver, cadmium, tin, gold, and brass on a cathode of polished "stainless" steel, to which the deposit does not adhere, are given. Nickel foil is a good filter for the radiations from a copper target X-ray tube.—J. S. G. T.

**Plating Glass and Clay.** Eugen Werner (*Sprechsaal*, 1930, **63**, 223–224; *Ceram. Abs.*, 1930, **9**, 496).—The main difficulty in electroplating non-conductive materials as glass, porcelain, and organic bodies is to make them conductive; as soon as the surface of such a material is covered with a conductive coat the most difficult work is done. The oldest method was to use a pure graphite with a metal. To plate a gypsum piece it must be immersed in liquid wax. After hardening it is covered by a paste of bronze powder with alcohol and traces of mercury chloride and dried. To render clay or porcelain conductive, cover with a graphite composition and heat to 200° C. or 400° C. The addition of volatile oils to the graphite batch increases the adhering capacity of graphite. The starting point for pieces which are covered with a graphite or metallic powder is always an acid copper bath consisting of 11 grm. water, 220 grm. copper sulphate free from zinc, arsenic, and iron, and 30 grm. of sulphuric acid free from arsenic. Correctly covered porcelain objects are indestructible.—S. G.

## X.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 195–198.)

**Aluminium in the Brewery.** G. l'Hoir (*Petit. J. Brass.*, 1932, **40**, 211–213; *J. Inst. Brewing*, 1932, 38, 213).—This paper provides a general discussion on the use of beer and wine in Belgium and France, and the conditions of the brewing industries in these countries since the Great War. The remainder is devoted to the applications of aluminium in the brewery, the development of the aluminium industry, and the influence of plant made of this metal on yeast and beer. Copper has been used for the construction of brewery plant for a long period, but is now little employed owing to its relatively high solubility and deleterious effect on yeast. In recent years stainless steel has been used, and found to yield good results, but the unsatisfactory nature of its welding is a serious objection. The first use of aluminium in the brewery some 20 years ago was adopted enthusiastically, but poor results were obtained, since the material at that time contained only 95–98% of the metal. Owing to improvements in manufacture, the purity may now be guaranteed to more than 99·5%. The brewers demand a material light in weight and free from serious oxidation, and the manufacturers of aluminium have been able to satisfy this demand. It is essential that the metal should dissolve but slightly, if at all, in wort and beer, should have no deleterious influence on yeast, and should not induce the formation of haze in beer. Numerous tests have shown that aluminium plant obtainable at the present day is satisfactory in these respects, since the solubility is much less than that of copper, the yeast and attenuation are unaffected, and beer shows no more tendency to loss of brilliance in aluminium than in glass vessels. Where isolated cases of corrosion of aluminium have occurred in the past, the trouble has been traced to the presence of particles of other metals derived from the rolling mills, the leakage of alkaline solutions, or the concentration by evaporation of water contained in the vessels. For the removal of scale from aluminium, preparations containing nitric acid are on the market, and yield excellent results, but a better procedure is washing down after each fermentation, thus inducing the formation of beer stone. Before taking aluminium vessels into use, it is a good precaution to apply a yeast paste, rinse off after a period of 2 hrs., and again apply yeast.—S. G.

**Is Aluminium Suitable as Material for Insertions in Beer Siphons?** G. Eckert (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, 4, 39).—This question is answered in the affirmative if the insertions are protected by the modified Bauer–Vogel method (cf. Eckert, *J.*, this volume, 438).—M. H.

**Aluminium Non-Injurious.** Anon. (*Aluminium Broadcast*, 1930, 2, (49), 7).—A translation from the German Ministry of Health Gazette, *Reichs-Gesundheitsblatt*, **1930**, (41) Oct. 8.—J. C. C.

**Applications of Aluminium and its Alloys.** A. W. Sibilev (*Zvetnye Metally* (*The Non-Ferrous Metals*), 1931, **6**, (12) 1672–1698).—[In Russian.] A *resumé*, from foreign published data, of present-day uses for aluminium and its alloys in all branches of construction, engineering, scientific equipment, and decorative work.—M. Z.

**The Application of Light Alloys in Mining.** Erwin Siegmund (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, 4, 33–38).—An illustrated article on the application of Lautal, Silumin, and KS–Seewasser as constructional material for mining appliances. Lautal is particularly suitable for the manufacture of boring stocks and spindles, oxygen flasks for respiratory apparatus, cages, skips, and drawing-frames.—M. H.

**Hopper Cars of Aluminium.** Anon. (*Eng. and. Min. J.*, 1932, **133**, 354).—Note to the effect that a subsidiary company of the Aluminum Company of

America has been using 70-ton hopper cars with bodies made of corrosion-resistant aluminium alloy for hauling bauxite ore, coal, and other materials. —R. Gr.

**Use of Silumin in Electrotechnics.** Ernst Blau (*Helios*, 1932, **38**, 129–131). —A survey of the mechanical and chemical properties of Silumin and of methods for working it. The alloy has been used for the manufacture of housings of motors, transformers, and switches, especially for railway wagons, and for cases for radio apparatus, &c.—v. G.

**The Application of Aluminium in the Construction of Radio Apparatus.** R. Wittig (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, **4**, 107–108). —The low specific gravity and magnetic susceptibility, and the good electrical conductivity and deep drawing capacity make aluminium well suited for the construction of radio apparatus, especially condensers, screens, cases, &c. —M. H.

**Light Metal Alloys and their Influence in Increasing the Capacity of Transport Apparatus.** Ad.-M. Hug (*Ingenieur-Zeit.*, 1932, **12**, 102–104).—The saving of weight effected by using light metals is illustrated with reference to a motor-boat, an overhead electric conductor, a railway wagon, and automobiles. —v. G.

**Aluminium Light Alloys in the Manufacture of Rolling Stock on Main-Line Railroads.** Domenico Pagnani (*Riv. tec. ferrovie ital.*, 1932, **41**, 65–88; *C. Abs.*, 1932, **26**, 3469).—The utilization of aluminium and its alloys in place of brass and bronze is proposed. Chemical analyses are given.—S. G.

**The Importance of the Eloxal Process for Fire-Brigade Apparatus.** Wolfgang Sternberg (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, **4**, 114–115). —The suitability of aluminium and its light alloys as material for manifold apparatus used in the fire-brigade is improved by surface protection by means of electrolytic oxidation (Eloxal process).—M. H.

**Increase of the Efficiency of Combustion Motors by Treatment of the Pistons [by the Eloxal Process]. Increase of the Efficiency of Electric Induction Furnaces [by the Use of Electrically Oxidized Aluminium Coils.] The Importance of the Eloxal Process for the Construction of [Electrical] Condensers. The Application of the Eloxal Process in the Textile Industry. The Application of the Eloxal Process for Light Metal Storage and Transport Tanks.** Vereinigte Aluminium Werke, Lautawerk. (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, **4**, 109–111).—The value of aluminium and its alloys for many industrial purposes is considerably improved by electrolytic oxidation (Eloxal process). The oxide film possesses a high surface hardness, heat radiation, insulation capacity, resistance against electric arc, dielectric constant, corrosion resistance, &c.—M. H.

**Cast Aluminium Alloys in the Construction of Motors for Aeronautics.** C. Panseri (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 301–325; and *Alluminio*, **1**, (1), 15–35).—[In Italian.] An interesting, detailed, and well-illustrated account is given of the fundamental laws governing the design of aeromotors. The large number of different alloys used in aero-construction is accounted for by the necessity of selecting alloys for different purposes according to the mechanical properties required. Suitable properties can frequently be obtained by appropriate heat-treatment. Stress is laid on the importance of structure, and of dimensional and mechanical stability and the properties required for alloys for the various parts of the motor are discussed. The value of aluminium bronze for guides and valve seating is also briefly discussed. —G. G.

**A French All-Metal Fighter.** Anon. (*Aircraft Eng.*, 1932, **4**, 115–116).—The Bréguet 410, a military aeroplane, is described. The structure is entirely of Duralumin except the wing-spars, which are of steel. Wings, fuselage, and tail coverings are in " L2R " alloy sheet.—H. S.

**Duralumin and Steel Construction.** G. H. Handasyde (*Aircraft Eng.*, 1932, 4, 88).—Methods employed at the Westland Works at Yeovil are described. Square Duralumin tubes are used in the construction of the fuselage. Highly stressed members are made in steel tube.—H. S.

**Alloy [" 43 "] in Architecture.** P. M. Haehnni (*Internat. Foundry Congress, Milan, Memoirs*, 1931, 227).—Among the various light alloys, used in architectural and ornamental work, those with silicon, and especially alloy " 43," occupy a prominent position, owing to their great corrosion resistance and good casting properties. The alloy is quite fluid at low temperatures, and its shrinkage is less than that of other alloys. In the construction of the church of Pittsburg, 5 tons of the alloy were used. The Koppers Building in Pittsburg contains more than 900 panels of alloy 43; other uses are mentioned, as in the Chrysler Building, the Empire State Building, and the "Cathedral of Learning" of the University of Pittsburg.—G. G.

**Chromium-Plated Wood Planer Knives.** Anon. (*Machinery* (*N.Y.*), 1930, 36, 436).—A chromium-plated knife operating on kiln-dried stock had a life 25% greater than that of ordinary knives, whilst the time between jointings on green timber was 200–300% longer.—H. F. G.

**Aluminium–Bronze.** Anon. (*Machinery* (*N.Y.*), 1930, 36, 379).—Abstract of an unspecified publication of the British Aluminium Co., Ltd., dealing with the possible applications of " aluminium–bronze " and the reasons why this alloy is not more commonly employed.—H. F. G.

**Copper Alloys in Industry.** L. Guillet (*Cuivre et Laiton*, 1928, 2, (13), 5–7).—A comparison of copper with nickel and iron with regard to physical properties. There follows a general discussion of the principal copper alloys. —W. A. C. N.

**Blue Vitriol Produced by Leaching Shot.** Pierce Barker (*Chem. and Met. Eng.*, 1932, 39, 258–261).—The production of copper sulphate consists in oxidizing the metal as rapidly as possible and dissolving the oxide in the least quantity of sulphuric acid while providing opportunities for any impurities such as gold, silver, lead, antimony, arsenic, metals of the platinum group, &c., to settle out before the precipitation portion of the cycle is reached. Copper must be in the form of shot to provide the maximum surface for oxidation and solution. The shot is porous with a surface made up of irregular kidney shapes and cracks which are obtained by using copper with a sulphur content of about 4%. Shots are formed by pouring the copper in a controlled stream against a rotating cylinder or cone, or from a board rolled to and fro on a pipe. The three types of equipment are illustrated. The copper spatters into a metal basket having perforated sides and placed in a pit of water at 180° F. (82° C.). —F. J.

**Copper in Transport Material.** V. E. Delayre-Paggi (*Cuivre et Laiton*, 1929, 2, (14), 15–17).—It is demonstrated that copper enters very considerably into modern transport either as pure metal or in the form of one of its alloys. Examples are taken from the instruments of transit on land and sea and in the air. It must be noted, however, that the increasing use of aluminium and its alloys discounts some of D.-P.'s arguments.—W. A. C. N.

**Copper and Brass in Water Services.** Anon. (*Cuivre et Laiton*, 1930, 3, 113–114).—It is stated that copper and brass tubes are preferable to iron or lead for carrying water on account of their ease of manipulation and erection, their hygienic properties, their resistance to diverse destructive influences, the high scrap value, and overall economy.—W. A. C. N.

