

## METALLURGICAL ABSTRACTS

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# METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 15

DECEMBER 1947

Part 4

## I.—PROPERTIES OF METALS

**\*Stress Relaxation Across Grain Boundaries in Metals [Internal Friction in Aluminium].** T'ing-Sui Kê (*Phys. Rev.*, 1947, [ii], 72, (1), 41–46).—Kê's view (*ibid.*, 1947, 71, 533; *Met. Abs.*, 1947, 14, 305), that grain boundaries in metals behave in a viscous manner, is tested by experiments on the temp. dependence of the internal friction and rigidity modulus of 99.991% aluminium at different frequencies of torsional vibration, using specimens with different grain-sizes. For the same specimen an increase in the frequency of vibration shifts the internal-friction curve and rigidity-relaxation curve to higher temp. At const. frequency, an increased grain-size shifts the two curves to higher temp. The observed phenomena agree with the hypothesis of stress relaxation across grain boundaries, arising from the viscous behaviour of the grain-boundary material. The observations lead to a heat of activation  $H = 32,000$  cal./mol. associated with the stress relaxation.—W. H.-R.

**\*On the Oxidation of Aluminium in a Dry Atmosphere.** Nicolas Cabrera, Jean Terrien, and Jean Hamon (*Compt. rend.*, 1947, 224, (22), 1558–1560).—The authors describe the oxidation of aluminium and comment on the various mechanisms suggested by N. F. Mott (*Trans. Faraday Soc.*, 1940, 36, 472; *Met. Abs.*, 1940, 7, 297): (a) the passage of ions is easier than that of electrons, (b) the passage of electrons is easier than that of ions (Mott leans towards hypothesis (a)). They obtained transparent films of aluminium by evaporation *in vacuo* and traced the variation of factors of transmission and reflection as a function of the time. The results indicated that aluminium corresponds more to hypothesis (b). W. Welkenhorst (*Z. techn. Physik*, 1941, 22, 14) attributes the acceleration of oxidation in the presence of ultra-violet light to the formation of ozone. Experiments show, however, that even in the presence of ozone, the oxidation is controlled by the diffusion of the  $Al^{+++}$  ions and is independent of the ozone or oxygen pressure.—J. H. W.

**\*On the Oxidation of Aluminium at High Temperature.** Nicolas Cabrera and Jean Hamon (*Compt. rend.*, 1947, 224, (24), 1713–1715).—The authors discuss a new theory of oxidation by Mott (in the press), which supposes that the electrons pass easily through the oxide film and thus produce in the film an electric field, which favours the diffusion of the  $Al^{+++}$  ions. This theory would lead one to expect a very rapid increase in the rate of oxidation at 200° C. Experiments on aluminium films, prepared as previously described (see previous abstract), show that the rate of oxidation does, in fact, increase at 200° C., becoming very rapid at 400° C. Above 200° C., aluminium films of this thickness (approx. 200 m $\mu$ ) are not continuous, but have a granular structure. C. and H. discuss G. Haas's experiments (*Optik*, 1946, 1, 134) on the variation of the oxide film at high temp. and deduce equations for the electron energy.—J. H. W.

**Beryllium as an Alloying Compound.** N. W. Bass (*Indust. Plastics*, 1946, 1, (11), 16–18, 36; *C. Abs.*, 1946, 40, (11), 3088).—The production of beryllium-copper master alloy and the physical properties of beryllium are discussed.

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

† Denotes a first-class critical review.



**\*Rapid and Direct Measurement of Vapour Pressure of Liquid Metals [Vapour Pressure of Bismuth at 969.6° K.].** A. H. Weber and Gonzaga Plantenberg (*Phys. Rev.*, 1946, [ii], 69, (11/12), 649-651).—A rapid direct method for measuring the vapour pressure of liquid metals is described in which a stream of vapour from the surface of the metal is allowed to impinge on the bottom of a glass bucket suspended from a helical quartz spiral, the resulting upthrust being measured. The theory of the method is described, and the vapour pressure of bismuth at 969.6° K. is determined as  $0.0166 \pm 0.0017$  mm. mercury. The errors of the method are discussed.—W. H.-R.

**\*The Effect of Temperature on the Intensity of X-Ray Reflection [of Gold, Copper, and Aluminium].** E. A. Owen and R. W. Williams (*Proc. Roy. Soc.*, 1947, [A], 188, (1015), 509-521).—The effect of temp. on the intensity of X-ray reflection by pure gold, copper, and aluminium was studied by making microphotometric measurements on lines in X-ray spectra obtained with powder specimens in a Debye-Scherrer camera. The cylindrical powder specimens, 0.8 mm. dia. and of uniform particle size, were held together without adhesive and were free from a core of foreign material. They were maintained *in vacuo* at temp. up to  $\sim 900^\circ$  K., the temp. being estimated from lattice-parameter measurements. The primary beam was standardized using a flat-plate X-ray camera furnished with a plate of pure gold, which provided a spectrum whose lines could be accurately measured. The observed fall of intensity of X-ray reflection by gold and copper as the temp. is raised up to  $\sim 900^\circ$  K. was found to be in accordance with the equation,  $\Theta_T = \Theta_1[1 - \alpha\gamma(T - T_1)]$ , where  $\Theta_T$  and  $\Theta_1$  are the characteristic temp. at temp.  $T$  and  $T_1$ ,  $\alpha$  is the cubical coeff. of thermal expansion, and  $\gamma$  is the Grüneisen constant. The equation was found to hold also for aluminium up to  $\sim 600^\circ$  K., but beyond this the fall in intensity exceeds that to be expected, and this may be due to the removal of energy from the primary beam to form extra reflections. The characteristic temp. at room temp. ( $293^\circ$  K.) were found to be: gold  $175^\circ$  K., copper  $314^\circ$  K., and aluminium  $395^\circ$  K. These values show good agreement with those obtained by specific-heat and electrical-conductivity measurements.—E. N.

**\*A Re-Determination of the Lattice Constant of Lead.** Harold P. Klug (*J. Amer. Chem. Soc.*, 1946, 68, (8), 1493-1494).—Lead of 99.999+ % purity was examined by K-X-radiation. The lattice constant at  $25 \pm 0.1^\circ$  C. is  $4.9408 \pm 0.0001$  kX. units.—J. B. C.

**\*Creep Rate of Various Industrial Leads.** J. Neill Greenwood and J. H. Cole (*Metallurgia*, 1947, 36, (215), 233-235).—Creep tests were carried out on several brands of industrial lead to determine whether results were in accordance with those obtained previously with synthetic laboratory products. No unexpected results were obtained. The behaviour of the metal under prolonged stress depended more on the nature of impurities present than on their total content. A 100-days test at 500 lb./in.<sup>2</sup>, supplemented by a test for embrittlement, is suggested as a means of classifying industrial lead alloys.

—M. A. V.

**\*Propagation of U.H.F. Sound in Mercury.** G. R. Ringo, J. W. Fitzgerald, and B. G. Hurdle (*Phys. Rev.*, 1947, [ii], 72, (1), 87-88).—A note describing measurements of the velocity and attenuation of sound in mercury in the frequency range 100 to 1000 Mc./s. The results for the velocity varied from  $1.44 \times 10^5$  to  $1.47 \times 10^5$  cm./sec. at temp. between  $24^\circ$  and  $28^\circ$  C., and did not show any definite dependence on the frequency. The values for the frequency-free pressure absorption coeff. varied from  $4.7$  to  $6.0 \pm 1.0$ .

—W. H.-R.

**\*The Adsorption of Vapours on Mercury. I.—Non-Polar Substances [Benzene, Toluene, and *n*-Heptane].** C. Kamball and E. K. Rideal (*Proc. Roy. Soc.*, 1946, [A], 187, (1008), 53-73).—Reversible results for the adsorp-

tion of pure benzene, toluene, and *n*-heptane vapours on mercury were obtained using the method of sessile drops. Isotherms were normally obtained at 25° and 50° C., but in the case of benzene vapours some measurements were made at 75° C. The films were found to be gaseous and obeyed the Volmer equation  $F(A - b) = kT$ , where  $F$  = spreading pressure,  $A$  = area per molecule, and  $b$  = co-area. The possibility that the films might be immobile was considered, and the Langmuir equation was applied but was found to be unsatisfactory. A standard state for the surface phase is defined which is independent of temp. in the same manner as the standard pressure of one atmosphere is independent of temp. Values for the free energy, total energy, and entropy of adsorption of the various substances at the various temp. are evaluated. It is shown that the heat of adsorption increases with the amount on the surface. After the completion of monolayer adsorption, which is stable up to high values of  $p/p_0$ ,  $p$  being the vapour pressure and  $p_0$  the saturation vapour pressure, a number of phase changes occur, the most striking being interpreted as the change from "flat" to "vertical" adsorption of the toluene molecule. Others are thought to be either two-dimensional condensation or adsorption of a second layer.—E. N.

**\*The Adsorption of Vapours on Mercury. II.—The Entropy and Heat of Adsorption of Non-Polar Substances.** C. Kemball (*Proc. Roy. Soc.*, 1946, [A], 187, (1008), 73–87).—Equations are derived which enable the entropy of adsorption on mercury of benzene, toluene, and *n*-heptane and the heat of adsorption of benzene to be calculated. The values obtained were of the same magnitude as the experimental values (see preceding abstract) and indicate with fair accuracy the amount of translational and rotational freedom possessed by the substances on the surface of the mercury. Benzene appears to rotate only in the plane of the ring and has no third degree of translational freedom, the surface mobility of toluene is considerably hindered, and the molecules of *n*-heptane are partially rolled up.—E. N.

**\*The Adsorption of Vapours on Mercury. III.—Polar Substances [Water, Acetone, Alcohols].** C. Kemball (*Proc. Roy. Soc.*, 1947, [A], 190, (1020), 117–137).—Cf. preceding abstract. Using methods previously described, determinations were made of the adsorption of water, acetone, and normal alcohols from methyl to hexyl on mercury at 25° and 50° C. All substances gave reversible adsorption, and, with the exception of water, as had been found with non-polar substances, the first region of the adsorption isotherm was always a gaseous monolayer obeying the Volmer type of equation. Methyl and ethyl alcohol both formed second layers, the double layer having half the co-area of the original monolayer, while the higher alcohols from *n*-butyl upwards formed condensed films. Acetone gave rise to a double and finally a triple layer. Contrary to the results of previous workers, water vapour was found to be adsorbed on mercury, although not strongly at 50° C. It showed no inclination to form a second layer, only a monolayer being formed at high ratios of  $p/p_0$ . The large entropy ( $35.9 \pm 1.1$  cal./deg. mol.) and heat of adsorption of water are evidence for the association of the adsorbed water molecules on the surface of the mercury, and this probably occurs to some extent with methyl alcohol as well.—E. N.

**\*The Activated Adsorption of Nitrogen on a Finely Divided Tungsten Powder.** Raymond T. Davis, Jr. (*J. Amer. Chem. Soc.*, 1946, 68, (8), 1395–1402).—The adsorption of nitrogen on tungsten powder was studied in a pressure range of  $10^{-6}$  to 35 mm. and a temp. range of 400°–750°. At saturation there was one molecule of nitrogen for every four surface atoms of tungsten. The thermodynamics of the tungsten–nitrogen system are discussed.—J. B. C.

**\*The Plastic Deformation of Non-Cubic Metals by Heating and Cooling.** W. Boas and R. W. K. Honeycombe (*Proc. Roy. Soc.*, 1946, [A], 188, (1004), 57–71).—A comparative study of the properties of tin-base and lead-base

bearing alloys revealed that after alternate heating and cooling, surface roughening and cracking occurred on the formerly smooth surface of the tin-base bearing, which increased with the number of treatments, whereas the surface of the lead-base bearing remained quite smooth. The phenomenon was found to be due to an inherent property of the alloy or its constituents. In order to make a fundamental study of the phenomenon, specimens of pure metals, relieved of residual stresses set up by previous cold work, were subjected to cyclic thermal treatment between 30° and 150° C. The non-cubic metals, zinc, cadmium, and tin showed signs of plastic deformation—slip lines, some evidence of twinning, roughness of the surface, and intensification of grain boundaries—after a small number of cycles, the effect becoming more pronounced the greater the number of cycles. The phenomenon was not observed in lead, which has a cubic crystal structure. It is shown that: (1) factors which influence the distortion are, duration and number of cycles, temp., and orientation of the crystals, (2) the deformation is independent of grain-size, (3) lattice distortions produced by the plastic deformation of the specimen are not removed by the cyclic treatment but remain in the specimen and, therefore, become more extensive as the number of cycles increases, (4) grain-boundary migration occurs with tin and cadmium but not with zinc; it is dependent on the duration of the cycle and occurs to a much greater extent during the cooling phase of the cycle, (5) slip lines continue through the crystals to the grain boundaries, where they are emphasized. It is concluded that the cause of the deformation is the anisotropy of thermal expansion in hexagonal and tetragonal crystal systems, and an estimation was made of the order of magnitude of the stresses set up, based on considerations of the linear boundary element between two crystals. Mention is made of some of the theoretical and practical applications of the phenomenon: the difficulty of obtaining completely strain-free zinc and cadmium at room temp., the failure of certain bearing alloys, and the effect of such stresses superimposed on externally applied stresses, e.g. fatigue and creep conditions.—E. N.

**\*The Anisotropy of Thermal Expansion as a Cause of Deformation in Metals and Alloys.** W. Boas and R. W. K. Honeycombe (*Proc. Roy. Soc.*, 1947, [A], 188, (1015), 427-439).—The work described in an earlier paper (see preceding abstract) has been extended to the temp. range - 190° to 250° C. As the temp. range is increased, the extent of deformation increases. Cyclic treatment of tin, cadmium, and zinc between room temp. and that of liquid air results in complex slipping and twinning, but grain-boundary migration is practically absent. Cooling from the liquid state, which represents half a thermal cycle, sets up stresses in metals possessing anisotropy of thermal expansion, e.g. zinc, cadmium, and tin, and leads to plastic deformation. In cadmium subsequent annealing results in marked grain growth. Duplex alloys of tin-rich tin-antimony, consisting of a tin-rich matrix in which particles of a hard second phase of cubic crystal structure are embedded, show considerably smaller deformation in the region of the boundaries between crystals of the two phases than that in the region of the crystal boundaries of the anisotropic matrix. Similar results are obtained with tin-base bearing alloys.—E. N.

**\*The Theory of Wedge Indentation of Ductile Materials.** R. Hill, E. H. Lee, and S. J. Tupper (*Proc. Roy. Soc.*, 1947, [A], 188, (1013), 273-288).—As a first step towards the correlation of hardness-test results with the deformation properties of a material under conditions of stress, e.g. the tensile test, a theoretical solution is given for the deformation produced by a rigid, frictionless wedge penetrating a plastic material. The solution determines the form of the lip and the deformation of the material squeezed out towards the surface. The variation with wedge angle of the force required for penetration



is determined in terms of the yield stress in the tensile test, and the average strain due to wedge indentation corresponds to an equivalent reduction of area in a tensile test, which increases with increasing wedge angle. The theory is compared with experiments in which lead blocks were indented by steel wedges coated with vaseline, and satisfactorily predicts the deformation of a grid of squares ruled on a cross-section of the block.—E. N.

**\*Deformation of Metals During Single and Repeated Tensile Impact.** J. A. Pope (*J. Iron Steel Inst.*, 1947, 157, (1), 31–54).—P. treats mathematically the case of a bar, one end of which is struck by a hammer, the other end being rigid. From consideration of the stress-wave reflections and deformations taking place at the ends of the bar, generalized curves are derived for the variations with time of the rates of deformation and energies absorbed at the two ends of the bar. A system of dimensionless units is employed in plotting these curves. In developing the theory a number of assumptions were made: (1) that the load on the bar remains const. after the metal has yielded (equal to the dynamic yield stress), (2) that the stress waves are reflected perfectly, (3) that the weight of the specimen is small compared with that of the hammer, and (4) that the kinetic and elastic energies of the bar are negligible in comparison with the plastic energy absorbed. P. describes the results of tests carried out on mild steel (carbon 0.22, manganese 0.49%) and Lowmoor iron (0.085% carbon), using a falling-tup impact machine. Stops were fitted to the machine so as to limit the amount of extension on the gauge length, the remaining energy in the tup, which greatly exceeded that required to deform the specimen, being absorbed by that part of the specimen outside the gauge length. It was thus possible (a) to split a single impact into stages by subjecting a number of specimens to different extensions, and (b) to carry out repeated-impact tests at approx. const. velocity. After impact, hardness explorations and microscopical examinations were performed on the specimens. The spread of deformation during impact was shown to be fundamentally different from that in a static test. The increase in hardness at the centre of the impacted specimens was greater than that at the edge by a larger amount than was the case with static specimens. Statically tested Lowmoor iron specimens show more slip bands than those tested in impact. In specimens of mild steel, under both single and repeated impact, necking at both ends occurs initially. After a small extension the necks disappear and the specimen again becomes parallel; eventually a single neck occurs near the centre of the specimen and leads to fracture. Specimens in Lowmoor iron also show double necking, but deformation does not spread to the centre until considerable extension has occurred, and the specimen generally breaks at one of the original necks. The ratio  $\frac{\text{impact elongation, \%}}{\text{static elongation, \%}}$  is a function of gauge length and is not a fundamental property of the material. P. concludes that, in general, the experimental results are in accord with the mathematical theory; such discrepancies as exist are attributed to the inaccuracy of assumption (1), which precludes deformation other than at the specimen ends.—R. W. R.

**\*Experiments on the Elastic Properties of Metals by Means of Two Oberbeck Resonance Pendulums.** Constantin Sălceanu (*Compt. rend.*, 1947, 224, (25), 1756–1758).—The elastic properties of iron, aluminium, silver, copper, and brass, were studied by means of the resonance exhibited by two pendulums of the same length connected by a wire of the metal being studied. One pendulum is made to oscillate and is followed by the other. The time between two minima of oscillation of one pendulum is measured and plotted against the tension. In all cases, time-saturation was obtained. The order of the metals given by this method does not correspond to any of the known elastic properties of the metals, and S. suggests that his results are indicative of a

property analogous to that of viscosity in liquids. Another set of experiments on the same metals, involving torsion under const. tension, gives an order inverse to that given by the first set.—J. H. W.

**\*The Application of the Method of the Resonant Pendulum to the Measurement of the Coefficient of Rigidity of Metals.** Constantin Sălceanu (*Compt. rend.*, 1947, 224, (26), 1810–1811).—The resonance of equal pendulums connected by a wire of the metal to be studied (see previous abstract) was used to measure the coeff. of rigidity of nickel, iron, steel, nickel-chrome, copper, silver, aluminium, and brass. The static method, involving torsion under const. tension (see above), showed that if  $C$  is the constant of torsion (given

by  $gd = C \frac{0r^4}{l}$ , where  $g$  is the tension,  $r$  the dia. of the wire,  $l$  the length, and  $\theta$  the torsion) and  $T$  the time, then  $C + T$  is a constant within the limits of experimental error. The effect of heating the specimens is described for each metal.—J. H. W.

**\*Finite Elastic Strain of Cubic Crystals.** Francis Birch (*Phys. Rev.*, 1947, [ii], 71, (11), 809–824).—Murnaghan's (*Amer. J. Math.*, 1937, 49, 235; *Met. Abs.*, 1938, 5, 468) theory of finite strain is developed for a medium of cubic symmetry subjected to finite hydrostatic compression plus an arbitrary homogeneous infinitesimal strain. The free energy is developed for cubic symmetry to include terms of the third order in the strain components. The effect of pressure upon the second-order elastic constants is found and compared with experiment, with particular reference to the compressibility. The compressibility data for numerous metals are tabulated and discussed. In general, the data confirm the theory, but there is an indication that Bridgman's results at pressures above 50,000 kg./cm.<sup>2</sup> are not directly comparable with those at lower pressures. The results are also compared with some of the calculations based on Born's lattice theory, and some developments of the latter by other workers are criticized.—W. H.-R.

**A Thermodynamic Criterion for the Fracture of Metals.** Edward Saibel (*Phys. Rev.*, 1946, [ii], 69, (11/12), 667).—A note. The difficulties in accounting for the difference between the calculated and observed strengths of metals are outlined. A new theory by S. is based on the following assumptions: (1) All of the strain energy is available for the abolition of cohesive strength. (2) The heat of fusion is uniformly partitioned throughout the vol. of the substance. (3) The quantity of energy required for the abolition of cohesive strength is that fractional part of the energy of fusion which is associated with the change in vol. on passing from the solid to the liquid state. These assumptions enable the criterion for fracture to be expressed in the form  $U = JQ\Delta V/V$ , where  $U$  is the strain energy per unit vol.,  $Q$  is the latent heat of fusion in kg.-cal./mole,  $V$  is the vol. occupied by a mole of the substance,  $\Delta V$  is the change in vol. per mole on passing from solid to liquid, and  $J$  is the mechanical equivalent of heat. Good agreement is shown for some substances which fail by brittle fracture, and reasonable agreement where plastic flow precedes fracture.—W. H.-R.

**Nature of Strength and Failure in Brittle Solids.** Eugene F. Poncelet (*Colloid Chem.*, 1946, 6, 77–88; *C. Abs.*, 1946, 40, (9), 2375).—An ideal brittle solid can be visualized as a collection of identical particles held at definite spacings by electrostatic bonds. The Morse curve is the graph representing the resultant of the simultaneously existing and changing attractions and repulsions. A broken bond arises when a critical distance between particles is exceeded. The following factors are considered: the physical nature of failure; failure under tension; fracture under compression; mixed stresses; the physical nature of strength in solids; and the fundamental difference between viscous and plastic flow. The "flaws" assumed by Griffith, Smekal, Orowan, and others are not essential to fracture. Compressive



strength exceeds tensile strength eight times or more (in glass between nine and fifty times).

**\*The Statistical Aspect of Fatigue of Metals.** A. M. Freudenthal (*Proc. Roy. Soc.*, 1946, [A], 187, (1011), 416–429).—Fatigue of metals, or the more adequate term “progressive failure” is the expression on a macroscopic scale of the progressive destruction of the cohesive bonds as a result of the repetitive action of an external load. As such it has the typical features of a mass phenomenon, for both the cohesive bonds and the load repetitions are collectives in the statistical sense. By applying the fundamental rules of the theory of probability, many of the established relations between the principal variables, e.g. amplitude, frequency and number of load cycles sustained, notch effect, &c., are theoretically deduced from the purely formal assumption of the separation-strength of cohesive bonds. The principal practical application is the evaluation of the damaging effect of repeated load cycles of varying amplitude and of the effect of overstress, which are the main problems in the design of structures.—E. N.

**\*The Relationship Between Fatigue and Stress Concentration.** R. B. Heywood (*Aircraft Eng.*, 1947, 19, (217), 81–84).—H. discusses the effect of stress concentration at notches on the elastic stress and fatigue properties. He

deduces, from observed values, that the expression:  $\frac{K}{K_f} - 1 = \frac{0.065}{\sqrt{r}}$  (where

$K$  is the elastic-stress-concentration factor, i.e. the max. stress in the notch divided by the nominal stress;  $K_f$  is the fatigue-stress-concentration factor, i.e. the endurance limit of un-notched specimens divided by that of notched specimens; and  $r$  is the radius of the stress raiser) gives fair agreement for carbon steels. For other classes of material, other values of the constant, which H. refers to as the “augmented constant”, are used.—H. S.

**A Summary of Published Literature on Internal Stresses in Metals.** — (B.S.A. Group Research Centre, Sheffield, Publ., 1947, (GRC/S. 29), 45 pp.).—185 abstracts are given of articles dealing with the occurrence, effects, measurement, and control of internal stresses, covering the period 1938–1946.—J. L. T.