**Copper and Brass Pipe Systems for Carrying Hot and Cold Water.** E. Grünfeld (*Cuivre et Laiton*, 1930, 3, 219–220).—Formerly American practice recommended a brass containing 61·5% copper, but owing to the fact that it was found not to stand up to the various treatments, an alloy containing 70% is now being increasingly adopted. Where pipes are exposed to soil corrosion Tombac—

85% Cu—is suggested. Copper tubes are more easily worked than those of brass. Water which contains carbonic acid, coloured water, and very hard filtered water are found to be more corrosive than ordinary water. The points to be borne in mind in considering the question of the effect of various classes of water are—H-ion concentration, quantity of carbonic acid, the amount of carbonates and bicarbonates, quantity of silver or silicic acid.—W. A. C. N.

**Copper Tubes in Domestic Water Services.** Anon. (*Cuivre et Laiton*, 1931, **4**, 543–549).—The various agencies in water which may give rise to corrosion are oxygen, salts of the alkaline earths, carbonic acid (free and uncombined), and traces of mineral and organic acids. The relative effects of these in iron, lead, and copper pipes are discussed. The hygienic point of view is kept in the forefront throughout the article.—W. A. C. N.

**Copper in the Food Industries—Sugar and Confectionery.** Anon. (*Cuivre et Laiton*, 1930, **3**, 233–235).—It is stated that copper, brass, and bronze play a big part in the manufacture of these materials. Baskets for centrifugals, evaporating pans, filters, refrigerators, boiling vessels are all made of bronze or brass. Extensive use is made of these materials for such purposes in the U.S.A. Among the principal properties of the copper alloys which enhance their suitability are, high conductivity, resistance to vapour pressure, and insensitiveness to many agents which attack other metals and alloys.—W. N.

**Copper in Musical Instruments.** Anon. (*Cuivre et Laiton*, 1930, **3**, 105–106).—Cf. *J.*, this volume, p. 497. The development of various kinds of horn instruments and of their manufacture is discussed.—W. A. C. N.

**Nickel Resources, Production, and Utilization.** E. S. Moore (*Amer. Inst. Min. Met. Eng., Preprint*, **1932**, Feb., 1–13).—A review of the history of nickel, its distribution and the production of each source, and the industrial uses of the metal. Reference is made to fluctuations in world production and the relatively small variations in price over the last five years.—R. G.

**Modern Monel Devices for Textile Uses.** J. F. Springer (*Textile Colorist*, 1932, **54**, 39–42, 59).—S. G.

**A 4000-Ampère Sodium Conductor.** R. H. Boundy (*Electrochem. Soc. Preprint*, **1932**, Sept., 13–22).—The installation of a 4000-amp. conductor, 850 ft. (259 m.) long, consisting of iron piping filled with sodium metal, is described in detail. The weight per unit conductivity is decidedly less than for copper, and the cost per running foot of conductor is approximately the same. The installation has been in successful use for several years.—S. G.

**Thallium.** Anon. (*Mineral Ind.*, 1931, **39**, 660–661).—Thallium compounds are used for pest-poisons and in photoelectric cells.—E. S. H.

**Thorium.** Anon. (*Mineral Ind.*, 1931, **39**, 661).—Metallic thorium, produced by electrolysis, is now available commercially.—E. S. H.

**Tin-Plated Toncan.** Anon. (*Chem. and Met. Eng.*, 1932, **39**, 104).—Tin-plated Toncan iron is claimed to be the only tinplate on the market with a rust-resisting base. Among the suggested uses are containers for chemicals and cases for gas-meters.—F. J.

**An Electric Lamp. How the Filament is Tempered.** Anon. (*Indian Eng.*, 1932, **91**, 67).—The production of tungsten wire from Scheelite, its swaging, reduction, and heat-treatment are described.—P. M. C. R.

**Tungsten.** William C. Hirsch (*Elect. Manufacturing*, 1931, **7**, (June), 43–45; *C. Abs.*, 1932, **26**, 3462).—A review of modern developments in the utilization of tungsten.—S. G.

**Vanadium.** Frank L. Hess (*U.S. Bur. Mines, Information Circ.* No. **6572**, 1932, 1–8).—A general discussion of the occurrence, resources, and uses of vanadium.—S. G.

**Zinc and Zinc-Alloy Use in the Automotive Industry.—II.—III.** Robert M. Curts (*Amer. Metal Market*, 1931, **38**, (22), 5, 10; (23), 5; (24), 5, 10).—See this *J.*, 1931, **47**, 560.—S. G.

## XI.—HEAT-TREATMENT

(Continued from p. 499.)

**The Bright-Annealing of Copper and its Alloys.** O. S. Haskell (*Elect. Manufacturing*, 1931, **8**, (Aug.), 41–42; (Sept.), 39–40; *C. Abs.*, 1932, **26**, 3465).—Costs of cleaning and pickling are reduced by bright-annealing. An outline is given of the phenomena involved in the annealing process, and of the advantages of various types of annealing furnaces.—S. G.

**Annealing Monel Metal.** W. E. Warner (*Machinery* (*N.Y.*), 1930, **36**, 392).—A brief practical note. As the quenching medium a mixture of 1 part wood alcohol with 80 parts water is recommended.—H. F. G.

**The Annealing of Metal Strip in Automatic Continuous Electric Furnaces.** Otto Clever (*Met. Ind.* (*Lond.*), 1932, **41**, 33–34).—A short description of a continuous electric annealing furnace and of the process adopted in using it for the annealing of metallic strip is given.—J. H. W.

## XII.—JOINING

(Continued from pp. 499–501.)

**Investigation of Duralumin Rivets.** I. G. Shoulgin (*Trans. Central Aero-Hydrodynamic Inst.* No. **81**, 1931, 1–81; *U.S.S.R. Sci.-Tech. Res. Inst. Supreme Council Nat. Econ.*, No. **449**).—[In Russian, with English summary.] The object of the research was to determine the correct chemical composition of the alloy, and the optimum conditions for the thermal treatment and fitting of the rivets. A summary of similar work carried out by investigators abroad, notably by Rosenhain and Archbutt (" Report on Aluminium Alloy Rivets ") is given. The investigation was carried out in accordance with the following scheme: (1) Determinations of (*a*) the annular space required between the rivet and the circumference of the hole in the plate; (*b*) thickness of the plate; (*c*) method of riveting; (*d*) rate of load increase; (2) Selection of the most suitable chemical composition; (3) Determination of the coeff. of shear of rivets of varying chemical composition: (*a*) with a copper content from 2 to 5%, quenched in water from 500° C. and allowed to age for varying periods; (*b*) with a copper content of 3%, quenched from temperatures of 400° C. to 525° C. (at intervals of 25°), and allowed to age for varying periods and also normalized at various temperatures (also at intervals of 25°) from 350° C. to 525° C. and allowed to age for varying periods; (*c*) with a copper content of 4·5%, normalized at 350° C.; effect of (*d*) the diameter of the rivets on their mechanical properties; (*e*) the number of shearing planes on the strength of the rivets; (*f*) the strength of the plates on the reliability of the riveted joint; (*g*) deformation on the strength of the rivets after quenching; (4) Determination of the behaviour of rivets under tensile stress; (5) Examination of the macro- and micro-structure. It is emphasized that the methods and testing procedure employed must be carefully selected, since they exercise a very profound influence on the results. Seven alloys were examined, and more than 4,000 mechanical tests performed, with the following conclusions: (1) all the alloys, if quenched in water from 500° C. and kept for 7 days, can be divided into 3 groups; (*a*) rivets with a copper content of 2% with an average coeff. of shearing of 20·5 kg./mm.$^2$ if allowed to age before fixing, and 22·5 kg./mm.$^2$ after fixing; (*b*) alloys with copper 2·5–3·5%, with corresponding average coeffs. of 21·5–23 kg./mm.$^2$ and 24·5–26·3 kg./mm.$^2$; and (*c*) alloys with copper 4–5% and coeffs. 23·3–25·5 kg./mm.$^2$ and 26·5–28·5 kg./mm.$^2$. Rivets of group (*a*) possess comparatively low mechanical properties and may therefore be employed in cases where maximum plasticity and low coeffs. of strength are required. Group (*b*) has medium mechanical properties, but is the best from the point of view of fixing, since the rivets show the best tendency to work-harden and have the longest workable period after quenching. They are thus the most suitable for aircraft construction, although the corrosion aspect has not been taken into account. Group (*c*) possesses the best mechanical properties, but is difficult to fix and has a shorter workable period. Owing to their great hardness, it is more difficult to safeguard against cracking, whilst even snapping off of the free end of the rivet may take place if the technique of riveting is not carefully controlled. Finally, the material of the riveted sheets itself acquires, to a marked extent, a cold-working stress. These rivets, therefore, should be used in cases where rivets of group (*b*) are unsuitable—*e.g.* on account of corrosion. The general mechanical properties of Russian rivets are identical with those from corresponding alloys of foreign manufacture. (2) The quenching temperature must be within the narrow limits of 490°–510° C. (3) The most suitable time intervals between quenching and fixing the rivets are: with a copper content of 2% not later than 15 hrs.; with 2·5% copper, 10 hrs.; with 3%, 7 hrs.; with 3·5%, 5 hrs.; with 4–5%, 3½ hrs. It is noted that there are no other accurate published data, similar to those given above, indicating the relationship between the chemical composition and the workable period, so that all previous information on this subject must be regarded as unreliable for practical purposes. (4) The rivets during the process of fixing undergo a process of plastic deformation which varies in intensity in different parts. The head and the neck experience the maximum stress, whilst the rest of the body should not, if the correct technique is used, undergo much cold-working, and cracking therefore occurs comparatively rarely. The heads, on the other hand, develop cracks, starting usually towards the centre, at the join with the neck, and this occurs with all the alloys, although not in every rivet. (5) Hand-riveting is conducive to cracks, which are increased by lengthening the time interval between quenching and fixing and by increasing the annular space between the rivet and the hole. Mechanical riveting exerts a lesser influence. In riveting, therefore, special attention must be paid to correct technique: the direction of the blow must be centrally along the rivet axis. In practice, the annular space may be as follows: for rivets up to 3 mm., 0·15–0·20 mm.; up to 4 mm., 0·20–0·30 mm.; up to 5 mm., 0·25–0·35 mm. (6) It is absolutely inadmissible to use rivets which have been quenched in air at room temperature, since their ageing process is much more rapid and their subsequent increase in strength is small, even though their final strength is high. (7) Rivets which have been quenched and allowed to age normally, when subjected to a shear stress in one plane a little short of a destructive load for 3 minutes, show no signs of flow at the join: on destruction a very slight crushing of the body is observable which decreases with increase in copper content. A detailed technical specification approved by the Standards Committee of the Supreme Council of National Economy for Koltchugalumin, *i.e.* Duralumin rivets as supplied for aircraft construction, is appended.—M. Z.

**The Riveting of Veneered Light Metal Sheets.** F. Thomas and A. Westlinning (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1931, 3, 173–181).—An illustrated description of the riveting of Lautal sheet (1·5 mm.) coated on one side or on both sides with 1·5 mm. oak veneer (as used in the construction of omnibuses) by means of Lautal rivets and the testing of these rivets under bending load.—M. H.

**Practical Notes on Light-Metal Work.** A. Eyles (*Mech. World*, 1932, **91**, 407–408).—The choice of rivets of correct physical properties and the different types of rivet-head for jointing light-metal structures are discussed. A number of typical joints are illustrated and described.—F. J.

**Brazing Metals with Silver Solders.** A. Eyles (*Mech. World*, 1932, **91**, 5).—A range of silver solders is given showing melting points from 720° C. to 830° C. Technical details of forming joints with silver solders are given.—F. J.

**Brazing with a Self-Fluxing Alloy.** C. J. Snyder (*Machinery* (*N.Y.*), 1931, **37**, 760–761).—A self-fluxing phosphor–copper alloy is particularly valuable for making joints in copper. An account is given of the operation of making joints with this alloy, using an electric welding machine, welding torch, or electric arc. If heating is prolonged, the melting point may rise through loss of phosphorus. The normal brazing temperature is 800° C.—J. C. C.