**\*Kinetic Friction in or Near the Boundary Region. I.—Apparatus and Experimental Methods.** B. Chalmers, P. G. Forrester, and E. R. Phelps (*Proc. Roy. Soc.*, 1946, [A], 187, (1011), 430–439).—An apparatus is described and illustrated for obtaining relatively pure boundary friction, which is done by controlling the conditions of load, speed, and contact area, so that little or no opportunity is given for fluid-film formation. One specimen (the plate) is driven at a fixed velocity and a second specimen (the slider) is applied to it by a dead load. The force required to restrain the second specimen is measured by balancing against a variable dead load, instability being suppressed by fluid damping. A direct reading of the coeff. of friction is thus obtained by a null method. Reproducibility of determinations is generally within 10%, the limiting factor being the accuracy with which exactly similar surfaces can be reproduced. The method of preparing the specimens is described; the tests can be conducted at temp. up to 150° C. within an accuracy of  $\pm 1^\circ$  C. of that required.—E. N.

**\*Kinetic Friction in or Near the Boundary Region. II.—The Influence of Sliding Velocity and Other Variables on Kinetic Friction in or Near the Boundary Region.** P. G. Forrester (*Proc. Roy. Soc.*, 1946, [A], 187, (1011), 439–463).—Using the apparatus described (see preceding abstract), a study was made of the causes underlying the change of friction with sliding velocity. Measurements were made of the friction of several different combinations of materials, mainly tin-base Babbitt (with 7% antimony and 3½% copper) running on steel and with hard steel on phosphor bronze, at velocities between 0.01–2.25 cm./sec. and under three different conditions: dry, with thin films of various lubricants applied by two different methods, and with excess of

lubricants. The lubricants used were oleic acid, medicinal paraffin, and I.C.E. (crank-case) oil. The experiments show that changes in friction with velocity may be derived from at least three different sources: (1) From the properties of clean metal surfaces. Certain combinations show, when unlubricated, a decrease in friction with increasing velocity. This is most marked when one component is a soft metal of low m.p., which suggests that it may be associated with reduction in shear strength of the metal with increasing temp. (2) From the partial destruction of the film under boundary conditions. This leads to an increase of friction with increasing velocity, as the rate of destruction rises with increasing sliding speed. (3) From the transition from boundary to fluid-film conditions. This tendency is also most marked when one component is a soft metal, in which case the real area of contact is greater and the local pressures lower than for two hard metals. It results in a decrease of friction with increasing velocity. "Running-in" brings about changes in the physical conditions and geometry of the metal surfaces and also in the state of the lubricant film; it may influence the friction either way, but its influence is always much greater with rough plates than with smooth. The influence of surface finish is wholly through its effect on the lubricant film; it accelerates the onset of fluid lubrication and has more influence on the combination Babbitt/steel than in the combination steel/bronze. The practical implications of the results are discussed.—E. N.

**\*Kinetic Boundary Friction.** J. R. Bristow (*Proc. Roy. Soc.*, 1947, [A], 189, (1016), 88–102).—Using an apparatus which is described, curves of boundary friction against velocity (0–0.5 cm./sec.) for various sliding surfaces (steel on steel and phosphor bronze, brass or tin on hard steel) were determined for a number of lubricants. The results show that smooth sliding and relaxation oscillations, or "stick-slips", under boundary-lubrication conditions, when frictional forces are measured by the deflection of an elastic system, are due to the dependence of kinetic friction on velocity. In cases giving smooth sliding, kinetic friction decreases as velocity decreases, at very low speeds; in cases giving relaxation oscillations, kinetic friction increases as velocity decreases. Thus, sliding under boundary conditions is not inherently discontinuous; any discontinuous motion is due to the dynamics of the measuring instrument as a result of the kinetic friction increasing as the velocity decreases. Generally the friction falls continuously with increasing molecular weight for a series of esters of fatty acids, and is dependent on the percentage of fatty oil in a compounded lubricant such as oleic acid in mineral oil, and on temp. for a pure substance such as ethyl palmitate, and a mineral oil. The temp. at which relaxation oscillations first occur depends on the speed of sliding, and it appears, therefore, that measurements of the temp. at which relaxation oscillations start at a const. sliding speed are not a measure of the temp. at which there is a discontinuity in the properties of the boundary layer.—E. N.

**The Surface of Solids and Liquids and the Films that Form on Them. II.—Solids and Adsorption at the Surface of Solids or Liquids.** W. D. Harkins (*Colloid Chem.*, 1946, 6, 1–76; *C. Abs.*, 1946, 40, (9), 2371).—A review of fifteen years' work which deals with: classes of solids; effect of sub-phase on metallic films; calculation and determination of surface-energy values illustrated by diamond and ionic crystals; adsorption at interfaces in solid, liquid, and gaseous systems; water/oil; the application of the Gibbs equation to solid surfaces; experimental procedures; areas of solids from adsorption isotherms; extension of the attractive energy of a solid into a liquid and the thickness of adsorbed films; theories of adsorption; desorptions; multi-molecular films and other types; experimental methods for determination of energy of adhesion, adsorption, heat of immersion, &c.; contact angle,

theory, data, and experimental methods for determining it; graphite as a hydrophobic solid; topochemistry; chemical changes at crystal corners, edges, and interfaces. Besides 68 numbered references, there are given 113 references to papers by Harkins and his school, classified chronologically.

**Colloidal Behaviour in Metals and Alloys.** Reginald S. Dean (*Colloid Chem.*, 1946, 6, 561-578; *C. Abs.*, 1946, 40, (9), 2427).—A discussion of: (1) Gases in metals: physicochemical nature of metallic interfaces; gas-metal systems as colloids; degasification of metals; grain-size control; hydrogen embrittlement. (2) Slag-metal systems: the Aston wrought-iron process; steelmaking reactions; powder metallurgy; magnetic, electric, and mechanical properties of metal compacts. (3) Dispersions of metals in metals: solid metals in solid metals; ordering in alloys; dispersion-hardening; internal friction or vibration-damping capacity of metals. 78 references are given.

**\*A New Method of Determining Electro-Negativity from Other Atomic Properties.** Walter Gordy (*Phys. Rev.*, 1946, [ii], 69, (11/12), 604-607).—

The empirical relation  $\alpha = 0.31 \left( \frac{n+1}{r} \right) + 0.50$  has been found to connect the electro-negativity,  $\alpha$ , of an element according to Pauling's revised scale, with  $n$  the number of electrons in its incompletely filled (valence) shells, and  $r$  its single-bond co-valent radius measured in Å. This relation does not hold for copper, silver, or gold, but is in good agreement with results for many elements, and is used to construct a table of electro-negativities for 52 elements. The theoretical justification is discussed.—W. H.-R.

**Magnetic Dipole Fields in Unstrained Cubic Crystals.** L. W. McKeehan (*Phys. Rev.*, 1947, [ii], 72, (1), 78).—Numerical errors and misprints in an earlier paper (McKeehan, *Phys. Rev.*, 1933, [ii], 43, 913; *J. Inst. Metals (Met. Abs.)*, 1933, 53, 441) are corrected. These mistakes involve the paper by Luttinger and Tisza (*Phys. Rev.*, 1946, 70, 954).—W. H.-R.

**\*Theory of Long-Period Magnetic Relaxation.** Charles Kittel (*Phys. Rev.*, 1946, [ii], 69, (11/12), 640-644).—Long-period changes in the magnetization of a mild-steel specimen are discussed. If a specimen in a const. field of the order of 0.5 gauss is submitted to alternating stresses for a period of the order of 5 years, it approximates to a state of infinite effective permeability. If the applied field is changed suddenly, a considerable fraction of the magnetization changes almost instantaneously; this fraction is determined by the ordinary permeability, and by the demagnetization coeff. Following this sudden change, a further slow change in magnetization occurs with a time constant of the order of 3 months, while the remainder of the magnetization changes with a period of the order of 5 years. A formal treatment of the phenomena is given following the lines of the time-dependent barrier potential used by Snoek (*Physica*, 1938, 5, 663; *Met. Abs.*, 1938, 5, 656).—W. H.-R.

**\*Transverse Magnetization in Ferromagnetic Crystals in Relation to Domain Structure.** A. von Engel and M. S. Wills (*Proc. Roy. Soc.*, 1947, [A], 188, (1015), 464-484).—Although the formal theory of ferromagnetic anisotropy is in good agreement with experimental results as regards the components of magnetization parallel to the field, similar results are not obtained with the transverse component for the planes (100), (110), and (111), where experimental results for single crystals show that it diminishes to zero in very weak fields, instead of increasing according to theory. However, if the directions of magnetization of domains (small regions spontaneously magnetized to saturation) are treated as being distributed continuously in angle rather than as restricted to a limited number of particular directions, and, assuming that the proportions of the volumes of domain magnetized in any direction are larger the lower the energy of magnetization in that direction, then reasonable agreement between theory and experimental results is obtained.—E. N.



**\*The Theory of the Magneto-Resistance Effects in Metals.** E. H. Sondheimer and A. H. Wilson (*Proc. Roy. Soc.*, 1947, [A], 190, (1023), 435-455).—General formulæ are obtained for the effect of a magnetic field on the electrical and thermal conductivities of a metal in which there are two overlapping partially filled electron bands of normal form, the *s*- and *d*-bands, in each of which the energy is proportional to the square of the wave number. It is assumed that *s-d* transitions are negligible, as is the quantization of the electron orbits due to the magnetic field. The formulæ, though not strictly valid for all temp. and fields, are further developed for the limiting cases of very high and very low temp. and for very strong magnetic fields; at very low temp. they are in fair quantitative agreement with experimental results on cadmium. The behaviour of the electrical resistance at low temp. is discussed, and it is shown that: (1) the formulæ explain the fact that in certain cases the resistance may pass through a minimum as the temp. is increased, provided that the magnetic field is large enough, e.g. cadmium at liquid-helium temp.; and (2) Matthiessen's empirical rule, that electrical resistivity consists of two parts, cannot be expected to be valid except more or less by accident. Considering the electronic thermal conductivity, in general the Lorenz number is increased by the presence of a magnetic field, which is in agreement with the experimental facts, whereas the thermal conductivity of the lattice is unaffected by a magnetic field.—E. N.

**\*An Experiment on the Mechanism of Supraconductivity.** J. G. Daunt and K. Mendelssohn (*Proc. Roy. Soc.*, 1946, [A], 185, (1001), 225-239).—Using an apparatus which is described, the Thompson coeff. of supraconductive lead was determined and found to be zero ( $<4 \times 10^{-9}$  V./deg.). This leads to the conclusion that the electrons engaged in the supraconductive current remain energetically at absolute zero, and sustains the authors' previous assumption that the apparent electronic specific heat,  $C_s$ , of a supraconductor is due to an excitation of electrons from the lowest state. It is shown that

$C_s = \frac{3\gamma}{T_c^2} T^3$ , where  $\gamma$  is the coeff. of the Sommerfeld electronic specific heat and  $T_c$  is the transition temp., a result borne out by Keesom and van Laer's calorimetric experiments on tin. Thus, the whole mechanism of supraconductivity seems to imply the existence of a small gap ( $\sim 10^{-4}$  eV.) in the energy distribution between the lowest state occupied by the supraconductive electrons and the higher states to which they can be thermally excited. The frictionless transport of electrons is due to metastable states within the gap in which energy cannot be dissipated. Calculated results show that (1) the number of electrons which are capable of such frictionless transport is only about  $10^{-3}$  of the number of atoms, and (2) the depth  $\lambda$  to which a magnetic field can penetrate into a supraconductor is about  $10^{-4}$  cm. for lead. It is concluded that the remarkable similarity between the frictionless transport in supraconductors and that in liquid helium II is due to the fact that they are caused by very similar mechanisms—an aggregation of freely mobile particles of zero thermal energy, irrespective of whether the particles in question are electrons or atoms.—E. N.

**Physical Interaction of Electrons with Liquid Dielectric Media. The Properties of Metal-Ammonia Solutions.** Richard A. Ogg, Jr. (*Phys. Rev.*, 1946, [ii], 69, (11/12), 668-669).—A note describing theoretical considerations which preceded recent work (R. A. Ogg, Jr., *J. Amer. Chem. Soc.*, 1946, 68, 155; *J. Chem. Phys.*, 1946, 14, 114, 295; *Phys. Rev.*, 1946, [ii], 69, 243) on the properties of metal-ammonia solutions. The basis of the treatment is the model of Kraus ("The Properties of Electrically Conducting Systems", Chemical Catalogue Co.: 1922) of an electrolyte-like character for the solute metal in ammonia solutions, the negative ion constituent being the "solvated" electron. At low concentrations, individual electrons are "self-trapped" in

physical cavities in the solvent, and the treatment shows that the lowest energy is given if the electrons are trapped in pairs, two electrons in each cavity. At higher concentrations, unpairing of the electrons occurs.—W. H.-R.

**\*The Magnetic Susceptibility of Sodium in Liquid Ammonia Solutions at Low Temperatures.** R. B. Gibney and G. L. Pearson (*Phys. Rev.*, 1947, [ii], 72, (1), 76–77).—A note. The claims made by Ogg (*ibid.*, 1946, 69, 243; 70, 93) regarding the supposed supraconductivity of frozen solutions of sodium in liquid ammonia at 180° K. were based on the detection of persistent currents. This method is regarded as unsatisfactory because the results may be affected by cracking of the sample. Measurements of magnetic susceptibility are not affected by small cracks, and give a sensitive test for the existence of supraconductivity. Experiments made with solutions of different concentrations indicated that if any supraconducting material was present, its amount was not greater than 1 part in 10,000 by vol. Other methods also gave negative results for the existence of supraconductivity.—W. H.-R.

**Erratum : Transition from Classical to Quantum Statistics in Germanium Semiconductors at Low Temperature.** Vivian A. Johnson and K. Lark-Horovitz (*Phys. Rev.*, 1947, [ii], 71, (12), 909).—Corrections to an earlier paper (*Phys. Rev.*, 1947, [ii], 71, 374; *Met. Abs.*, 1947, 14, 306).—W. H.-R.

## II.—PROPERTIES OF ALLOYS

**\*The Intermetallic-Compound Phases of the System Aluminium-Manganese-Zinc.** G. V. Raynor and D. W. Wakeman (*Proc. Roy. Soc.*, 1947, [A], 190, (1020), 82–101).—The aluminium-manganese-zinc system was examined in the range 0–95% zinc and 0–3% manganese. The alloys were prepared from pure aluminium, zinc, and aluminium-manganese master alloys, which were melted in an electric furnace, using a crucible lined with alumina-fluorspar mixture, and then slowly cooled in the furnace at 1–2° C./min. All alloys were examined micrographically, after which primary and secondary crystals were extracted by an electrolytic method and then subjected to micrographic, X-ray, and analytical examination. According to the composition, the succession of phases deposited on passing along the eutectic valley towards the ternary eutectic is:  $\text{MnAl}_6 \rightarrow T_1 \rightarrow \text{MnAl}_4 \rightarrow T_2 \rightarrow T_3 \rightarrow \text{MnAl}_3$ . Up to a zinc content of ~35% at 2% manganese or 43% at 3% manganese, the primary phase is  $\text{MnAl}_6$ , which can take up small quantities (~0.8%) of zinc. In a region from 35 to ~69% zinc, for manganese contents between 1 and 3%, the ternary compound  $T_1$  crystallizes as the primary constituent; it is characterized by a ratio of four aluminium atoms to one of combined solutes, and an electron:atom ratio of 1.85, calculated on the basis of the Pauling theory of transitional metals. According to this theory, transitional metal atoms have vacancies for electrons in their atomic orbitals, and the present experiments, in conjunction with earlier work, suggest that these may be filled up as a consequence of alloy formation. The compound  $T_1$  is analogous to the ternary compounds observed in the aluminium-manganese-nickel and aluminium-manganese-copper systems. The primary  $\text{MnAl}_4$  field extends, at low manganese contents, only from ~69–76% zinc and will dissolve zinc up to a limit of ~5.2%. The ternary phases  $T_2$  and  $T_3$  may be represented respectively by the formulæ  $\text{Mg}_2\text{ZnAl}_9$  and  $(\text{Mn.Zn})_5\text{Al}_{11}$  or  $\text{Mn}_{2.8}\text{Zn}_{2.2}\text{Al}_{11}$ .  $\text{MnAl}_3$ , which can dissolve small quantities of zinc, enters into equilibrium at a ternary eutectic (Zn 95, Mn 0.05%; at 378° C.) with the primary solid solutions in zinc and aluminium respectively. Specimen photomicrographs are reproduced, together with diagrams showing the form of the surfaces of primary separation.—E. N.

**\*The Compressive Strength of Short Circular Tubes [Aluminium Alloys].** I. G. Bowen (*Aircraft Eng.*, 1947, 19, (218), 128-129).—A brief digest of M.A.P. Scientific and Technical Memoranda 17/44. Reliable estimates of the strength of axially loaded tubes in compression, with friction opposing displacement of the ends, can be gained by the use of Donnell's equation where thin-walled tubes are concerned, and in the case of medium and thick tubes by the use of equations deduced by B. for steels and aluminium alloys.—H. S.

**Beryllium as an Alloying Compound.** (Bass). See p. 137.

**Contributions to the Theory of Beta-Phase Alloys [Brass].** Clarence Zener (*Phys. Rev.*, 1947, [ii], 71, (12), 846-851).—(1) The theory of the  $\alpha/\beta$  brass equilibrium is discussed and extended. The original theory of H. Jones (*Proc. Phys. Soc.*, 1937, 49, 243, 250; *Met. Abs.*, 1937, 4, 237) is correct in predicting the approx. position of the  $\alpha/\alpha + \beta$  and  $\alpha + \beta/\beta$  phase boundaries in alloys of the copper-zinc type. It does not, however, predict the correct variation with temp., and Z. regards J.'s work as involving an error in computation. (2) The high elastic anisotropy of single crystals of  $\beta$ -brass is discussed. The anomalously low value of the  $(C_{11}-C_{12})/2$  shear coeff. of  $\beta$ -brass results from the combination of a body-centred cubic lattice with ions containing only closed shells. It is to be expected that all  $\beta$ -type alloys with closed inner shells will have a similarly low value of this shear constant. The susceptibility of a body-centred cubic structure to mechanical instability with respect to a (100)[110] type shear explains the limitation of body-centred cubic lattices to elements in certain places in the Periodic Table. The same line of argument explains the positive value of the temp. coeff. of  $E_{100}$  in  $\beta$ -brass.—W. H.-R.

**Copper-Manganese-Aluminium Alloys.** — (*Engineer*, 1947, 183, (4766), 470).—A short review of some recent publications dealing with alloys containing copper 60, manganese 5-25%, and zinc remainder, and with the solid-solution area of the copper-manganese-aluminium system.—R. GR.

**\*Note on a Variation with Frequency of the Torsional Modulus of German-Silver Wire and Its Relation to Gyromagnetic Measurements.** S. J. Barnett and D. S. Webber (*Phys. Rev.*, 1947, [ii], 71, (12), 896-902).—The dynamic torsional modulus,  $M_d$ , of German-silver wire was measured at frequencies ranging approx. from 17 to 50 c./s., and at much lower frequencies, the periods of which ranged from 4 to 28 sec. No change in modulus could be detected in either the high-frequency or the low-frequency range, but the modulus in the high-frequency range was about 1% smaller than that for oscillations of period 5 sec. This variation is in the right direction to account for part of the difference between results for the gyromagnetic ratios obtained by S. J. Barnett (*Proc. Amer. Acad. Arts Sci.*, 1940, 73, 401; 1944, 75, 109; *Met. Abs.*, 1945, 12, 107; 1946, 13, 204) and by Bates and by Sucksmith (*Proc. Roy. Soc.*, 1923, [A], 104, 499; 1925, [A], 108, 638; *J. Inst. Metals*, 1925, 34, 347), because the latter work involved the assumption that the torsional modulus of a rapidly vibrating German-silver wire was the same as the static value. The greater part of the discrepancy must, however, be due to some other cause.—W. H.-R.

**\*The Intermetallic Compound  $Mg_4Na_4Pb_3$ .** George Calingaert, Hymin Shapiro, and Ivar T. Krohn (*J. Amer. Chem. Soc.*, 1946, 68, (3), 520-521).—A note giving details of experimental melts, testing, and microscopical analysis of the compound. Some of its properties are mentioned.—J. B. C.

**Joint Discussion on the Papers:** "Graphite Formation in Cast Iron and in Nickel-Carbon and Cobalt-Carbon Alloys", by H. Morrogh and W. J. Williams, and "A Note on the Occurrence of Tellurium in Cast Iron", by H. Morrogh. — (*J. Iron Steel Inst.*, 1947, 156, (4), 491-496; 157, (2), 193-197).—Cf. *J. Iron Steel Inst.*, 1947, 155, (3), 321-371; see *Met. Abs.*, this vol., p. 35.—J. L. T.



**\*Ferromagnetic Resonance at Micro-Wave Frequencies** [Supermalloy]. W. A. Yager and R. M. Bozorth (*Phys. Rev.*, 1947, [ii], 72, (1), 80–81).—A note. The resonance phenomenon discovered by Griffiths (*Nature*, 1946, 158, 670; *Met. Abs.*, 1947, 14, 4) for ferromagnetic materials was interpreted theoretically by Kittel (*Phys. Rev.*, 1947, [ii], 71, 270; *Met. Abs.*, 1947, 14, 310). Experiments have been made on Supermalloy in order to test Kittel's theory and to evaluate the gyromagnetic ratio. The results indicated a Landé splitting factor,  $g$ , greater than 2, and as this is not to be expected, a refinement of Kittel's theory will be necessary. Some results were in better agreement with Frenkel's (*J. Physics (U.S.S.R.)*, 1945, 9, 299) form of damping term than with that of Kittel.—W. H.-R.

**\*High-Temperature Heat Contents of Titanium Carbide and Titanium Nitride.** B. F. Naylor (*J. Amer. Chem. Soc.*, 1946, 68, (3), 370–371).—High-temp. heat contents above 298° K. of these compounds were measured from about 360° to 1735° K. Specific-heat equations, heat contents, and entropies are given for each substance.—J. B. C.

**Order-Disorder Phenomena in Ferromagnetics and Binary Alloys.** J. de Boer (*Ned. Tijdschr. Natuurkunde*, 1947, 13, (3), 29–49; (4), 57–74).—[In Dutch]. A critical consideration of modern theoretical treatments of these phenomena. The exactness with which various parameters, calculated from the viewpoint of different theories, approach practical conditions is discussed. Among these parameters are: specific heat, spontaneous magnetization, and transition temp. Considerable space is devoted to a discussion of the mathematical problems involved. It is shown that Onsager's rigorous treatment of the phenomenon (*Phys. Rev.*, 1944, [ii], 65, 117; *Met. Abs.*, 1944, 11, 253) as an "eigenvalue" problem approaches reality most closely, and that there are serious errors if one of the numerous approx. treatments is used. This is particularly true as regards the representation of discontinuous parameters in the region of their discontinuity (transition point).—S. M.

**Thermodynamic Equilibria of Higher Order.** E. F. Lytle (*Phys. Rev.*, 1946, [ii], 69, (11/12), 652–665).—Theoretical.—W. H.-R.

**\*X-Ray Reflections from Dilute Solid Solutions.** K. Huang (*Proc. Roy. Soc.*, 1947, [A], 190, (1020), 102–117).—A theoretical study was made of the effects on the X-ray reflection of deviations of the atoms from the ideal lattice sites, caused by the presence of randomly-distributed foreign atoms in a dilute solid solution. It is shown that the reflections should be modified in a manner similar to that caused by thermal agitation, producing (1) a weakening of the ordinary interference maxima, and (2) the presence of "diffuse maxima". The results are discussed with regard to solid solutions of gold and copper (10 and 20%), which are of the cubic, face-centred lattice type, and it is concluded that although it should be possible to detect the first effect experimentally, the second effect may be masked by thermal diffuse maxima.—E. N.

**Colloidal Behaviour in Metals and Alloys.** (Dean). See p. 145.

### III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

[For all abstracts on the constitution of alloy systems, including X-ray studies, see II.—Properties of Alloys.]

**\*On the Determination of the Deformation of Single Crystals in Polycrystalline Metals by X-Ray Methods** [Aluminium]. Adéla Kochanovska (*Rev. Mét.*, 1947, 43, (7/8), 192–196; discussion, 196–197).—K. describes the use of reflection photographs, taken at wave-lengths so chosen that reflections on  $\theta = 90^\circ$  are obtained from three crystallographic directions, for the determin-

ation of the cell dimensions in cubic crystals. Internal standards (reflections from silver) were used on each plate in order to obtain the requisite high accuracy. The method was used for the study of the effect of deformation on the single crystals in polycrystalline steel and aluminium. In aluminium, the unit cells were compressed, but not deformed, i.e. they remained isotropic; in steel, on the other hand, they became anisotropic.—S. M.