**Making Joints with Electric Brazing Tongs.** Anon. (*Machinery* (*N.Y.*), 1931, **38**, 23–24).—An illustrated description of a portable brazing equipment consisting of brazing tongs, transformer, and foot-switch developed by the General Electric Co. for silver-soldering by the resistance method.—J. C. C.

**Non-Ferrous Metals—Everdur.** M. Powell and I. T. Hook (*Welding Eng.*, 1932, **17**, (4), 25).—Long abstract of a paper on the welding of Everdur, read before the American Welding Society. See *J.*, this volume, p. 112.—H. H.

**Report of a Special Committee of the British Acetylene Association on the Use of Higher Pressure in Acetylene Apparatus.** A. Hoddle, Alex Jackson, A. G. C. Lucas, C. S. Milne, and A. Stephenson (*Brit. Acetylene Assoc.*, **1930**, 1–27).—The committee has accumulated data concerning the practice in America and the various countries of Europe. The regulations in force in Great Britain are discussed in comparison and also with regard to technical details of acetylene generation. The hazards in the generation and use of acetylene are explained. The committee concludes that there is no industrial demand for apparatus to generate acetylene at higher pressures than those at present permitted.—H. W. G. H.

**The Testing of Blowpipes for Low-Pressure Acetylene.** W. Knoch (*Autogene Metallbearbeitung*, 1931, **24**, 179–183).—The main requirements of a blowpipe are said to be economy and safety. A method of testing developed by the Welding Research Department of the German State Railways is described. This is claimed to give satisfactory comparison values in a short time and without damaging the blowpipes in any way. Results are tabulated giving the pressures in the injector chambers of various blowpipes with the acetylene shut off, with a regulated flame and cold nozzle, and with a regulated flame and hot nozzle. K. concludes that it is difficult to obtain the best results with injector-type blowpipes when using low-pressure acetylene and that high-pressure acetylene gives greater safety and easier flame control (see also following abstract)—H. W. G. H.

**The Testing of Blowpipes for Low-Pressure Acetylene.** K. Pöttgen. W. Knoch (*Autogene Metallbearbeitung*, 1932, **25**, 33–38).—Knoch's paper (see preceding abstract) is criticized by P., who considers that the results given therein fail because the time up to back-firing and the temperature of the nozzle at the instant of back-fire are not taken into account, the assumption being made that all blowpipes back-fire at about the same nozzle temperature, given as 360° C. P. describes experiments in which the nozzle is heated in a small electric furnace and the injector pressures are recorded for different times and nozzle temperatures. The figures show that not only do different blowpipes behave differently, but also that different nozzles on the same blowpipe give varying results. In reply, Knoch states that the ignition temperature of a given mixture of acetylene and oxygen is a constant for given conditions and that the nozzle temperatures given by P. are useless, being the temperatures of the outside of the nozzle. These temperatures are higher than those of the inside, which is cooled by the gas stream. The different times of back-firing are explained by differences in the exit velocity of the gases. In reply to this, P. asserts that it has been proved that the temperature inside the nozzle during actual welding can rise to more than 700° C. The exit velocities in two burners among those examined are said to contradict the theory that they explain early or late back-firing. K., in further reply, maintains that P.'s reasoning is fallacious.—H. W. G. H.

## XIII.—WORKING

(Continued from pp. 502-504.)

**The Manufacture of Bronze Powder.** Anon. (*Cuivre et Laiton*, 1930, 3, 107–108).—This material was first made in Nuremburg in the 19th century and used for painting work. The alloy is rolled out into extremely thin strip and in its brittle form is then pounded in a special mill to cause it to fracture into fine pieces. These are then polished by rumbling in another mill in the nature of a long chute. Different colorations may be obtained by heating.—W. A. C. N.

**The Manufacture of Seamless Tubes of Metals with a High Melting Point.** J. A. M. van Liempt (*Metallwirtschaft*, 1932, 11, 357–359).—Tungsten tubes have been prepared by heating a molybdenum wire at 2000° C. in tungsten hexachloride vapour, whereby the wire becomes coated with a film of tungsten the crystals of which continue the orientation of the molybdenum crystals. The molybdenum core is then dissolved out with a mixture of nitric and sulphuric acids at 90° C.; in this way tubes of 1–12 mm. diam. and with walls 0·1–1 mm. thick have been prepared. By using a single-crystal molybdenum wire single-crystal tungsten tubes can be prepared. Wires coated with tungsten can be drawn down to smaller diameters before the molybdenum is dissolved out. —v. G.

**The Extrusion Pressure of Metals and Alloys at Different Temperatures.** W. P. Schischokin (*Zvetnye Metally* (*The Non-Ferrous Metals*), 1930, 5, (5), 662–671).—[In Russian.] See this *J.*, 1930, 44, 676.—S. G.

**Extruded Metal.** William C. Hirsch (*Elect. Manufacturing*, 1931, 7, (Mar.), 38–40).—A review.—S. G.

**Manufacture of Copper Wire for Weaving.** Anon. (*Cuivre et Laiton*, 1930, 3, 236).—After reduction in diameter the wire is annealed and then dipped in cyanide solution to remove any oxide that may be present. Afterwards it is silvered or gilded by deposition from cyanide solutions. The wire is fed into the baths continuously on a series of drums. When gold is not to be used on account of its high cost, a rich brass is employed. The wire is afterwards polished.—W. A. C. N.

**The Production of Lead-Encased Cable.** Waldo L. Sherman (*Wire and Wire Products*, 1932, 7, 179–182, 204–205).—As a result of a questionnaire sent to 16 leading cable manufacturers (? in the U.S.A.) the following standard practice for lead-casing cables is recommended: pure lead is mostly used, but sometimes 0·5–0·9% antimony and 1–3% tin. A variation in wall thickness of ± 10% is allowed. The expansion test is of 2 diameters, with a taper of 30° for the expanding plug test. The pressure test is 5–150 lb./in.$^2$ for 24 hrs.–6 months. The bend test is 10 bends at 180°. The lead is 99·85% pure, according to A.S.T.M. standards. The die-block temperature should be measured and should be between 325° and 375° F. (163°–191° C.). Speed of extrusion varies from 50 to 200 ft./minute. The lead sheath is cooled with water immediately it leaves the die-block; steam should be used for antimonial sheath. Samples of lead are taken before and after sheathing. Defects may occur anywhere on the cable. The melting pot and die-block should be cleaned out when changing to and from antimonial alloy and pure lead. Mineral oil, tallow, and lard oil are used, but sparingly. The melting-pot temperature is controlled at 750° F. (399° C.) for lead and at 850° F. (454° C.) for antimonial lead. —J. H. W.

**A Survey of Rolling-Mill Bearings.** W. H. Bowman (*Mech. World*, 1932, 91, 152–153).—More attention is now being paid to rolling-mill bearings, owing to the high percentage of driving power in roll-necks wasted in overcoming friction. In many large slabbing, blooming, and plate mills, anti-friction metal has been tried successfully, resulting in a saving of 50% of the power used in overcoming friction. The design of a chock using anti-friction metal (which should contain a minimum of 70% tin, plus antimony and copper) is illustrated and described. Water-cooling in the shell of the chock is often adopted. As an emergency measure, in the case of the white metal being melted by the heat generated by roll-neck friction, "brass" grids are cast into the lining. Experience shows that wear with white-metal bearings is much less than with brass chocks. Some makers mount their roll-bearings on spherical seats, to ensure correct alignment with the necks, thereby increasing roll-strength and solidity. The advantages of roller-bearings are also discussed.—F. J.

**Speed in Relation to Deformation of Copper.** M. P. Dalton (*Machinery* (*Lond.*), 1931, **37**, 681).—It was found possible to form a deeply embossed copper badge without using a heavy coining press, provided that the blow was struck sufficiently smartly. A 60-lb. drop hammer with a 4-ft. drop gave good results. It is concluded that the deformation was complete before work-hardening took effect. Again, in rolling copper strip, it was found that the spread in the rolls was a function of speed of rolling.—J. C. C.

**Researches on Deep Drawing.** W. Riem (*Z. Metallkunde*, 1932, **24**, 157–161).—Abridged from a paper by G. Sachs and W. Riem in *Mitt. Material.*, *Sonderheft* **16**, 1931, 11–18; cf. *J.*, this volume, pp. 56–57.—M. H.

**Drop Forgings and Stampings.** W. A. Thain (*Aircraft Eng.*, 1932, **4**, 96–97, 120–122).—The production, properties, and utility of drop-forgings and stampings in steels and light alloys are discussed. Special reference is made to inclusions and defects, which are illustrated by good photographs.—H. S.

**The Production of Metal Fittings for Aircraft.** Anon. (*Machinery* (*Lond.*), 1930, **37**, 33–38).—Drop forgings which are to be turned, bored, or faced are placed in a suitable position in a split cast-iron box which is then filled with molten lead, or, preferably, a good grade of white metal. A variety of indexing and universal drilling jigs and press tools for use with Duralumin sheet are described.—H. F. G.

**Power and Hand Press Production. Methods of Application, Tool Design, and Construction.** R. Wake (*Mech. World*, 1932, **91**, 248–251).—Press-shop production plant, in conjunction with the co-ordination and application of the necessary equipment, has occupied a foremost position in the manufacture of engineering and other industrial requirements. The pressed products industry is advancing, and further rapid expansion in the near future is anticipated. Cold-forming and pressing, which improve the strength of the material as compared with hot-pressing, possess also the advantages of lower cost of manufacture, and longer life of dies and punches. Blanks are made from steel, brass, nickel, tinplate, and copper, supplied in the form of sheet and strip, which must possess special physical and mechanical properties. Practical details of tools and plant are described and illustrated, mainly in reference to the production of a deep-drawn steel container.—F. J.

**Forming and Blanking Die for Radiator Fins.** P. H. W. (*Machinery* (*Lond.*), 1930, **37**, 393).—Brief illustrated description of a die designed for producing brass fins for steam radiator tubes.—H. F. G.

**The Production of Aluminium Hot-Water Bottles.** J. A. (*Machinery* (*Lond.*), 1930, **37**, 199).—Blanks of 22-gauge sheet metal, 11·5 in. in diam., are passed through rolls and are then subjected to 3 press operations, the final thickness being 0·026 in. The resulting cylinders, 9 in. long and 3·625 in. in diam., are corrugated by a special chuck and roller. The neck is annealed by immersion in molten lead and is then spun to the required form. Finally, the screw thread is rolled on the neck.—H. F. G.

**The Forming of Aluminium.—II.—III.** F. V. Hartman and C. M. Craighead (*Metal Stampings*, 1932, **5**, 407–408, 418, 463–465).—Cf. *J.*, this volume, p. 503. (II.—) Blanking, bending, embossing, and deep drawing of aluminium and aluminium alloys are described. (III.—) A discussion of the hammering and spinning operations employed in the forming of aluminium and its alloys. —J. H. W.

**Round Blank Formulæ.** John Langton (*Mech. World*, 1932, 91, 338–340). —In order to save time spent on tedious repetitive calculations, simple methods of determining diameters of round blanks for press-production of shells are suggested. The proper use of formulæ, easily understood and applied, makes it possible, where the sheet-metal works possesses a drawing office, quickly to estimate, by the aid of a slide-rule, the diameter of a blank so near to the actual blank, that it is often only necessary subsequently to cut and try one blank for verification purposes. The application of the formulæ to a large number of illustrated examples is exemplified.—F. J.

**Producing External Curls on Seamless Boxes.** John Langton (*Mech. World*, 1932, 91, 385–386).—External curling for metal boxes produces a better product than the more usual method of internal curling, and although special processes and machinery are required, a cheaper article is produced by the technique described.—F. J.

**Proportions of Duralumin Bends.** Anon. (*Mech. World*, 1932, 91, 218).—Allowances for bends in sheet metals, viz.: aluminium, Duralumin, and steel, are tabulated.—F. J.

**On the Machining and Cutting of Pure Aluminium and Aluminium Alloys.** U. Magnani and C. Panseri (*Metallurgia italiana*, 1931, 23, 265–291; and (abstract) *Light Metals Research*, 1931, 1, (11), 26).—The questions inherent in machine working of the various alloys are first examined, with particular reference to cutting, planing, &c. A discussion on the characteristics of modern machine tools for light metals follows, and the importance of threads in the construction of valves, cocks, taps, &c., is outlined, especially for the chemical industry and as a substitute for bronze, brass, &c.—L. L.

**Machining Aluminium Crankcases for Heavy Motor Vehicles.** Anon. (*Machinery* (*Lond.*), 1930, 37, 1–4).—Details are given of the methods of milling, drilling, and boring employed by Thornycroft & Co., Ltd.—H. F. G.

**New Developments in Machining Aluminium.** R. L. Templin (*Machinery* (*Lond.*), 1931, 37, 545–546).—An abstract of a paper read before the Society of Automotive Engineers. See this *J.*, 1931, 47, 233, 403, 602.—J. C. C.

**The Machining of Alpax.** Anon. (*Aluminium Broadcast*, 1931, 3, (1), 3–11).—A reprint of the instructions issued by Light Alloys, Ltd. for machining modified aluminium–silicon alloys. Design and construction of cutting tools, lubrication, and cutting speeds are dealt with in detail.—J. C. C.

**Compressed Nitrogen for Cutting Copper and Nickel Sheets.** Anon. (*Met. Ind.* (*Lond.*), 1932, 40, 572).—Cutting thin copper and nickel sheets with acetylene results in the fusing of the cut parts and with coal gas, in ragged edges. A new system has been devised whereby coal gas and compressed oxygen are supplied through the central nozzle of the burner and diluted with compressed nitrogen supplied through a ring nozzle. As the nitrogen encircles the gas flame, it causes it to form a conical shape little greater in diameter than a pencil point. The finished part falls off the sheet, and does not require any dressing or trimming, and unskilled labour may be used throughout the operation. —J. H. W.

**A Carborundum Tool for Cutting Fine Surfaces.** Roland Schaffert (*Rev. Sci. Instruments*, 1931, 2, 55–56).—A lathe-tool for holding a carborundum crystal used in cutting smooth polished surfaces on brass is described. A mirror surface comparable with that obtainable by most careful polishing can be prepared with the tool.—J. S. G. T.

**Tungsten– and Tantalum–Carbide Cutting Tools.** H. Shaw (*Mech. World*, 1932, 91, 490–494).—Tungsten carbide bonded in a matrix of cobalt, and tantalum carbide bonded in a matrix of nickel, are extremely hard materials capable of scratching sapphire, of cutting white iron, glass, &c., and of exceptional performance when cutting any metals or alloys. The technique of manufacturing these tools, including "brazing" tips to shanks, is described and illustrated. Cutting speeds, with appropriate angles of top rake and clearance of tools, are given for a large number of metals and alloys, ferrous and non-ferrous. An interesting application is described, of aluminium switchboxes, which, by replacing the abrasive segments of a grinding wheel with Widia-tipped cutters, could be cut at a speed of 6200 ft./minute, taking one sixth the time previously required for grinding.—F. J.

**Some Experiences with Tungsten Carbide Tools.** Karl F. Smith (*Machinery* (*N.Y.*), 1931, 37, 415–416).—Tungsten carbide tools have proved of value at the San Diego Naval Air Base in machining grooves in aluminium alloy pistons and in reaming Kelmet and lead–bronze bearings. They have not been found satisfactory in operations where the point is subject to shock. Tungsten carbide inserts for sand-blast nozzles have a life of 1800 hrs., as against 3 hrs. for manganese steel; and, owing to the decrease in wear, show considerable economies by the reduction of air consumption.—J. C. C.

**Savings Effected by the Use of Tungsten Carbide Tools.** Anon. (*Machinery* (*Lond.*), 1930, 37, 338).—The use of a tungsten carbide tool for turning a die-cast ferrule having a chilled surface increased the production per grind from 6 pieces to 15,000. An aluminium part was machined at the rate of 1013 pieces per grind, compared with 34 pieces when steel tools were used, and at a surface speed of 938 ft./minute. The life of tungsten carbide tools used for rough-boring Babbitt metal was 100 times that of the tools used previously. Various other production rates are quoted.—H. F. G.

**Ramet—A New High-Speed Cutting Metal.** Anon. (*Machinery* (*N.Y.*), 1931, 37, 540–541).—See *J.*, this volume, p. 119.—J. C. C.

**What We Have Learned About Tungsten Carbide.** Frank W. Curtis (*Machinery* (*N.Y.*), 1931, 37, 867–869, 938–940).—The advantages, fields of application, construction, and operation of tungsten carbide cutting tools are discussed.—J. C. C.

**The Broadening Field of Tungsten-Carbide Tools.** Anon. (*Machinery* (*Lond.*), 1931, 38, 41–44; and *Machinery* (*N.Y.*), 1931, 37, 511–515).—Examples of milling cutters, drills, forming tools, and counterbores fitted with tungsten-carbide tips are illustrated.—J. C. C.

**Molybdenum Cushions Protect Tantalum–Carbide Tools.** Anon. (*Machinery* (*N.Y.*), 1931, 38, 246).—Inserts of pure molybdenum are brazed between the tantalum–carbide tip and the steel shank of cutting tools to form a buffer to prevent cracks developing as the tool cools.—J. C. C.

**Cutting Steel with a New Cemented Carbide.** Roger D. Prosser (*Machinery* (*N.Y.*), 1931, 38, 296–298).—Details are given of the results of cutting tests on chrome–nickel steel made with "Widia-X," an alloy developed by Fried. Krupp A.G. specifically for machining steel.—J. C. C.

**The Lapping of Tungsten Carbide Tools.** H. J. W. (*Machinery* (*Lond.*), 1930, 37, 245).—A lapped cutting edge on a tungsten carbide tool will last from 2 to 4 times as long as a plain ground edge. The dull appearance of a surface lapped with a less expensive abrasive than diamond dust is shown by photomicrographs to be due to shallow pitting as compared with fine parallel scratches; it does not indicate an unsatisfactory finish. In the method developed by the Carborundum Co., Ltd., a fine finish is produced by lapping with grade R 40 carborundum fine, first on a cast-iron disc and then on a wooden disc; a surface speed of 900–1200 ft./minute is recommended.
—H. F. G.

**Tungsten Carbide in an Automobile Plant.** Anon. (*Machinery* (*N.Y.*), 1931, 37, 573).—Tungsten carbide tools are used most successfully on hard bronze, malleable and cast iron, and aluminium alloys for operations which do not require an intermittent cut. Tungsten carbide-tipped drills have been used for hardened parts, and a small piece inset in the work-rest of a centreless grinder has satisfactorily reduced wear. Thin copper is the best brazing material for fastening the carbide to its steel support.—J. C. C.

**Boring with Tungsten Carbide Tools.** J. B. G. (*Machinery* (*Lond.*), 1930, **37**, 417–418).—Describes a form of 2-lip boring tool which takes into account the special properties of tungsten carbide. The high machining speeds employed necessitate care in designing pilot or guide bushings; a double-row radial thrust ball-bearing is recommended.—H. F. G.

**Cutting Lubricants and Soluble Oils.** H. N. Bassett (*Mech. World*, 1932, **91**, 276–277).—The advantages of the fatty oils over mineral oils are largely offset by their considerably higher cost, and efforts have been made to produce compound oils and emulsions in order to produce a cheaper cutting lubricant. The successful use of these liquids depends largely on maintaining their stability, and an important problem relates to their antiseptic properties.—F. J.

**Use of Cutting Fluids.** J. D. Roney and G. L. Sumner (*Mech. World*, 1932, **91**, 418–419).—The use of cutting fluids gives a better finish to the work and a longer life to the tool. Tests of various fluids are discussed and it is shown that it is essential to use correctly-ground tools and to note the effect of continuous work on the properties of the fluid.—F. J.

**Cutting Compounds Used by Ford.** Charles O. Herb (*Machinery* (*N.Y.*), 1931, **37**, 569–572; and *Machinery* (*Lond.*), 1931, **38**, 262–263).—Formulæ are given for the cutting compounds used in the Ford machine shops, and the handling systems are outlined. Disinfectant is added daily to the soluble oil compound, and bacterial counts are taken regularly to determine when the solution should be discarded.—J. C. C.

## XIV.—FINISHING

(Continued from pp. 501–505.)

**Improvements in the Schoop Spraying Process.** A. Karsten (*Helios* (*Fachzeit.*), 1932, **38**, 180–181).—A description of a new pistol for spraying metals having a high melting point (cf. Salmony, *J.*, this volume, p. 30).—v. G.

**The Colouring of Aluminium.** Anon. (*Met. Ind.* (*Lond.*), 1932, **41**, 35–36).—The Sheppard aluminium colouring process is described. It is claimed that the colours obtained satisfy all possible requirements in respect of corrosion- and heat-resistance, fastness to light, and the range of colours available. The process is an electrolytic one, relying on the formation of an anodic film in an ordinary acid bath. A brief summary is given of the properties, advantages, and uses of these coloured films, which differ from those produced by chromic treatment in being translucent rather than opaque.—J. H. W.

**Colours in Aluminium by Plating, Dyeing, and Oxidizing.** J. D. Edwards (*Production Eng.*, 1931, **2**, 107–109; *C. Abs.*, 1932, **26**, 3470).—Aluminium can be plated with nickel, chromium, gold, silver, copper, zinc, or brass. By oxide coating, the impurities give a grey to black colour. Oxide coating is produced by either chemical or electrochemical action, and makes a superior foundation for protective paints. By immersing the electrolytically oxidized aluminium in a hot solution of dye, the colour is readily absorbed by the oxide. If alloys of aluminium are oxidized electrolytically, the alloying constituents have a decided colouring effect. In general, a wide variety of colour, texture, lustre, hardness, and protective qualities can be obtained.—S. G.

**The Burnishing and Colouring of Copper.** Anon. (*Cuivre et Laiton*, 1930, **3**, 212–214).—The larger the copper surface the more difficult is the burnishing operation to obtain the correct finish. The complete removal of all grease is the first essential. Various formulæ are given for making up solutions for colouring purposes.—W. A. C. N.

**Metal Cleaning.** E. G. Porst (*Amer. Enameler*, 1930, **3**, (6), 9; (7), 5; *Ceram. Abs.*, 1930, **9**, 921).—No one of the many cleaning solutions on the market can do all kinds of work. The type of cleaner to be used for each piece of work is determined by the kind of dirt to be removed. The process of metal cleaning can be divided into two steps: (1) wetting the dirt, and (2) suspending the dirt. Emulsification, or lowering of the interfacial tension, is an important part of the wetting process, and depends largely on the scrap compounds in the cleaner. After the wetting process, the actual dislodging of the dirt is accomplished in one or more of the following ways: (1) saponification, (2) dissolving, (3) dissolving chemically, (4) agitation, (5) colloidal action, and (6) heating. A brief description of each process is given.—S. G.

**Preparation of Surfaces for Chromium Plating.** Anon. (*Abrasive Ind.*, 1930, **11**, (6), 44–46; *Ceram. Abs.*, 1930, **9**, 604).—Describes briefly a few polishing operations performed at the plant of the Olds Motor Works, Lancing, Mich., in preparing the surfaces on bumpers and radiator wheels for polishing before plating.—S. G.