**\*On the Relation Between Deformation and Recrystallization Texture of Nickel-Iron with Cubic Orientation.** J. F. H. Custers (*Physica*, 1947, 13, (1/3), 97–116; and *Lab. N. V. Philips' Gloeilampenfabrie. Eindhoven, Separaat*, 1947, 1727).—[In English]. Work was undertaken to find a satisfactory explanation for the fact that while nickel-iron (50:50) and aluminium, when rolled in the same direction, give rise to the same deformation structures, their structures become markedly different after subsequent recrystallization. The deformation structure of aluminium and nickel-iron, cold rolled in the [110] direction parallel to the (100) plane, is a combination of (110)[112] and (112)[111] orientations. While aluminium recrystallizes in this same orientation, nickel-iron orientates with a (100) plane parallel to the rolling plane and a [100] direction parallel to the rolling direction. It is thought that this recrystallization arises from fragments in this orientation situated on the slip planes acting as crystallization nuclei. No direct evidence for this could be found, however, so that the work in this sense must be called negative. It is held, however, that the quantitative data collected confirm Burgers's theory of recrystallization if allowance is made for some modifications due to Barrett.—S. M.

**Grain Boundaries in Metals.** — (*Engineer*, 1947, 184, (4779), 196–197).—A discussion of the work of Professor Zener and his co-workers at the University of Chicago on the viscous behaviour of grain boundaries.—R. GR.

**\*Stress Relaxation Across Grain Boundaries in Metals [Internal Friction in Aluminium].** (T'ing-Sui Kê). See p. 137.

**\*A Dynamical Model of a Crystal Structure.** (Sir) Lawrence Bragg and J. F. Nye (*Proc. Roy. Soc.*, 1947, [A], 190, (1023), 474–481).—The crystal structure of a metal can be represented by an assemblage of bubbles 2.0–0.1 mm. in dia. floating on the surface of a soap solution. The bubbles are blown from a fine pipette beneath the surface, with a const. air pressure and are remarkably uniform in size. These small bubbles are sufficiently persistent for experiments lasting an hour or more, they slide past each other without friction and they can be produced in large numbers. This model most nearly represents the behaviour of a metal structure, because the bubbles are of one type only and are held together by a general capillary attraction which represents the binding force of the free electrons in the metal. The assemblage shows structures which are supposed to exist in metals and simulate effects which have been observed. Photographs are given which show grain boundaries, dislocations and other types of fault, slip, recrystallization, annealing, and strain due to foreign bodies.—E. N.

**\*Finite Elastic Strain of Cubic Crystals.** (Birch). See p. 142.

**\*A Simple Technique for the X-Ray Determination of Fibre Axes in Electro-deposited Metals.** M. R. J. Wyllie (*Rev. Sci. Instruments*, 1947, 18, (6), 425–429).—The method described was specially developed so as to avoid stripping of the deposit. It therefore uses a glancing-beam method with a circular, fairly high camera in order to be able to record the largest possible number of lines. Methods of calculation for use in the interpretation of such photographs are given.—S. M.

**Stability and Spectrum in the Wave Mechanics of Lattices.** Aurel Wintner (*Phys. Rev.*, 1947, [ii], 72, (1), 81–82).—A theoretical note.—W. H.-R.

**\*Transverse Magnetization in Ferromagnetic Crystals in Relation to Domain Structure.** (von Engel and Wills). See p. 145.

## V.—POWDER METALLURGY

**Sinter-Alumina.**—I. Felix Singer and Hans Thurnauer (*Metallurgia*, 1947, 36, (215), 237–242).—Previous work on the production of ceramics from pure oxides is briefly reviewed, and the mechanical properties of sintered alumina described.—M. A. V.

**Carbide Cutting Tools.** — (*Amer. Exporter (Indust.)*, 1946, 138, (6), s24).—Cemented carbides are produced by powder-metallurgy methods from the carbides of tungsten, titanium, and tantalum, together with a suitable binding material such as cobalt. The highly abrasive aluminium-silicon alloys now used for pistons are examples of the type of material now being easily machined by cemented-carbide-tipped tools.—H. PL.

**\*Rate of Sintering of Copper Powder.** A. J. Shaler and J. Wulff (*Phys. Rev.*, 1947, [ii], 72, (1), 79–80).—A note. Frenkel (*J. Physics (U.S.S.R.)*, 1945, 9, 392; *Met. Abs.*, 1946, 13, 249) has proposed that the sintering of metal powders is caused by the driving force of surface tension which accounts for a flow having the linear relation between strain rate and stress characteristic of viscous liquids. The phenomenon of self-diffusion entails the existence of such a viscous flow. By extending the analysis of Frenkel, expressions have been derived for the rate of shrinkage at various temp. of powder aggregates having pores of uniform size. Equations have also been obtained which include the presence of foreign gases inside the pores and outside the aggregate. Experimental results for the sintering of uniform spherical copper particles in argon and in a vacuum are in qualitative agreement with those ideas, but indicate a heat of activation of self-diffusion of copper of over 85,000 cal. instead of the 57,000–61,000 cal. reported by Barrer ("Diffusion in and through Solids"). The effects when both large and small pores are present are discussed.—W. H.-R.

**Metallic Hydrides [Production and Uses of Titanium].** — (*Amer. Exporter (Indust.)*, 1946, 139, (3), s30).—Pure titanium metal is being made by Metal Hydrides, Inc., from the powdered hydrides pressed into briquettes and heated *in vacuo* to between 400° and 500° C. Sintered titanium has an electrical resistivity about 100 times that of copper so that it can be used in special conditions for electrical resistors for temp. much higher than those permissible for Nichrome and the other high-resistivity alloys. Titanium may prove a valuable substitute for tin in the production of special bronzes. At 900° C., it spreads like oil in a thin layer over a copper surface, and on cooling presents a coating much harder than pure copper. A layer of copper in which titanium is diffused by heat-treatment adheres very firmly to thin plates of iron and provides a protective coating on the inner surfaces of condenser tubes, &c. Zirconium, thorium, tantalum, chromium, and columbium of 99% purity are also produced by the hydride process.—H. PL.

**Packing of Material in Bulk.** Douglas Rennie Hudson (*Machinery (Lond.)*, 1947, 70, (1807), 617–622; (1809), 681–683).—Investigations on the packing densities of spheres, polyhedral materials, and irregular materials are reviewed. With actual spheres the packing is not nearly as close as in such metallic lattices as gold, silver, copper, aluminium (cubic), magnesium,  $\beta$ -calcium, and  $\beta$ -chromium (hexagonal); the voidage in the former case is approx. 37%, in metallic lattices it is approx. 26%.—J. L. T.

**Modern Powder Metallurgy.** H. W. Greenwood (*Engineering*, 1947, 163, (4246), 492).—G. reviews the general progress made in powder metallurgy up to the present and particularly during the war years in Germany, America, and Britain. He states that the progress made during the empirical era has been steady if not spectacular. Future fundamental investigations should provide valuable knowledge for wider fields of application. The possibilities



of powder metallurgy are beyond the range of conditions governed by the crucible and furnace, which means that the limitations of the phase rule, as indicated in the equilibrium diagram, do not hold.—R. GR.

**Powder Metallurgy : Some Queries.** H. W. Greenwood (*Engineer*, 1947, **183**, (4766), 471).—G. discusses the average figures for the mechanical properties of powder products, limitations of form and dimensions of components, cost and life of dies, and the advantages of powder methods.—R. GR.

**Powder Metallurgy [the Key to High-Temperature Power Applications].** — (*Amer. Exporter (Indust.)*, 1946, **139**, (1), s26.—See *Met. Abs.*, this vol., p. 106.—H. PL.

## VI.—CORROSION AND RELATED PHENOMENA

**Resistance of Aluminium Alloys to Fresh Water.** D. W. Sawyer and R. H. Brown (*Corrosion*, 1947, **3**, (9), 443–457).—A review of recent experience and published data.—M. A. V.

**Bearing Corrosion.** H. H. Zuidema (*Oil Gas J.*, 1946, **44**, (41), 100–108); (42), 151–158; (43), 66–72; *Machines et Métaux*, 1947, **31**, (343), 104–106; *C. Abs.*, 1946, **40**, (10), 2775).—A general discussion and literature review. A description is given of the ten groups of bearing metals, classified according to composition: tin-base Babbitt, lead-base Babbitt, alkali-hardened lead, cadmium alloy, copper-lead, bronze, silver, aluminium alloy, zinc alloy, and sintered powdered metals. Z. discusses also test methods, the mechanism of corrosion, factors influencing corrosion, and control of corrosion. Compounds for which inhibition of bearing corrosion is claimed in 163 representative U.S. patents are listed, together with the concentration required. 42 references are given.

**\*Anodic Corrosion of Brass.** J. M. Bialosky (*Corrosion and Material Protection*, 1947, **4**, (1), 15–16).—A series of experiments have been performed using Muntz metal, naval brass, arsenical Muntz, and arsenical naval brass with applied anodic current in various aqueous solutions at room temp. to determine the dezincification characteristics of these alloys. The results indicate that arsenical Muntz and arsenical naval brass resist this type of attack, and that naval brass is more resistant than Muntz metal under the conditions explored. The initial dezincification occurs in the  $\beta$ -phase and attack of the  $\alpha$ -phase follows. The dezincification reaction which was produced in these tests must have been due to selective attack of the zinc, rather than to redeposition of copper, which could not plate out on the anode of the cells.—AUTHOR.

**\*A Study of the Corrosion of Copper Alloy Condenser Tubes.** N. W. Mitchell (*Corrosion*, 1947, **3**, (5), 243–251).—The electrochemical and chemical corrosion, stress-corrosion, corrosion-fatigue, and impact erosion of copper alloys used in condenser tubes in petroleum refineries are described and illustrated by photomicrographs. A table is given showing the loss in tensile strength, due to sulphur corrosion of antimonial Admiralty brass (72% copper), Admiralty brass (71% copper), red brass, 20% cupro-nickel, 30% cupro-nickel, aluminium brass, and Muntz metal, after various periods of exposure in different parts of the plants. Data are also given of corrosion by water, and certain chemicals.—M. A. V.

**\*Copper-Base Alloy Tubes in Power Plants.** C. L. Bulow (*Southern Power and Ind.*, 1946, **64**, (5), 54–59, 76, 98; *C. Abs.*, 1946, **40**, (13), 3713).—Recently, some replacement tubes in condensers and heat exchangers have failed much more rapidly than the original tubes of the same alloy. Among the causes of this are the longer hours of operation, higher water velocities, and chlorination. The average life of condenser tubes in sea water of pH

7-8 is normally shorter than in fresh water of the same pH. Admiralty tubes are satisfactory with pH ranging up to 10; copper-nickel is satisfactory in alkaline waters of pH 7-14. Acid gases and ammonia have an adverse effect. Organic and suspended matter and their decomposition products may increase corrosion. Increased localized corrosion may be due to uneven deposition of corrosion products; an endeavour should be made to secure the formation and maintenance of a thin, continuous, uniform film on the surface of the proper alloy. Impingement corrosion is reduced by the use of aluminium brass, 70:30 copper-nickel containing about 0.5% iron, "Duronze IV", and special inserts. Corrosion may be due to stresses: where these cannot be controlled, copper, 70:30 copper-nickel, or duplex tubes should be used. Cyclic stresses due to vibration must be eliminated. Corrosion in heat exchangers can be minimized by keeping tubes clean and operating at the minimum temp. The elimination of carbon dioxide, ammonia, and hydrogen sulphide may also be necessary.