**Removing Metal Scale.** Anon. (*Ceram. Ind.*, 1930, **14**, 552; *Ceram. Abs.*, 1930, **9**, 510).—A firm in New England has perfected a method of removal of scale resulting from heat-treating and hardening operations on metals, not only from flat surfaces, but also from such intricate machine parts as gears, shafts, &c., as well as from cutting tools, such as drills, taps, dies, cutters, and reamers. The scale is removed without in any way injuring the surface structure of the steel or metal part. The process is an electrochemical one, the descaling action being brought about by the generation of hydrogen on the work, at the same time protecting the work from hydrogen embrittlement or pitting by coating the cleaned work by depositing a metal on it. The coating remains on the work, if it does not interfere with subsequent operations. It can easily be removed electrolytically if found to be undesirable. The process makes it possible to do away with the handwork formerly necessary, like filing, sand-blasting, scraping, and scratch-brushing, and thus greatly reduces the labour cost. Further study is being made of the adaptation of this process to the special fields in the metal industry. It is expected that it will have very wide application, and it is said to be so simple that only a small installation is required embracing a motor-generator for the current and tanks in which the treatment is given.—S. G.

**Precision Working of Metals.** Alf. Schroeder (*Maschinenbau*, 1932, **11**, 205–209).—The methods used in obtaining high finishes on metals are reviewed and an attempt is made to classify them.—v. G.

**Polishing Aluminium.** Anon. (*Machinery* (*Lond.*), 1931, **38**, 338).—Aluminium oxide abrasives, with the addition of oil or grease, should be used for rough polishing operations on aluminium. Tripoli, followed by lime, produces a high finish. Rouge should be avoided as tending to become embedded and impart a reddish tinge to the metal.—J. C. C.

**Polishing Aluminium.** E. D. (*Machinery* (*Lond.*), 1931, **38**, 743).—Cf. preceding abstract. A letter emphasizing the necessity for using sufficient lubricating medium and the correct wheel speed when polishing aluminium. Comparatively slow polishing speeds are generally advisable.—J. C. C.

**Polishing Aluminium Castings.** Anon. (*Abrasive Ind.*, 1930, **11**, (10), 45–48; *Ceram. Abs.*, 1930, **9**, 1003).—The mirror finish given to various parts adds to the attractive features of electric cleaners. The system is described. —S. G.

**Polishing Aluminium.** Andrew V. Re (*Abrasive Ind.*, 1931, **12**, (1) 42; *Ceram. Abs.*, 1931, **10**, 242).—Polishing of aluminium alloys is no more difficult than polishing brass, copper, &c. For aluminium castings Nos. 80, 120, and 150 abrasive, emery, or manufactured alumina is used. On colour buffing, a small wheel can be used. The use of good colouring rouge and a little paraffin now and then will keep the cloudy appearance from the aluminium and will give a good finish.—S. G.

**Polishing Pastes for Copper, Brass, and Bronze.** Anon. (*Cuivre et Laiton*, 1929, **2**, (20), 17–18).—The compositions of several polishing pastes for these materials is given. Instructions for their application are added.—W. A. C. N.

**Polishing Brass Castings of Awkward Shape.** W. E. W. (*Machinery* (*Lond.*), 1931, **39**, 239); also A. E. (*ibid.*, 1931, **39**, 379).—Workshop notes.—J. C. C.

**Heading Up Polishing Wheels.** Anon. (*Abrasive Ind.*, 1930, **11**, (10), 48; *Ceram. Abs.*, 1930, **9**, 1003).—A polishing wheel headed up properly will last for an indefinite period if it is set up with glue and abrasive as soon as it becomes too dull to cut properly. If a poor quality of glue is used, the head may crack. Undue moisture will loosen the glue. In removing heads from polishing wheels, machines designed for trueing wheels should be used to ensure a true running wheel. With the wheel face running true, a sizing coat of glue somewhat thinner than the glue used for setting up wheels should be applied; after this coat is thoroughly dry, a light cut over the face is taken. The wheel is headed up by coating with the glue and rolling in abrasive; usually 3 to 4 coats are applied. This forms the so-called wheel head.—S. G.

**Finishing [Aluminium Alloy] Pistons.** Anon. (*Abrasive Ind.*, 1930, **11**, (3), 31–32; *Ceram. Abs.*, 1930, **9**, 323).—Illustrates and describes some grinding operations performed at Aluminum Industries, Inc., Cincinnati, O.—among the heaviest producers of aluminium alloy pistons in the U.S.—S. G.

**Grinding Chromium Plate.** Anon. (*Abrasive Ind.*, 1930, **11**, (8), 40–41; *Ceram. Abs.*, 1930, **9**, 808).—Grinding of chromium-plated gauges leaves minute wheel marks which soon wear away, making the gauge undersize. Lapping after grinding, or lapping only, is required.—S. G.

**Uneven Heating Causes Grinding Wheel Breakages.** Revere Chapell (*Abrasive Ind.*, 1930, **11**, (3), 24–25; *Ceram. Abs.*, 1930, **9**, 323).—If the temperature of the wheel remains constant and uniform throughout its entire structure, it should not break. Heat is generated in the grinding operation to such an extent that actual fusing of the metal chips takes place. If no cooling solution is used, some of this heat is transmitted to the wheel face; when a cooling solution is used, as in precision grinding, little heat is transmitted to the wheel from the chip; in dry grinding it is also negligible unless the sparking is uninterrupted. The most important source of heat to be considered in either wet- or dry-grinding operations is pressure of the wheel against the work and the friction heat generated by the non-cutting resistance of dull surface grain on the working face of the wheel. Two grinding operations are cited to illustrate these two different sources of heat.—S. G.

**Grinding Lubricant, Cooling Solution, Grinding Compound.** Robert J. Spence (*Abrasive Ind.*, 1930, **11**, (4), 32–33; *Ceram. Abs.*, 1930, **9**, 400).—The solution is spoken of in different terms, *i.e.* "grinding lubricant," "cooling solution" or "coolant," and "grinding compound." Neither "grinding lubricant" nor "cooling solution" gives the idea of the purpose of the solution. As a lubricant, the grinding liquid plays a very small part. Sufficient evidence was, however, obtained from tests to emphasize the fact that any grinding solution, to be properly effective, should act in some degree at least as a lubricant. The idea is universal that a grinding solution is a "cooling solution" and is used for the purpose of cooling the work; this idea is erroneous. The solution is to keep the work at a uniform temperature throughout its whole length. A grinding solution is a convenient conveyer of excess heat.—S. G.

## XV.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 506–510.)

**Organization of the Bronze and Cast-Iron Foundry of the Compagnie du Chemin de Fer du Nord (France).** —— Castelain (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 255–470).—[In French.] A very interesting description of the organization of the foundry, management, and design, &c.—G. G.

**On the Theory of the Rate of Cooling in the Pouring of Non-Ferrous Metals and Alloys.** P. A. Sarytchev (*Zvetnye Metally* (*The Non-Ferrous Metals*), 1931, **6**, (12), 1664–1671).—[In Russian.] A criticism of a report dated Feb. 5, 1929, of the testing station of the Siemens–Schuckert works. The process of casting in moulds of the Erichsen type is examined, with the conclusion that German technique of cooling is only in the experimental stage. Doubt is also cast on the views expressed in the report on the phenomenon of liquation.—M. Z.

**Casting of Aluminium Rolling Billets.** Società Italiana dell' Alluminio (*Internat. Foundry Congress, Milan, Memoirs*, **1931**, 341–351).—[In Italian.] The advantages of electric furnaces, especially as regards gas absorption, are illustrated. Methods for degassing the molten metal, casting temperatures, and mould temperatures to prevent liquation and to obtain bars with a fine homogeneous structure are given. The importance of small additions of titanium is stressed. The best results are obtained with a casting temperature of 730° C. (700° C. at the end of the casting), and a casting rate of 8–10 kg. per minute. Ingots should have a volume : surface ratio of 1·4–1·6, and a thickness exceeding 50–60 mm.; plates should be not less than 70 mm. thick. The article is illustrated.—G. G.

**Defects and Resistance of Castings in Aluminium, Related to Casting Temperature, System of Cooling, and Presence of Gases.** M. Barbero (*Internat. Foundry Congress, Milan, Mem.*, **1931**, 259).—See *J.*, this vol., p. 195.—G. G.

**The Deoxidation of Copper with the Metallic Deoxidizers Calcium, Zinc, Beryllium, Barium, Strontium, and Lithium.** Earle E. Schumacher and W. C. Ellis (*Electrochem. Soc. Preprint*, **1932**, April, 249–257; and (abstract) *Met. Ind.* (*Lond.*), 1932, **40**, 517–520).—In order that true alloys be not produced by the union of an excess of deoxidant with the copper, thus reducing the conductivity of the latter, it is necessary to know the oxygen content of the copper within close limits. Curves show, in terms of equivalent oxygen, the effect of calcium, zinc, and beryllium. It is shown that residual calcium has less effect on copper conductivity than the other metals. Barium and strontium are satisfactory deoxidizers, and are only slightly soluble in copper, but their high cost prevents their general adoption in this connection. Lithium is probably too active in reacting with oxygen; it reduces other refractory oxides and the metals contaminate the copper.—W. A. C. N.

**Preparation of Sand-Cast Copper of the Highest Conductivity Deoxidized with Beryllium.** Anon. (*Z. ges. Giesserei-Praxis* : *Das Metall*, 1932, **53**, 226).—By deoxidation with beryllium, copper of 52–54 reciprocal ohms conductivity can easily be obtained. The purest electrolytic copper is melted in crucibles under borax in an oil-fired furnace, the temperature being raised to 1150° C. Deoxidation is effected with 10% beryllium–copper alloy (= 0·011–0·012% beryllium). The best pouring temperature is 1100° C., the alloy being sand-cast.—J. H. W.

**Ancient Bell Founding.** Anon. (*Cuivre et Laiton*, 1930, **3**, 159–161).—A general, illustrated, description of the preparation of the moulds, melting, and casting of the metal.—W. A. C. N.

**Metallurgical Notes on the Handling of Anti-Friction White Metals.** Anon. (*Met. Ind.* (*Lond.*), 1932, **40**, 587–588, 611–612).—Notes are given on the compounding and melting of tin- and lead-base anti-friction white metals containing copper 0–8·3, tin 0–91, antimony 4·5–15, and lead 0–90%, and the following properties are tabulated for 12 such alloys: composition, sp. gr., yield-point, Johnson's apparent elastic limit, ultimate strength, Brinell hardness, temperature of complete liquation, and the proper pouring temperature. Notes are given on the Babbitting of bearing shells, precautions to be taken in tinning, composition, and application of flux, pouring white-metal linings, general precautions necessary, and causes of bearing failures.—J. H. W.

**Babbitting Large Bearings.** James Silberstein (*Machinery* (*N.Y.*), 1930, **36**, 470–471).—Filling the mould from the bottom is recommended as a means of obviating blow-holes and air pockets.—H. F. G.

**Cleaning Bearing Shells Preparatory to Re-Lining.** W. E. Warner (*Machinery* (*N.Y.*), 1930, **36**, 472).—Cleaning with a thin paste of pumice powder and turpentine is advocated. If the shell is then etched with a solution of copper sulphate, the lining metal will adhere more readily; this treatment may advantageously be applied both before and after tinning the shell.—H. F. G.

**The Refining of Nickel.** A. N. Kuznetzov and S. A. Baranov (*Metallurgist* (Suppt. to *Engineer*), 1932, **8**, 69–71).—A summary of a paper in *Sobshenia Vsesouznogo Instituta Metallov*, **1931**, (7), 93–104. See *J.*, this volume, p. 266.
—R. G.

**Permanent Moulds for Zinc-Alloy Castings.** Edward Heller (*Machinery* (*N.Y.*), 1931, **37**, 829–831, 945; and *Machinery* (*Lond.*), 1931, **38**, 825–826).—An illustrated description of two permanent moulds for small zinc-alloy castings.—J. C. C.

**The Composition of Kettles for the Melting of Zinc.** Anon. (*Giesserei u. Masch. Zeit.*, 1932, **5**, (1), 8).—Cast steel or semi-steel kettles are recommended instead of those usually of cast iron. The higher price of the former is balanced by their longer life, and also by the fact that thinner-walled vessels may be employed. Alloy steels are being tried in America for a similar purpose.—W. A. C. N.

**Casting Zinc Rods.** Anon. (*Machinery* (*Lond.*), 1931, **38**, 635–636).—Advice is given, from two sources, on the method of casting zinc Leclanché rods, tapered from each end, and attached to the connecting wires. A gravity-fed die is illustrated and the use of zinc alloys discussed by one writer. The other recommends pressure feed to graphited cast-iron moulds and the use of electrolytic zinc. The wires should be tinned and the zinc closed under a press to ensure good contact, but even then the joint will probably not resist corrosion (see also following abstract).—J. C. C.

**Casting Zinc Rods.** L. C. S. (*Machinery* (*Lond.*), 1931, **39**, 5).—See also preceding abstract. The construction of a 2-impression permanent mould for casting Leclanché cell rods is described and illustrated.—J. C. C.

**Report of Committee B-6 [of A.S.T.M.] on Die-Cast Metals and Alloys.** H. A. Anderson and P. V. Faragher (*Amer. Soc. Test. Met. Preprint*, **1932**, 1–21).—The use of high-grade slab zinc (guaranteed purity, 99·99%) is essential for the production of high-quality zinc-base die-castings. Certain recent alloys appear to have slightly greater stability of size and physical properties in the presence of heat and moisture, although having lower initial tensile strength, than previous alloys. These alloys range about: aluminium 4; copper 3; magnesium 0·1%; zinc (99·99%) remainder, with slight variations of the copper and magnesium. Tables have been prepared, and are published as an Appendix to the report, showing the properties of the Committee's test-specimens after 1 year's exposure at different stations. The various finishes which can be applied to die-castings for protective purposes are discussed. The influence—often detrimental—of the heat-treatment necessary to procure some of these finishes, is emphasized.—W. A. C. N.

## XVI.—FURNACES AND FUELS

(Continued from pp. 510–513.)

**The Technical Heat Consumption of a Furnace.** G. Neumann (*Arch. Eisenhüttenwesen*, 1932, 5, 471–475).—A scheme is given and discussed for the calculation of the heat balance of technical annealing furnaces.—J. W.

**Heat Balances of Industrial Furnaces and their Practical Application.** W. A. Moorshead (*Fuel Econ. Rev.*, 1932, 11, 38–46).—The deduction of a heat balance of a gas- or oil-fired regenerative furnace from a few simple measurements is explained, and factors affecting efficiency and working of the plant are briefly discussed.—J. S. G. T.

**The Helberger Universal Melting Furnace.** Anon. (*Helios* (*Export-Zeit.*), [A], 1932, 38, 341–343).—A description of a new modified type of this furnace suitable for vacuum melting and some suggested applications.—v. G.

**Semi-Rotary Furnace for Melting Gun-Metal.** Anon. (*Machinery* (*Lond.*), 1931, 38, 543–544).—A brief description of a 350-lb. semi-rotary furnace built for oil or coal-gas firing by Sir W. G. Armstrong, Whitworth and Co., Ltd. Details of melting tests carried out with both fuels on various alloys are tabulated.—J. C. C.

**An Important Advance in a Brass Foundry.** Anon. (*Cuivre et Laiton*, 1929, 2, 7).—An account is given of the use of a container made of a special alloy which resists the action of fused brass. The number of heats from each receptacle before it need be scrapped is 12 to 15 times the number obtained from an ordinary crucible. The temperature within the vessel is regulated automatically.—W. A. C. N.

**Investigation and Calculation of Gas Burners.** P. Rheinländer (*Arch. Eisenhüttenwesen*, 1932, 5, 407–411).—Diagrams have been constructed showing the relations between gas and air as a function of the pressure in the burner head in technical gas-fired furnaces. The fall in pressure between burner head and furnace with the air pipe fully open must be a definite multiple of that with the air pipe closed if the theoretical quantity of air for complete combustion is to be drawn in. These relations are given for different gases and different types of burner.—J. W.

**A New Gas Furnace.** Anon. (*Cuivre et Laiton*, 1930, 3, 83–86).—The advantages claimed are: (1) economic melting—2·5 ft.$^3$ of gas per lb. of metal; (2) lower cost; (3) reduction of loss; (4) increased production with better quality of castings; (5) suppression of certain gas evolutions. The crucible of the furnace is not made of refractory material, but of a metallic alloy, and it lasts for considerably more heats. The crucible is surrounded by a jacket which is mounted on trunnions and within which the gas burns, giving a uniform heat. By regulating the air supply the atmosphere above the melt may be rendered oxidizing, reducing, or neutral. The temperature may be regulated automatically. A description of a foundry in which these furnaces are used, and of the general lay-out follows.—W. A. C. N.

**Gas-Fired Furnace.** Anon. (*Chem. and Met. Eng.*, 1932, 39, 347).—Operation on artificial or natural gas or compressed propane is possible with a new high-temperature furnace developed for the determination of pyrometric cone equivalents and the testing of refractories. The furnace is supplied with 4 tangential burners, to which the air–gas mixture is supplied by an electric motor-driven blower, mounted directly beneath the furnace, the speed of the blower being controlled by a rheostat.—F. J.

**Gas-Fired Unit Bright-Anneals Copper Wire in Atmosphere of Steam.** J. B. Nealey (*Gas World* (*Indust. Gas Suppt.*), 1932, 4, (7), 11–13).—A gas-fired furnace for bright-annealing copper wire in an atmosphere of superheated steam moving through the annealing chamber at very high velocity is described.

The wire can be made from 25% to 40% softer than code requirements relating to ductility.—J. S. G. T.

**Furnaces for the Heat-Treatment of Wire.** R. Whitfield (*Fuel Econ. Rev.*, 1932, **11**, 140–143).—Gas- and oil-fired furnaces for heat-treating wire are briefly described and illustrated.—J. S. G. T.

**The Applications of the Rocking Indirect Arc Electric Furnace.** A. E. Rhoads and Carl H. Morken (*Electrochem. Soc. Preprint*, **1932**, April, 295–324).—The furnace is of the indirect arc type having 2 horizontal electrodes and is equipped with automatic mechanical rocking. In it can be melted ordinary ingot and heavy scrap charges, and, in particular, borings, turnings, and similar fine material. The rocking action promotes rapid melting. Other notable features brought out in practice are the low metal losses, accuracy of temperature control, homogeneity of the melt, control of atmosphere, and high thermal efficiency. For copper and high copper alloys the power consumption is about 325 kw.-hr. per ton; for brass with 85% copper, 300 kw.-hr. per ton; for brass with 75% copper, 250 kw.-hr. per ton. The melting speed for these alloys is roughly 1 ton per hr. Nickel, aluminium, and lead alloys have been made successfully in these furnaces. Results from working tests have been tabulated. Among special applications which are discussed is the smelting of glass at temperatures up to 1600° C. The power consumption is approximately 600 kw.-hr. per ton. In certain instances special ports for the introduction of air or other gases are inserted in the end walls in order to change the atmosphere when necessary. The production of strontium oxide of better quality from strontium carbonate, with greater efficiency, has also been undertaken in these furnaces. Cobalt ores have been reduced giving a product of high purity.—W. A. C. N.

**Melting Fine Silver in High-Frequency Induction Furnace.** Daniel L. Ogden (*Electrochem. Soc. Preprint*, **1932**, April, 221–223; also (abstracts) *Met. Ind.* (*Lond.*), 1932, **40**, 474, and *Brass World*, 1932, **28**, 141).—An Ajax–Northrup high-frequency induction furnace has replaced an oil-fired tilting furnace for melting down fine silver crystals from the Thum parting cells. The tilting furnace had 70,000 oz. capacity and needed a 13-hr. cycle. Considerable silver was lost by volatilization. In the electrical installation a 100-kw. furnace having a metal capacity of 13,800 oz. of silver is used. The cathode silver is put in damp. The cycle occupies less than 2 hrs. A direct monetary saving in melting of some 3*d*. per 1000 ozs. has been effected. Losses are considerably smaller.—W. A. C. N.

**Stopping and Re-Starting of an Ajax-Wyatt Furnace.** Koltchugin Works Report (*Opyt Predpriatie* (*Experience of Undertakings*), **1931**, (5), 39).—[In Russian.] An account of the technique of stopping an Ajax-Wyatt furnace and re-starting it after standing for a greater or less period.—M. Z.

**Seamless Refractory Shells for Ajax Furnaces.** Koltchugin Works Report (*Opyt Predpriatie* (*Experience of Undertakings*), **1931**, (11), 39–41).—[In Russian.] The method of constructing seamless shells of refractory material suitable for Ajax induction furnaces, is briefly described. Such shells are stated to be much more reliable and longer-lived than those constructed by the usual method of joining 2 halves together, the resulting seam being always a source of weakness.—M. Z.

**Electric Annealing and Hardening Apparatus.** Victor Paschkis (*Z.V.d.I.*, 1932, **76**, 359–363).—A description of modern resistance furnaces.—v. G.

**Electric Annealing Furnace for Aluminium.** Anon. (*Machinery* (*Lond.*), 1931, **38**, 278).—An illustrated description of a 150-kw. electric resistance furnace having a hearth 24 ft. long by 7 ft. 5 in. wide for annealing aluminium sheet. Also described in *Metallurgia*, 1931, **3**, 172. See this *J.*, 1931, **47**, 243.
—J. C. C.

## XVII.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 513–518.)

**Properties of Refractories in Metallurgy.** Anon. (*Corriere ceram.*, 1930, **11**, 315–332; *Ceram. Abs.*, 1930, **9**, 1054).—The chemical compositions of raw materials used for refractories, and a list of the maximum temperatures at which the different refractory products can be used are given. Clay bricks become plastic at high temperatures and pressures and resist crushing up to a temperature of 1200° C.; after 1300° C. they yield to pressure, and are improved above that point by the effect of increased firing temperature and duration of firing. Silica bricks break directly under pressure without undergoing any previous deformation; at 1700° C. they resist a pressure of 20 kg./cm.$^2$. Magnesia, chromium, and silicon carbide blocks resist high temperatures and pressures. Tests for refractory products include: (1) chemical and micrographic analyses, (2) mechanical resistance while cold, (3) porosity, (4) permeability, (5) texture, (6) density, (7) conductivity, and (8) expansion. Tests on the fusibility, scorification, mechanical resistance when cold, scaling, and abrasiveness should be made in order that the consumer may be informed under what conditions the use of a given material is suitable. Methods for these tests are outlined. Causes of the destruction of refractories are also given.—S. G.

**Manufacture and Properties of Carbidic and Nitridic Crucibles.** O. Meier (*Ber. deut. keram. Ges.*, 1930, **11**, 333; *Ceram. Abs.*, 1931, **10**, 355).—M. tried to find a new material suitable for melts at high temperatures of metals as well as all oxides. The carbides tested were $Cr_3C_2$, $Mo_2C$, $W_2C$, WC, and SiC. The carbide crucibles were bonded with glucose. M. gives special data on the manufacture of the crucibles, sintering temperature, &c. Not all of the carbidic crucibles withstood the influence of pure metals; all of them, however, withstood the melting influence of the so-called oxides. Copper was the only metal that did not attack the crucibles. A mixture of chromium tungsten–carbide was also tried, but with no better results. Silicon carbide was less resistant to the influence of the oxides. Of the nitride crucibles, those of titanium nitride were the best. None of the metals attacked these crucibles, but all the oxides were harmful. It has not been possible to develop a crucible material suitable for metals as well as for oxides. Titanium nitride is a new material which is resistant to pure metals as well as to such metals containing carbon, and which is superior to the ordinary mixture.—S. G.