**A Survey of High-Temperature, Gas-Atmosphere Corrosion of Iron-Nickel-Chromium Alloys.**—I. —II. James T. Gow (*Corrosion*, 1947, 3, (7), 311-324; (8), 383-403; discussion, 403-405).—(I.—) The available literature on the structure, properties, and corrosion-resistance of iron-nickel-chromium alloys of various compositions is reviewed. Corrosion by hot oxygen, steam, carbon dioxide, sulphur dioxide, carbon monoxide, hydrocarbons, and hydrogen sulphide is considered. (II.—) Recent work by Brasunas, Gow, and Harder on the effect of nickel content on hot-air corrosion of alloys of various fixed chromium contents is discussed. Results of Hatfield's and Avery's researches on furnace-atmosphere corrosion are summarized, and the work of various investigators on scaling, sub-surface corrosion, and the nature of the oxide layer discussed. In conclusion, the complex nature of gas-atmosphere corrosion, and the present lack of understanding of its fundamentals, are emphasized.—M. A. V.

**Chemical Corrosion-Resistance of Lead.** — (*Corrosion*, 1946, 2, (6), 330-333).—A list of chemical corroding agents, and their effects upon lead.

—M. A. V.

**Discussion of Paper on Chemical Corrosion-Resistance of Lead.** H. H. Uhlig (*Corrosion*, 1947, 3, (3), 149-150).—Cf. preceding abstract. A note on the toxic effect of corrosion of lead piping.—M. A. V.

**Further Discussion of Paper [on] Chemical Corrosion-Resistance of Lead.** Robert L. Ziegfeld (*Corrosion*, 1947, 3, (7), 347-348).—Cf. preceding abstract. Z. discounts Uhlig's warning as to the toxic effect of corrosion of lead piping.

—M. A. V.

**\*The Rate of Dissolution of Magnesium and Zinc in Acids.** Cecil V. King, Henry Wishinsky, and Harry Bloodgood (*J. Amer. Chem. Soc.*, 1946, 68, (2), 238-239).—The rates of solution of magnesium and zinc chips in acids are independent of the stirring speed. These rates are compared with those obtained with sheets of metals suspended in similar acid solutions.—J. B. C.

**Resistance of Some Nickel-Containing Alloys to West Texas Crudes.** B. B. Morton (*Corrosion*, 1947, 3, (1), 23-36).—The corrosion-resistances of metals and alloys used in W. Texas oil-producing equipment are reviewed. These include nickel-plated sucker rods, Monel metal polished rods, chromium-plated nickel-copper alloys for pumps, K-Monel metal wire and gas-lift equipment, copper-nickel vessel linings, Inconel and 70:30 copper-nickel condenser tubes, and Ni-Resist, S-Monel, and K-Monel pump parts.—M. A. V.

**Corrosion—The Great Destroyer [Galvanized Tanks].**—D. J. Fergus (*Corrosion*, 1947, 3, (2), 55-66).—The problem of corrosion of galvanized steel hot-water tanks is discussed. It is concluded that the best counter-measure is cathodic protection by magnesium, which, in addition to its galvanic action, generates protective films on the tank walls.—M. A. V.

**Failures of [Galvanized] Domestic Hot-Water Storage Tanks.** Charles P. Hoover (*Corrosion*, 1947, 3, (4), 185-191).—See *Met. Abs.*, 1946, 13, 390.

—M. A. V.

**Corrosion of Galvanized Hot-Water Storage Tanks.** J. M. Bialosky (*Corrosion*, 1947, 3, (4), 192-197).—See *Met. Abs.*, this vol., p. 39.—M. A. V.

**Corrosion of Hot-Water-Storage Heaters.** Chris Goldkamp (*Gas*, 1946, 22, (2), 33-35; *C. Abs.*, 1946, 40, (8), 2098).—An important cause of corrosion is galvanic couples, caused by the use of galvanized tanks with water pipes and intake pipes of copper. Local corrosion can be caused by defects in the galvanizing and by lead in the coating. Corrosion occurs rapidly if the salt concentration of the water is high, and increases rapidly with temp., the rate of corrosion being twice as great at 180° F. (82° C.) as at 140° F. (60° C.). Other minor causes are listed. The use of non-ferrous metals throughout the tanks and piping would solve the problem; vitreous enamel and plastic coatings might be effective.—J. L. T.

**Corrosion-Resistant Processing Equipment of Clad Steels for Chemical and Allied Industries.** Everett C. Gosnell (*Corrosion*, 1946, 2, (6), 287-306).—An account of the corrosion-resistant properties and applications of various clad steels. The cladding metals include nickel, Monel metal, Inconel, aluminium, and silver.—M. A. V.

**Mechanical and Metallurgical Control of Sulphuric Acid Corrosion in Petroleum Processes.** E. R. Wilkinson (*Corrosion*, 1947, 3, (5), 252-262).—The corrosion rates of steel, nickel-chromium alloys, copper alloys, and lead in sulphuric acid of varying concentrations at 100° F. (38° C.), and in 45% sulphuric acid at 50°-350° F. (10°-177° C.), are presented graphically, and the suitability of various materials for specific applications shown in tabular form. The selection of materials is discussed in the light of these data.—M. A. V.

**The Electrical Engineer's Responsibility for Recognizing Corrosion as a Factor in the Design of Electrical Structures.** M. C. Miller (*Corrosion*, 1947, 3, (7), 341-346).—M. A. V.

**\*Thermogalvanic Corrosion.** N. E. Berry (*Corrosion*, 1946, 2, (5), 261-267).—The question of electrochemical corrosion due to a temp. difference between two separated areas is considered thermodynamically, and tests with a copper/copper sulphate cell, in which  $dE/dT$  was measured, are reported. The observed values agreed well with theoretical calculations.—M. A. V.

**Corrosion Ratings for Metals.** H. D. Holler and R. A. Frye (*Corrosion*, 1947, 3, (1), 8-21; discussion, 22).—A number of common metals and alloys are listed in order in an electromotive series, and their corrosion ratings, against the attack of various corroding agents, are tabulated.—M. A. V.

**Corrosion Criteria—Their Visual Evaluation.** Marc Darrin (*Corrosion*, 1946, 2, (5), 268-272).—See *Met. Abs.*, 1946, 13, 297; 1947, 14, 261.—M. A. V.

**Economic Aspects of Corrosion Problems.** F. A. Rohrman (*Corrosion*, 1947, 3, (2), 67-72).—A general discourse.—M. A. V.

## VII.—PROTECTION

(Other than by Electrodeposition.)

**War-Time Aircraft Finishes Used by the Army Air Force [Protection of Aluminium Alloys].** Louis Pereny (*Nat. Paint, Varnish, Lacquer Assoc., Sci. Sect. Circ.*, 1946, (714), 8-25; *C. Abs.*, 1946, 40, (13), 3911).—A review of the performance of aircraft finishes, together with some comments on the military requirements and considerations involved and some very general references to the types of composition that were found most successful. General results



of paint tests are summarized. Included in the discussion are : effectiveness of paint coatings in retarding corrosion ; causes of corrosion in order of importance ; conclusions resulting from laboratory tests of surface pre-treatment of aluminium alloys ; problems in the measurement of specular gloss ; chalking ; and fading problems in low-gloss camouflage paints.

**Continuous Galvanizing [of Pipes].** A. D. Stout, Jr. (*Iron Age*, 1947, 160, (9), 79–80).—S. describes a continuous pipe-galvanizing process capable of coating 600 tons of 2-in. pipe every 24 hr. It is said to produce greater smoothness, lustre, and uniformity than previous processes.—J. H. W.

**Zinc-Plate Corrosion. New Phosphating Process.** — (*Chem. Age*, 1946, 55, (1420), 325).—The Westinghouse Company has found that the use of a pre-dip of di-sodium phosphate containing traces of titanium gives greatly improved results.—M. A. V.

**Rust-Proofing of Metals [“Banox” Process for Steel and Zinc].** — (*Amer. Exporter (Indust.)*, 1946, 139, (5), s32).—A brief description of the “Banox” process, a chemical method of producing a protective phosphate coating on steel, zinc, and other metals and alloys.—H. PL.

**Phosphating Metallic Surfaces. I.—History and Pre-Treatments.** W. G. Cass (*Chem. Age*, 1946, 55, (1410), 5–8).—A brief history of the process, with particular reference to patents.—M. A. V.

**Phosphating Metallic Surfaces. II.—Baths and Compositions : Accelerating Methods. III.—Finishing Treatment.** W. G. Cass (*Chem. Age*, 1946, 55, (1411), 35–38 ; (1412), 67–70).—Cf. preceding abstract. A review of patent literature.—M. A. V.

**Phosphating Metallic Surfaces. IV.—Anti-Trust and Patent Litigation in the U.S.** W. G. Cass (*Chem. Age*, 1946, 55, (1413), 101–104).—Cf. preceding abstract.—M. A. V.

**The Prevention of Metallic Corrosion.** G. Fitzgerald-Lee (*Aeroplane*, 1947, 73, (1890), 251–253).—Thirty methods of corrosion prevention are mentioned. Cadmium plating is the best process for the treatment of steel parts and is widely used for aero-engine cylinder barrels, valve springs, studs, nuts, &c. The Bengough-Stuart anodizing process is the best process for aluminium and its alloys. Anodizing is better for wrought than for cast alloys, because differences in grain-size of the castings cause variations in the thickness of the film. Chromate pickling is particularly used for magnesium alloy castings. Bengough has originated a bath containing selenium dioxide and sodium chloride for the treatment of magnesium alloys to specifications D.T.D. 59A, 88B, 136A, and 259.—H. PL.

**Designing to Prevent Corrosion.** R. B. Mears and R. H. Brown (*Corrosion*, 1947, 3, (3), 97–118 ; discussion, 119–120 ; (6), 299–300).—The prevention of corrosion by avoiding the setting up of galvanic couples or the contact of dissimilar metals, is discussed. Cathodic protection, protective coatings, and inhibitors receive attention.—M. A. V.

**Fundamental Factors in Corrosion Control.** Herbert H. Uhlig (*Corrosion*, 1947, 3, (4), 173–184).—See *Met. Abs.*, 1947, 14, 261.—M. A. V.

**The Protection of Lighting Fittings Against Weathering and Corrosion.** W. E. Harper and C. A. Morton (*G.E.C. J.*, 1946, 14, (2), 111–120).—H. and M. review the nature of atmospheric corrosion and discuss the standard methods of protection used for the various materials utilized in making lighting fittings. The importance of proper maintenance is stressed.

—J. B. C.

**Protective Coatings on Bell-System Cables.** V. J. Albano and Robert Pope (*Corrosion*, 1947, 3, (5), 221–226).—An account of the construction, efficacy, and application of various types of cable protection, including tape-armoured cable, gopher-protected thermoplastic covered cable, and copper-jacketed cable.—M. A. V.

**Maintenance of Oil-Field Equipment.** D. R. Hiskey (*Corrosion*, 1946, 2, (5), 235-247; discussion, 247-248).—Corrosion of oil-field equipment and its prevention are discussed generally. Non-ferrous metals are often used for instrument cases; these may well be protected by plastic-base coatings.—M. A. V.

**Plastic Coatings to Control Metal Corrosion—A Review.** S. P. Wilson (*Corrosion*, 1947, 3, (3), 141-148).—The characteristics and applications of numerous types of plastic coating are outlined.—M. A. V.

**\*Chemical Reaction in Metal Protective Paints.** E. J. Dunn, Jr. (*Corrosion*, 1947, 3, (8), 374-382).—Investigations are reported on the chemical changes in anti-corrosive paints during drying and weathering. The formation of lead soaps has a beneficial effect.—M. A. V.

**Cathodic Protection of 138-kV. Lead-Sheathed Power Cables of the Los Angeles Department of Water and Power.** Irwin C. Dietze (*Corrosion*, 1947, 3, (9), 432-442).—The main problems to be solved in designing cathodic protection for the system were the maintenance of the entire cable system at an adequate negative potential; providing a voltage step between cable sheaths and ground at each end of the line to pass fault currents but restrict drainage currents; and equalizing sheath potentials of other systems to prevent current at crossing points.—M. A. V.

**\*Galvanic Aluminium Anodes for Cathodic Protection.** R. B. Hoxeng, E. D. Verink, and R. H. Brown (*Corrosion*, 1947, 3, (6), 263-274).—Progress in the development of aluminium anodes for cathodic protection of underground steel structures is reviewed. Zinc, which is anodic to aluminium, has been found a useful alloying element. Results of laboratory and service tests are quoted, and it is concluded that, in the present stage of development, aluminium alloy anodes can be constructed to give 675 amp. hr./lb., a performance superior to magnesium or zinc.—M. A. V.

**\*Magnesium Anodes for the Cathodic Protection of Underground Structures.** H. A. Robinson (*Corrosion*, 1946, 2, (4), 199-218; and (abridged) *Metal Progress*, 1947, 51, (5), 814, 818).—The strongly anodic solution potential of magnesium and its low electrochemical equivalent suggest that it is well suited for the cathodic protection of most common structural metals. An extensive series of laboratory and field tests was undertaken to determine the performance of magnesium anodes. Laboratory tests showed that a good performance should be expected of magnesium-6% aluminium-3% zinc anodes; field tests, although not yet complete, generally support laboratory data.—M. A. V.

**\*A Magnesium-Anode Installation for Preventing the Corrosion of Lead Cable Sheath.** H. A. Robinson and R. L. Featherly (*Corrosion*, 1947, 3, (7), 349-357).—The Dow Chemical Company has developed and tested a galvanic magnesium anode for protecting underground lead cable. Results of tests are presented. The test installation showed no sign of deterioration after 21 months of service.—M. A. V.

**Construction and Ratings of Copper Oxide Rectifiers for Cathodic Protection of Pipelines.** L. W. Burton and C. E. Hamann (*Corrosion*, 1947, 3, (2), 75-95).—The construction, electrical characteristics (including ageing), and practical use of copper oxide rectifiers are described.—M. A. V.

**Selenium Rectifiers for Cathodic Protection.** W. F. Bonner (*Corrosion*, 1946, 2, (5), 249-260).—The construction, characteristics, and application of selenium rectifiers are described. Single-phase power is generally used for cathodic protection.—M. A. V.

**Cathodic-Protection Rectifiers.** W. L. Roush and E. I. Wood (*Corrosion*, 1947, 3, (4), 169-172).—Factors affecting the service life of self-cooled, fan-cooled, and oil-immersed rectifiers are considered. Experience shows the oil-immersed type to be the most adaptable for all atmospheric conditions.

—M. A. V.

**Cathodic Protection.** C. H. McRaven (*Corrosion*, 1946, 2, (6), 320–329).—A general discourse.—M. A. V.

**Contributions of Sir Humphrey Davy to Cathodic Protection.** I. A. Denison (*Corrosion*, 1947, 3, (6), 295–298).—An historical review.—M. A. V.

### VIII.—ELECTRODEPOSITION

**Colloid Factors in the Electrodeposition of Metals.** Louis Weisberg (*Colloid Chem.*, 1946, 6, 579–586; *C. Abs.*, 1946, 40, (9), 2394).—W. discusses interference with crystal growth, colloid formation at the cathode, colloidal and surface-active addition agents, brighteners, stress and embrittlement, and anodic effects. 47 references are given.

**Some Impressions of Electroplating in the U.S.A.** A. W. Hotherhall (*Galvano*, 1947, 16, (128), 7–11).—See *Met. Abs.*, this vol., p. 47.

\***A Simple Technique for the X-Ray Determination of Fibre Axes in Electrodeposited Metals.** (Wyllie). See p. 150.

### IX.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

\***Oxide Coatings. The Effect of the Coating Core Interface on Conductivity and Emission [Coatings on Nickel].** D. A. Wright (*Proc. Roy. Soc.*, 1947, [A], 190, (1022), 394–417).—Measurements were made of the electrical conductivity and emission of typical barium/strontium oxide coatings on a base of nickel containing small amounts of magnesium or aluminium, under continuous current conditions at low c.d. It was found that a potential barrier occurs at the interface, leading to rectifier action, this barrier restricting the flow of current from metal to semi-conductor. The barrier layer,  $< 10^{-4}$  cm. thick, is probably a semi-conducting layer, of nickel-containing magnesium oxide, with a higher resistance than that of the bulk coating. The rapid decay of emission immediately following the application of anode voltage is also to be associated with the barrier, and it is possible that an adsorbed film of barium is present on the nickel surface, in equilibrium, which reduces the work function of the nickel and consequently reduces the height of the barrier. The results are discussed and applied to the operation of cavity magnetrons. —E. N.

### X.—REFINING

**The Story of Malleable Platinum.** M. Schofield (*Endeavour*, 1947, 6, (23), 125–128).—To the early Spanish gold miners, platinum was merely an objectionable impurity. S. deals with the history of the attempts to fabricate platinum and their ultimate success. There is special reference to the work of W. H. Wollaston, who applied powder-metallurgical methods.—J. B. C.

### XI.—ANALYSIS

**Recent Developments in Analytical Chemistry.—XVII. [Detection and Determination of Copper].** — (*Chem. Age*, 1946, 55, (1415), 163–166).—Notes are given on recent methods of detecting and determining Cu, including spot-tests for Cu in steel, using  $\alpha$ -benzoin oxime; the separation of Cu and



Cd by Evans, Garrett, and Quill's volumetric method, and Bishop's chromatographic method; the electrolytic estimation of Cu in bronzes, brasses, and Al alloys; the rapid volumetric determination of Cu in steel; and polarographic, colorimetric, and spectrophotometric methods. The Baker and Reedy test for Ag and the Evans and Higgs volumetric method are also described.—M. A. V.

**Distinguishing the Be-Cu Alloys.** Frank C. Bennett, Jr. (*Metal Progress*, 1947, 52, (2), 250).

**\*Two Very Sensitive Qualitative Tests for Metallic Mercury and Tin.** Georges Denigès (*Compt. rend.*, 1947, 224, (26), 1799-1801).—Three reagents are described. Reagent A: a 5% aqueous solution of  $\text{Hg}(\text{CN})_2$ ; reagent B: an aqueous solution of mercury potassium iodide; reagent C: reagent B + an equal amount of 15% NaCl, which stabilizes the solution. D. gives details of the use of these reagents in the identification of metallic Hg and Sn, and its practical applications.—J. H. W.

**\*Applications of the Polarograph to Metallurgical Analysis. III.—Further Studies on a Polarographic Method for the Determination of Lead in Copper-Base Alloys.** G. W. C. Milner (*Metallurgia*, 1947, 36, (215), 287-289).—Cf. *Met. Abs.*, 1947, 14, 394. Polarographic methods of determining Pb in Cu-base alloys, previously described, are not completely satisfactory if Mn is present. A new method is described, in which the interfering Mn is converted by triethanolamine into a complex which is stable in the alkaline cyanide medium required for Pb determination.—M. A. V.

**Polarography. The Electrochemical Analysis of Metals.** L. Sanderson (*Chem. Age*, 1946, 55, (1419), 289-292).—The basic principles of the process are outlined.—M. A. V.

**\*A Study of the Effect of the Microstructure of the Electrodes on the Reproducibility of Spectrographic Analysis of Al-Cu-Mg-Si Alloys.** J. M. Pourvreau (*Rep. 7me. Congr. Groupement Avancement Méthodes Anal. Spectrograph. Produits Métallurg.* (Jan. 21-23), 1947, 61-63).—Al alloys containing 4% Cu, with Mg, Mn, Si, and Fe each <1%, were cast in 6-mm. rods in Cu chill moulds, and other samples were remelted and cast in slowly cooled graphite cylinders. 40 spark spectra were recorded from each sample, and the standard deviations of the concentration of the elements Mg, Mn, Si, and Fe were worked out from the microphotometric measurements of stepped spectra for each element. They ranged from 3.4 to 4.8% for the chill-cast samples and 8-11% for the remelted samples.—E. VAN S.

**\*The Spectrochemical Analysis of Nickel Alloys.** Edwin K. Jaycox (*J. Opt. Soc. Amer.*, 1947, 37, (3), 159-165).—To get over the difficulty of comparing various forms of wrought Ni and its alloys, they are treated by dissolving in  $\text{HNO}_3$  and evaporating to give a mixture of nitrate and oxide, which is mixed with carbon dust so that it can be smoothly arc-ed in a graphite crater. Wave-lengths for the estimation of B, Cu, Mg, Mn, Fe, Si, Ti, Pb, and Zn are given with details and a few examples of analytical results. B can be estimated down to 0.0003% and the other elements down to 0.005%. —E. VAN S.

**\*Report on Tests of the Spark Generator for Spectrographic Analysis Made by M. R. Durr in the Spectral-Analysis Section of the Research Department of the Uginé Steelworks.** R. Castro (*Rep. 7me. Congr. Groupement Avancement Méthodes Anal. Spectrograph. Produits Métallurg.* (Jan. 21-23), 1947, 79-85).—A controlled-spark generator of the Feussner type, with a rotary interrupter in the discharge circuit, was compared with the Feussner generator by recording spectra from the two circuits on the same plate, using nominally the same values of capacitance and inductance in the discharge circuit. The differences observed appear to be due to different values of the indicated current in the H.F. circuit, and it is suggested that if this current, as well

as the capacitance and inductance, are specified, the spectrographic value of a spark can be completely described so that it can be reproduced by other workers. In reproducibility of spectra, the Durr source is similar to the Feussner one.—E. VAN S.

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

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

**\*Measurement of Metal-Polish Performance.** Frank E. Clarke and Robert C. Adams (*Bull. Amer. Soc. Test. Mat.*, 1947, (147), 57–62).—A method of giving a standard degree of tarnish to a polished specimen, and then polishing away the tarnish under specific conditions, is described. The degree of tarnish and polish is measured by the reflectivity of the specimen. The efficiency of the metal polish is taken as the percentage restoration of reflectivity after standard polishing. Abrasion, caking, and other tests are also mentioned.—J. B. C.

**Fisher Hi-Temp. Bath.** — (*Laboratory*, 1947, 17, (2), 57).—The bath is cast in aluminium and has a built-in thermostat. It can be used for distilling, extracting, and melting.—J. L. T.

**A New Polarograph.** James H. Schulman, H. Bruce Batty, and Demetrius G. Jelatus (*Rev. Sci. Instruments*, 1947, 18, (4), 226–231).—Electrical and mechanical details of the construction of a polarograph are given. The essential feature is the use of a new type of D.C. amplifier, which permits instantaneous records to be obtained on a permanent ink-track recorder giving full deflection for 0.5 m.amp. The time lag in this current-recording system is of the order of 0.5 sec., so that accurate records can be obtained even at high rates of voltage change.—S. M.

**\*The Measurement of the Intensity Ratios of Spectral Lines with Electron-Multiplier Photo-Tubes.** K. G. Kessler and R. A. Wolfe (*J. Opt. Soc. Amer.*, 1947, 37, (3), 133–144).—A detailed description of the properties of some available photo-multiplier tubes and of a new circuit for measuring the ratio of the intensity of two spectrum lines. Each line illuminates one tube, and the photo-currents from the tubes are taken to calibrated potential dividers, followed by narrow band-pass filters tuned to twice the A.C. frequency. These raise the signal:noise ratio from the tubes. After one more stage of amplification each output is rectified, and they are fed in opposition to a valve voltmeter, used as a null instrument to balance the two circuits. The variable actually observed is the potential-divider reading in one of the circuits, and the precision of reading is about as good as photographic methods for Cr in Fe. One analysis takes about 2 min.—E. VAN S.

**\*Method of Correcting Low-Angle X-Ray Diffraction Curves for the Study of Small Particle Sizes.** Jesse W. M. Du Mond. (*Phys. Rev.*, 1947, [ii], 72, (1), 83–84).—A note. The reflection-type focusing, curved-crystal spectrometer of Guinier (*Ann. Physique*, 1939, [xi], 12, 161; *Met. Abs.*, 1940, 7, 66) is described, and also a new two-crystal spectrometer for the study of low-angle X-ray diffraction. The diffraction patterns obtained in both cases require a correction in order to obtain the true radial intensity distribution. A method for making this correction is described.—W. H. R.

**\*An Investigation of the Properties of Evaporated [Nickel] Metal Bolometers.** R. H. Billings, W. L. Hyde, and E. E. Barr (*J. Opt. Soc. Amer.*, 1947, 37, (3), 123–132).—Strips of nickel less than 1  $\mu$  thick, deposited on a plastic base by evaporation, form one of the most sensitive methods of detecting

radiation, and a useful comparison with thermistor bolometers, dielectric bolometers, and thermocouples is given. A theoretical analysis of the performance of bolometers is complicated by the fact that both the coeff. of resistivity and the temp. coeff. of resistivity of evaporated nickel are functions of the film thickness in the range 100–500 Å. Useful details on the determination of electrical resistivity and film thicknesses are given: an interferometric estimate of thickness is recommended since the films are somewhat porous.—E. VAN S.