**Advancement of Refractory Oxides.** E. Ryschkewitsch (*Ber. deut. keram. Ges.*, 1930, **11**, 619; *Ceram. Abs.*, 1931, **10**, 432).—Technical progress made in the manufacture of laboratory crucibles, &c., of alumina, zircon, &c., is reported. Pure alumina may be moulded by different methods and will become dense above 1900° C., resembling porcelain; when fired to about 2000° C. the body appears as though covered with a glaze. Receptacles of alumina may be used up to 1900° C. The melting point of pure BeO is about 2500° C. This oxide also may be moulded, and will develop a porcelain-like body. It is possible to use crucibles of beryllium oxide up to 2200° C. Magnesia oxide melts at 2800° C. and it is necessary to fire above 2000° C. to get dense bodies; the limit for magnesia is 2400° C. Zircon oxide melts at about 2700° C. A body of zircon oxide will have remarkable porosity, but it is possible to get a dense body at 2000° C. Thorium oxide has the highest melting point, which is about 3000° C. Even at 2000° C. a body of thorium oxide will have distinct porosity. This material is valuable because of its high resistance to the attack of basic oxides. It would scarcely be attacked by molten alkalis even at 1000° C.—S. G.

**Electric Furnace Lining.** Dorsey A. Lyon and Edwin R. Cox (*Queensland Govt. Min. J.*, 1929, **30**, 422; *Ceram. Abs.*, 1930, **9**, 539).—L. and C. remark in a patent specification that it is well known that no refractory lining has yet been devised for an electric furnace which does not become a fairly good conductor of electricity at the temperature of the electric crucible, and that the heat-resisting properties of the usual refractory lining, such as fire-brick, have about reached their limit in a blast furnace; wherefore, if to the heat which the walls receive by direct radiation and conduction from the melting zone, there be added heat generated by stray electric currents passing through the walls of the crucible, the life of the lining is very short, the refractory material being rapidly melted down and passing away into the slag.—S. G.

**Refractory Mortars.** O. Philipp (*Chem. Fabrik*, **1930**, 86–88; *Ceram. Abs.*, 1930, **9**, 536).—A mortar for refractory brickwork must have sufficient adhesion when first applied and also must have, after firing, a porosity no more than that of the brickwork, so that slags are not formed. The first requirement is satisfied by the use of fire-clay, or, if refractory oxides are used instead, by the addition of a binder such as sodium silicate, dextrin, &c. The second requirement demands that the working temperature shall be above the sintering temperature of the mortar, but below the softening point. In many cases it is necessary to lower the sintering temperature by addition of salt, sodium silicate, asbestos, &c. Refractory mortars for very high temperatures are usually composed largely of the material of the brickwork finely ground and mixed with a cement such as bentonite. Another cement addition is a mixture of starch, powdered glass, and crushed quartz.—S. G.

**Advances in Refractory Field in England during 1931.** W. Steger (*Feuerfest*, 1932, **8**, 65–69).—A review.—v. G.

**Trade Names in Refractories and Furnace Construction.** Anon. (*Feuerfest*, 1932, **8**, 104–106).—A continuation of the earlier indexes of trade names applied to German and non-German refractory materials (see this *J.*, 1930, **43**, 700; and this volume, p. 273).—v. G.

**Refractories.—II.** R. M. Doidge (*Blast Fur. and Steel Plant*, 1930, **18**, 345–350; *Ceram. Abs.*, 1930, **9**, 355).—Cf. *J.*, this volume, p. 516. Resistance to erosion depends chiefly on texture, chemical composition, manner in which the ingredients are blended, on firing, and other similar factors. In general, dense, close, fine-textured, hard-fired bricks are more resistant than those that are more open in texture, but unfortunately such bricks are more liable to spalling and cracking troubles. As to chemical composition, the tendency to-day is, as the service demanded from refractories becomes more severe, to use more and more highly aluminous materials. It is a matter of experience that, other things being equal, siliceous bricks are eroded more rapidly by slags at high temperatures than those higher in alumina. There are few deposits of high alumina clays in Great Britain; the china clays are among the purest and most refractory, but costly, with maximum alumina content (fired) of about 44%. A few Scottish fire-clays approach this figure, and the enviable reputation of the Scottish refractories is due to these. The Ayrshire bauxite clay has no plasticity, and hence is not a clay or a bauxite, but is the most refractory material in these islands. Its manufacture into ware presents difficulties; it has to be carefully selected, since the composition varies from place to place, it is non-plastic, and its firing temperatures have to be high. These difficulties are being overcome, however, and bricks with this material as a base and containing up to 60% and even 70% of alumina are now on the market, and are being tested extensively with encouraging results.—S. G.

**Heat Insulation and Refractories for High-Temperature Work.** (Sir) Robert Hadfield and R. J. Sarjant (*Fuel Econ. Rev.*, 1932, **11**, 119–126).—Progress in research relating to the insulation and refractory character of furnace walls is briefly reviewed. Reference charts for the determination of heat flow through a composite wall of firebrick and diatomaceous insulating brick are given. Walls of different thicknesses in typical industrial installations are compared; fluctuating flow of heat in the furnace wall is discussed in some detail, and the possibility of reducing heat storage losses is treated.—J. S. G. T.

**A New Source of Raw Materials for High-Temperature Heat Insulation.** J. Bryte Barnitt and R. H. Heilman (*Proc. Eng. Soc. Western Pennsylvania*, 1931, **7**, 349–371).—Certain naturally occurring heat-insulators are first discussed. Their value consists in their cellular structure, and by proper treatment bauxite, alumina, and certain residues and hydrated products can be given such a structure. Investigations of the insulating values of these materials are described. Monohydrated bauxite and aluminium monohydrate gave most satisfactory results, and are very light, whilst water-floated bauxite residue, although its density constitutes a commercial disadvantage, showed good insulating properties. Ease of moulding and fabrication is considered, and in the discussion further questions as to shape, size, strength, shrinkage, and temperature-range are raised.—P. M. C. R.

**Sillimanite, Cyanite, Andalusite, and Dumortierite.** Alice V. Petar (*U.S. Bur. Mines Information Circ.* No. **6255**, 1930, 1–19; *Ceram. Abs.*, 1930, **9**, 535).—The minerals andalusite, cyanite, and sillimanite differ in physical properties, but have the same chemical composition. They are silicates of alumina having the formula $Al_2O_3 \cdot SiO_2$. Another mineral closely related to this group is dumortierite. The report gives a brief description of the minerals and their properties, together with the history, uses, mining, preparation, and occurrence. In the U.S., the commercial production of these minerals commenced in 1920, but practically no statistics are available. These minerals are mined in California, Nevada, Virginia, and North Carolina, in the U.S.A., and mainly in British India abroad. A list of possible producers and buyers is attached and a fairly complete bibliography is included.—S. G.

**Some Properties of Silica Brick.** L. Longchambon (*Rev. Mat. Constr. Trav. Publ.* No. **244**, 1930, 5–8B; *Ceram. Abs.*, 1930, **9**, 535).—L. discusses the raw materials, the quartz inversion, influence of alkalis, influence of alumina, thermal expansion, and refractoriness of siliceous products. Very pure quartz (99·9% $SiO_2$) was ground and then pressed into samples after the addition of $Na_2CO_3$. The samples were fired for 2 hrs. at 1250° C. and the densities were determined. The densities for from 0·1 to 0·7% $Na_2O$ were, respectively, 2·55, 2·41, 2·37, 2·34, 2·32, 2·30, and 2·30. The decrease in density shows the transformation of quartz to tridymite and cristobalite. The same experiment was performed with 0·5% $Na_2O$ and 0·5, 1·2, and 3% $Al_2O_3$. The densities were, respectively, 2·50, 2·55, 2·57, and 2·30. It is evident that $Al_2O_3$ diminishes the speed of inversion of quartz and opposes the action of the alkalis. The thermal expansion of a sample of silica brick is always less than that which is calculated from the mineralogical composition. If the sample is pulverized, however, and again pressed into a specimen, the expansion is increased and agrees more closely with the calculated one. This has been determined by many repetitions of the experiment. L. states that each crystal of $SiO_2$ in a silica brick is covered with a silico-calcareous cement, and that the softening of such a brick at high temperatures is due to the fusion of the cement.—S. G.

**Simple Process for Testing Refractories.** C. P. Fernandez (*Quim. e Ind.*, 1930, **7**, 91–92; *Ceram. Abs.*, 1931, **10**, 38).—A simple method for making a thermal test of refractory products (silico-alumina materials) which gives results sufficiently satisfactory for comparing different classes of refractories is given. The materials necessary are an oxy-acetylene blowpipe, a small quantity of quicklime and refractory clay or mortar, and a crucible of graphite or extra-alumina, No. 14 or 16 approximately. After making the thermal test, it is advisable to make a chemical analysis in order to determine the coeff. of Bischoff, which is very useful in the study of refractory products :

$$Q = \frac{Al_2O_3 + SiO_2}{Fe_2O_3 + CaO + MgO + Na_2O + K_2O.}$$

All tests are described.—S. G.

**Chemical Analysis of Refractory Materials.** W. König (*Tonind.-Zeit.*, 1930, **53**, 995–996, 1041–1042, 1055–1057 ; *Ceram. Abs.*, 1930, **9**, 941).—Two series of experiments were undertaken to find out the most satisfactory method of analyzing refractory materials. The methods are described and results tabulated.—S. G.

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## XX.—BOOK REVIEWS

(Continued from p. 528.)

[All books reviewed are contained in the Library of the Institute.]

**Lehrbuch der Metallkunde. Chemie und Physik der Metalle und ihrer Legierungen.** Von Gustav Tammann. Vierte erweiterte Auflage. Med. 8vo. Pp. xv + 536, with 385 illustrations. 1932. Leipzig: Leopold Voss. (RM. 48; geb. RM. 49.50.)

The name "Metallographie" has been dropped from the fourth edition of this well-known work, in favour of the more comprehensive term "Metallkunde," for which we have no convenient English equivalent. Whilst similar in scope and aim to the earlier editions, the present work contains far more matter, and a more extended bibliography. It retains, however, the same essential character, being in the main a record of the study of metals and alloys, and of problems of crystallization bearing on them, carried out in the laboratory of the author at Gottingen by himself and his students. There are few aspects of the physico-chemical study of metals that have not been touched in the course of these researches, and the book is intensely interesting as an individual record of a science studied from a single point of view, that of the author, who occupies an outstanding position in this field. It should be read by every research worker in metallography, who will find in it a unity of plan which renders it remarkably interesting to anyone who can appreciate the point of view from which it is written. Moreover, it is extraordinarily suggestive in respect of matters calling for further study. On the other hand, it is less satisfactory if regarded as a text-book for students. The survey of the subject is far from complete, and the work of foreign investigators is often completely ignored. An overwhelming proportion of the papers cited is from German sources, Japan probably coming next, whilst English workers receive scant attention. Thus the preparation and deformation of single crystals of metals are discussed without mention of Carpenter, Edwards, Elam, or Taylor; the work of Beilby is ignored; crystal boundaries are discussed, but the name of Rosenhain does not appear in connection with them, and many other examples could be mentioned. Hence the book should be read in conjunction with, and not as a substitute for, other works on metallography. Attention may be directed to the summary of the author's views on the "resistance limits" of solid solutions and their bearing on the general theory of the solid state. These views have been criticized by many other workers, but they have never been fully set forth in this country, and they deserve attention, although some of the conclusions are based on analyses which do not reach the standard of accuracy demanded in industrial metallurgy. Throughout, in fact, the treatise differs from other German works on *Metallkunde* in concerning itself solely with laboratory experiments, without reference to technical processes. It is a little surprising to find no reference to the theory of Kossel and Stranski of the growth of crystals, or to the views of Smekal on mosaic structure, but this is no doubt also connected with the point of view adopted, which is little concerned with atomic conceptions, except in regard to the structure of solid solutions.

Professor Tammann has now retired from teaching, but continues his research work at Göttingen, and so aids greatly in maintaining the activity of the school of metallographic research which he founded, and which has had so wide an influence on the development of the science. This admirably printed and illustrated volume is essentially a record of that school, and as such will be welcomed.—C. H. DESCH.

**Protective Films on Metals.** By Ernest S. Hedges. Being Volume Five of a Series of Monographs on Applied Chemistry under the Editorship of E. Howard Tripp. Demy 8vo. Pp. xi + 276, with 23 illustrations in the text. 1932. London: Chapman and Hall, Ltd. (15*s.* net.)

This book appears at an opportune time in view of the interest now taken in corrosion matters and the acknowledged importance of surface films both in determining the course of corrosion and in affording protection to the metal. It is particularly welcome as coming from the pen of Dr. Hedges, whose reputation for skilful and lucid presentation it well maintains.

Following an introductory chapter in which the field is surveyed as a whole, there is a chapter on "The Mechanism of Corrosion"; this gives a concise yet pleasantly didactic account of modern corrosion theory. Prominence is naturally given to the "differential aeration" principle, now so widely accepted, but recent work that is tending to modify this principle in several important ways also receives recognition. It is, indeed, patent that Dr. Hedges has set out to give a scrupulously fair statement of the position; and, as he truly says, "the results of further researches along both of these lines will be awaited with great interest." Incidentally, the distinction between atmospheric and submerged corrosion is probably more fundamental than one would gather from the author's remarks; for even when electrolytic reactions are common to each, as most frequently obtains, the controlling factors are usually entirely different. A welcome feature of this and of another chapter is a discussion of the periodic dissolution of metals, a subject that Dr. Hedges has made so very much his own.

The third chapter deals with the protective effects of very thin films of oxide. The author appears to doubt whether such films can have a crystalline structure; the recent work of Darbyshire, however, employing electron diffraction methods, has shown definitely that the film on copper has the lattice of cuprous oxide. On page 72 a diagram is reproduced showing by means of an idealized vertical section the oxidized surface of a metal; there is a real danger that this diagram (for which in the original paper nothing more than a schematic representation appears to be claimed) may be taken too literally by the average reader. The next two chapters are concerned respectively with protective films formed during atmospheric corrosion and in liquid media respectively; these topics fall very definitely within the immediate purview of the work and call for little further comment. Passivity is dealt with at length; anodic films are interestingly discussed in a separate chapter.

The remainder of the book comprises one short chapter on "Practical Applications of Oxide and Similar Films," five chapters on various metallic coatings, and an appendix on "Paints, Lacquers, Enamels, &c." It is in this latter part that a certain lack of balance may be noted, for much more might have been said about the useful properties of "natural films," whilst the discussion of artificial coatings might well have been curtailed without detriment to the author's main thesis. Conspicuous among untapped sources of information are the reports to the Corrosion Committee of the Institute of Metals by Bengough and his collaborators. Thus, no reference appears to the protection of condenser tubes by surface films, to the use of aluminium-brasses, or to May's "film potential method" of following the development and self-healing of films. Nevertheless, it would seem to be a little ungracious to dwell on such sins of omission in view of the excellent and generous manner in which Dr. Hedges has handled those parts of the subject he has selected for extended treatment. The book can be heartily recommended as a readable and enlightening survey of current research; it should especially be in the hands of all those who wish to follow the further developments that may confidently be expected. It remains to add that the printing is excellent, typographical errors appear to be absent, and there are complete author and subject indexes.—W. H. J. VERNON.

### **Tin Solders: A Modern Study of the Properties of Tin Solders and Soldered Joints.** By S. J. Nightingale. With an Introduction by R. S. Hutton. Crown 8vo. Pp. x + 89, with 44 illustrations. 1932. London: The British Non-Ferrous Metals Research Association, Regnart Buildings, Euston St., N.W. 1. (5*s*. net.)

This little book is in the main a record of an experimental investigation carried out by the British Non-Ferrous Metals Research Association, and is largely modelled on the well-known report published in 1920 entitled "Soft Solders and Soldered Joints."

Two introductory chapters aim at presenting a rapid review of the principles of metallography—with special reference to the solder alloys—and the last ten pages deal with the choice of a solder for a specific purpose from among the British Standard grades, but the greater part of the book is devoted to setting out the results of a well-planned series of tests devised to determine on the one hand the properties of the solder alloys and on the other the strength of joints made from these alloys under various conditions. The outstanding feature of this investigation is its demonstration of how antimony may, within defined limits, replace twice its weight of tin without appreciable effect on the melting range or mechanical strength of the solders. For the tests on joints, a plug and ring type of construction was devised, and experiments were carried out to determine how the shear strength was influenced by (*a*) the amount of solder melted, (*b*) the time of contact of the molten solder, (*c*) the joint thickness, (*d*) the soldering temperature, (*e*) the solder composition. The significance of alloying is discussed, and it is suggested that in the strongest joints alloying is at a minimum, but wetting is complete.

The later sections of the book are presented under the general heading of "Some Practical Considerations," and give an account of experiments on the use of a low-melting flux consisting of the eutectic mixture of zinc and ammonium chlorides, and a discussion on wiped joints. The choice of this heading is only one of several indications that the book is intended to be regarded as rather more than a simply worded account of a laboratory investigation. It would, however, be a great disservice to claim for it more than this. Actually no attempt is made—and, with our limited knowledge, rightly so—to translate the experimental results into definite rules for practical guidance. On the other hand, there is no attempt to discuss even elementary questions of manipulation, to enumerate and classify the various classes of joints, or to review existing types of equipment such as irons, blowpipes, and pots. It is by no means a complete text-book on the subject. It is written in a somewhat "popular" style, with a free use of analogy. The manner may not be to everybody's taste, and it is open to question how far it adds to clarity or helps in keeping the reader's attention. There is a bibliography, but no index. It is, however, a most valuable contribution towards the study of solders and soldered joints, and will be indispensable to all those interested in the joining of metals.

—J. C. CHASTON.

### **Foundry Work and Metallurgy. A Practical and Authoritative Guide for Moulders, Patternmakers, and Apprentices.** Edited by R. T. Rolfe. Cr. 8vo. Parts 13–23. 1931. London, Bath, Melbourne, Toronto, and New York: Sir Isaac Pitman & Sons, Ltd. (1*s*. per part.)

See also *J*., this volume, p. 141. In this series, which complete the serial parts of this work, the cupola furnace is first dealt with very fully—its design, the reactions of the charge, the operation, air distribution, the control of working, and costs. Next is given a description of various types of reverberatory furnace—stationary and rotating. Melting of non-ferrous metals in furnaces heated by all types of fuel are fully treated, and there is a fairly full discussion of electrically-heated types. In the next section a specialist deals with the various practical and theoretical aspects of bronze and brass melting, and another specialist discusses the production and desirable features of chilled cast iron for rolls. Steel foundry practice is dealt with separately, and is followed by an equally important section on malleable castings. Passing again to non-ferrous work, aluminium is the next metal to be dealt with, and this portion comprises a study of the metal, its more important alloys, and their proper commercial treatment, in both the cast and the worked states. A full description of all types of die-castings is included, embracing those in copper-, tin-, lead-, and aluminium-base alloys. The necessity of good quality die material and design is emphasized. Considerable attention is also paid to modern methods of centrifugal casting. Specially large moulds, cores, and castings are illustrated. The editor deals with specifications and with the important question of alloy cast irons which is now one of the principal subjects of investigation.

It must necessarily be the case that where different parts of a book have been undertaken by separate authors some duplication in the exposition of general principles must arise. This occurs to some extent in the work under review, but, taking a broad view, it may be repeated that the survey of foundry-work which is provided should constitute an excellent groundwork for all persons interested in the processes which are incident to the casting of machine parts.

—W. A. C. NEWMAN.

**Chemisch-technische Untersuchungsmethoden.** Von Ernst Berl und Georg Lunge. Achte, vollständig umgearbeitete und vermehrte Auflage. Herausgegeben von Ernst Berl. Zweiter Band. Erster Teil: pp. xl + 1–878, with 215 illustrations in the text. Zweiter Teil: pp. iv + 879–1795, with 86 illustrations in the text. 1932. Berlin: Verlag von Julius Springer. (R.M. 69 per part.)

The second volume of the eighth edition of this well-known work deals with the analysis of fuels, water, air, the products of the alkali and mineral acid industries (Part I), and ores, metals, alloys, and metallurgical products (Part II). The enormous advances made in inorganic analysis since the last edition was published have necessitated the division of the book into two parts, the second of which deals almost exclusively with metals. Other than portions of the fuel section in the first part, there is little of interest therein to members of the Institute of Metals; it is sufficient to say that the contents should prove of invaluable assistance to those engaged in the heavy chemical industry, and include all the latest methods in this field of analysis.

Part II contains a judicious selection of analytical procedures for the determination of all the common metals, and most of the rarer metals in ores, alloys, and metallurgical products; in many cases procedures are also given for the complete analysis of ores and alloys, as well as for the determination of impurities in finished products. Every section is written by a specialist with an intimate knowledge of his subject. Two important preliminary sections describe the methods used in sampling ores, metals, intermediate products and residues, and electrolytic methods for all the metals which can be determined by electrolysis, but no electrometric methods are given in the book. The section on aluminium contains details for the complete analysis of aluminium and all its important alloys, that on cobalt methods for analyzing hard alloys used for cutting tools, and that on beryllium procedures for the determination of the metal in age-hardening alloys of copper, nickel, and iron. There is also an extensive section on the platinum metals, containing all the recently published Russian and American methods for separating the metals from native platinum and osmiridium and for the analysis of commercial alloys; this section is, nevertheless, perhaps the least satisfactory in the book, as many of the methods described are exceedingly tedious, and in some cases give results which leave much to be desired.

The first part of the book contains a table of contents extending over 46 pages, and the second part terminates with comprehensive author and subject indexes extending over 62 pages, three columns to a page. This will give some idea of the extraordinarily wide range of subjects covered. Needless to say, the style, paper, and type are all first class, and reflect great credit on all concerned in the production of the work. In spite of the high price, the volumes should prove a sound investment to every analyst.—A. R. POWELL.

**Jahresbericht 1931 der Stoff-Abteilung der Deutschen Versuchsanstalt für Luftfahrt.** Von Paul Brenner (Sonderdruck aus dem Jahrbuch 1931 der Deutschen Versuchsanstalt für Luftfahrt e.E., Berlin—Adlershof. Herausgegeben von Wilh. Hoff. Demy 4to. Pp. xxiii + 379–566, illustrated. 1931. München und Berlin: R. Oldenbourg. (R.M. 14.)

This report on the work of the Materials Section of the D.V.L. is, like previous publications of that department, of high standard. The general work on light metals, steels, non-metallic materials, protection against corrosion, components, and investigation of failure is surveyed in an admirable manner. A short summary of reports on the more important items is given. A considerable amount of space is given to fuels, lubricants, and cooling media for use in aero-engines.

The rest of the report contains papers, presented in full text, on subjects of special research, viz. the use of steel tubes and welding in aircraft construction, static and dynamic properties of light metals, influence of form of test-piece on tensile strength and elongation of light metal sheet, corrosion testing, corrosion tests and protection of light metal sheets, the use of sodium chloride solutions of different concentrations in corrosion tests in the alternating immersion apparatus, sea-water resistance of electrodeposited coatings on iron and light metals, corrosion tests of cables, &c. While a distinctly practical attitude is noticeable throughout the report, the subjects treated and the manner of treatment denote a full appreciation of the importance of fundamental scientific research.—H. SUTTON.