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

**\*Conducting-Paint Electrodes for Dielectric Measurements.** E. Gerald Meyer and Myron A. Elliott (*Bull. Amer. Soc. Test. Mat.*, 1947, (147), 63–64).—Various types of conducting materials, including tin-foil, zinc, and “conducting silver paint”, are compared as electrode materials for dielectric-constant and power-factor measurements on polystyrene. A convenient method of preparing and applying the paint as a quick-drying spray is described. There is no damaging of the surface of the specimen by this method.—J. B. C.

**Non-Destructive Thickness Measurements.** — (*Metal Finishing*, 1947, 45, (10), 87).—Engineering data sheet.—J. L. T.

**\*The Micro-Sclerometer: A New Micro-Hardness Tester.** R. Girschig (*Metallurgia*, 1947, 36, (215), 269–273).—An abridged translation of *Rev. Mét.*, 1946, 43, 95–112; see *Met. Abs.*, this vol., p. 25.—M. A. V.

**\*New Apparatus for Axial-Load Fatigue Testing.** William N. Findley (*Bull. Amer. Soc. Test. Mat.*, 1947, (147), 54–56).—A fatigue-testing machine is described which permits testing of specimens in axial tension or compression. The machine is designed so that strains, introduced into the specimen when clamped, may be detected and corrected. Hence, the stress in the specimen may be made more nearly uniform over the cross-section than is usually possible.—J. B. C.

**\*Reproducibility of the Single-Blow Charpy Notched-Bar Test.** N. A. Kahn and E. A. Imbembo (*Bull. Amer. Soc. Test. Mat.*, 1947, (146), 66–74).—Charpy test-specimen blanks, completely machined but not notched, were prepared from a uniformly stress-relieved mild steel. 24 blanks were sent to seven different laboratories. Each prepared 12 specimens with the key-hole notch and 12 with the V-notch. 6 of each type were tested at the laboratory and 6 by the authors. The temp.-impact relationship for both types of notch was determined. Evidence is presented which indicates definite superiority of the keyhole notch over the V-notch for the material tested, with respect to the reproducibility of the Charpy energy values and revelation of the transition zone in the temp.-impact relationship.—J. B. C.

**The Notched-Bar Impact Test-Piece.** — (*Engineer*, 1947, 184, (4779), 197).—Schnadt, as quoted by J. A. Haringx, proposes to remove the material in the region which would become the compression zone in an impact test-piece, by drilling a hole in the specimen and inserting a loose-fitting hardened steel pin. The pendulum strikes against the steel pin instead of the softer material of the test-piece. This proposal is discussed. The study made by Kahn and Imbembo on the reproducibility of results obtained in the single-blow Charpy test with two types of notch (see preceding abstract) is also summarized.—R. GR.

**\*The Effect of Notching on Materials of Construction Under Static and Dynamic Tension.** Georges Welter (*Metallurgia*, 1947, 36, (215), 283–286).—Static and dynamic tensile tests are reported on notched specimens, of various



sizes and shapes, of aluminium, aluminium alloy, copper, brass, AM57S magnesium alloy, zinc, Monel R.B, and steel. Loading speeds in the dynamic tests were 11.78, 16.68, and 29 ft./sec. Work of previous investigators (which is reviewed) showed the resistance to increase generally with testing speed.—M. A. V.

**Engineering Significance of Metal Testing.** Blake D. Mills, Jr. (*Iron Age*, 1947, 160, (6), 78–83).—M. discusses several types of physical-testing methods, including tension, compression, notched-bar, high-velocity, creep, and fatigue tests, with particular reference to their correlation with engineering practice, and describes the use of statistical methods of checking material quality.—J. H. W.

**\*Deformation of Metals During Single and Repeated Tensile Impact.** (Pope). See p. 141.

**Inspection in a Mechanized Foundry.** P. Cook (*Proc. Inst. Brit. Found.*, 1945–46, 39, B32–B45).—See *Met. Abs.*, 1946, 13, 307.—J. E. G.

### RADIOLOGY

**Radiography in the Die-Casting Industry.** R. W. Dively (*Indust. Radiography Non-Destructive Test.*, 1947, 6, (1), 20–21, 39).—A 140-kV. X-ray unit is utilized to determine the presence of porosity, cold shuts, inclusions, and shrinks in aluminium and zinc die-castings up to 5 in. and  $\frac{3}{8}$  in. in thickness, respectively, with a sensitivity of 0.5%. Inclusions of a precipitated sludge of Al–Si–Fe–Mn have been found in aluminium alloy die-castings.—L. M.

**Sliding Scales to Increase the Usefulness of Radiographic Exposure Charts.** G. M. Corney (*Indust. Radiography Non-Destructive Test.*, 1947, 6, (1), 44–46).—A standard radiographic-exposure chart for any given metal and X-ray equipment may be readily used for different films, other film densities, and increased or decreased focus–film distances, by substituting a sliding scale for the fixed scale on the exposure axis. A fixed mark on the sliding scale is moved to coincide with reference marks on the exposure axis, which are fixed from a knowledge of the changes of exposure resulting from use of a different film, density, or focus–film distance.—L. M.

**A Densitometer of Unusually High Sensitivity.** Monroe H. Sweet (*Indust. Radiography Non-Destructive Test.*, 1947, 6, (1), 47–48).—A brief description of a densitometer for measuring film densities, e.g. in X-ray sensitometry, up to 6.0.—L. M.

**Engineering Radiography.** V. E. Pullin (*Engineer*, 1947, 184, (4784), 319).—P. states that in future radon or radium emanation for radiography will become generally available. It has advantages over radium salt, which he enumerates.—R. GR.

**High Speed X-Ray Photography.** — (*Machinery Lloyd*, 1946, 18, (10), 87).—The Westinghouse Electric Corporation has perfected an X-ray tube capable of making exposures of a millionth of a second. In arc welding, it is possible to take X-ray photographs which are not in the least blurred by the light from the electric arc, and thus the transfer of metal during welding can be studied.—H. PL.

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## XIV.—TEMPERATURE MEASUREMENT AND CONTROL

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**Temperature Determination of Molten Metal.** G. Vennerholm and L. C. Tate (*Amer. Foundryman*, 1947, 11, (5), 56–63).—Recent developments in the construction and application of radiation and immersion pyrometers, for measuring molten-metal temp. in the range 2200°–3200° F. (1204°–1760° C.), are discussed.—V. K.

**Temperature Measurement by Means of an Immersion Pyrometer.** E. Hunter, A. R. Parkes, and J. W. Dews (*Proc. Inst. Brit. Found.*, 1945-46, 39, B75-B81).—See *Met. Abs.*, 1946, 13, 133.—J. E. G.

**An Air-Operated Automatic Controller.** — (*Engineer*, 1947, 184, (4778), 171-173).—A description is given of a controller for temp., pressure, &c. It is designed to perform the following kinds of control: proportional, floating and proportional, proportional and first derivative, and floating plus proportional plus first derivative.—R. GR.

## XV.—FOUNDRY PRACTICE AND APPLIANCES

**Casting Magnesium in Metal Moulds.** Herbert Chase (*Iron Age*, 1947, 160, (13), 73-76).—C. describes the practice followed in a large plant for producing magnesium parts as die-castings and in permanent and semi-permanent moulds, stressing the need for close control of the casting cycle, especially ejection. He also describes a magnesium die-casting alloy with improved ductility and impact strength.—J. H. W.

**Gating Magnesium Alloy Castings.** H. E. Elliott and F. G. Mezoff (*Amer. Foundryman*, 1947, 11, (5), 71-79).—A modification of the side-gating method is described. The main feature of this method is an annular screen loosely filled with coarse steel wool through which the metal flows before entering the slot gate. Soundness and freedom from inclusions in the casting are claimed to result from the unidirectional solidification and non-turbulent flow of metal which are obtained by the application of this type of gate.—V. K.

**Elektron Moulding Boxes.** — (*Found. Trade J.*, 1947, 83, (1624), 127-128).—A brief account of the design, manufacture, and utilization of Elektron moulding boxes.—J. E. G.

**Melting Aluminium Scrap in the Low-Frequency Induction Furnace.** (Tama). See p. 164.

\*[Ageing of] **Aluminium Sand-Casting Alloys.** (Quadt). See p. 164.

**Fluidity Testing of Foundry Alloys.** K. L. Clark (*Proc. Inst. Brit. Found.*, 1945-46, 39, A52-A63; discussion, A64-A71).—See *Met. Abs.*, 1946, 13, 402.—J. E. G.

**Standard Test Bars for the Non-Ferrous Foundry.** Frank Hudson (*Proc. Inst. Brit. Found.*, 1945-46, 39, A72-A78; discussion, A78-A88).—See *Met. Abs.*, 1946, 13, 368; 1947, 14, 26, 223.—J. E. G.

**Duplex Pump Castings.** R. H. Brown (*Proc. Inst. Brit. Found.*, 1945-46, 39, B4-B14).—See *Met. Abs.*, 1946, 13, 309.—J. E. G.

**The Technological Principles of Casting Design.** Victor M. Shestopal (*Proc. Inst. Brit. Found.*, 1945-46, 39, B51-B63; discussion, B63-B65).—See *Met. Abs.*, 1946, 13, 100, 309.—J. E. G.

**Gates and Risers.** Nathan Janco (*Amer. Foundryman*, 1947, 11, (6), 57-60).—A method of calculation of sizes of gates and risers is suggested. The ratio of the area of section of casting to the perimeter of the same section is defined as its cooling factor, and this must be smaller than the cooling factor of the riser, or gate which serves as a riser.—V. K.

\***New Process Chemically Treats Moulding Sand.** Thomas W. Curry (*Amer. Foundryman*, 1947, 11, (6), 51-56).—Large-scale trials on specially treated moulding sand were carried out under industrial conditions. The sand is initially mulled with a high carbon resin which is soluble in suitable chemicals (the compositions are not given). It is claimed that the sand so treated gives better moulding and casting properties, resulting in an overall saving in production costs.—V. K.

\***Foundry-Sand Reclamation.** J. M. Cummings and W. M. Armstrong (*Amer. Foundryman*, 1947, 12, (1), 35-39, 65).—Small-scale experiments

were carried out to determine the costs of full reclamation of foundry sands. It was found that a satisfactory process requires three stages, viz. scrubbing, classification, and calcining, and that it becomes economically advantageous when transport charges are considerable.—V. K.

**\*[Testing of] Moulding Sands.** C. R. Gardner (*Amer. Foundryman*, 1947, 11, (6), 34–38).—Standard properties of two types of synthetic sands were measured as functions of moisture content and degree of ramming. G. suggests that the graphs thus obtained could be used as a basis for non-destructive testing of sand in a mould.—V. K.

**Determination of "Gas Content" of Sand Cores.** — (*Proc. Inst. Brit. Found.*, 1945–46, 39, A192–A194).—See *Met. Abs.*, 1946, 13, 336.—J. E. G.

**Sand Supply to Moulding Machines for Overhead Hoppers.** N. C. Blythe (*Proc. Inst. Brit. Found.*, 1945–46, 39, B1–B2; discussion, B2–B3).—See *Met. Abs.*, 1946, 13, 136.—J. E. G.

**Mould and Core Materials.** N. J. Dunbeck (*Western Metals*, 1946, 4, (Sep.), 51–52, 54–56, 58–62; and *Nassau*, 1947, 9, (4), 3–11; (5), 3–11).—A review, presented to the Southern California Chapter of the American Foundrymen's Association.—J. L. T.

**Liquid Phenolic Resins for Casting.** C. R. Simmons (*Amer. Foundryman*, 1947, 11, (5), 94–96).—The technique of producing patterns in phenolic resins is discussed.—V. K.

**Making Plastic Patterns.** E. J. McAfee (*Amer. Foundryman*, 1947, 12, (1), 26–31).—The technique of producing mounted and unmounted patterns in various types of phenol plastics is described. Such patterns could be used for hand or machine moulding and have certain advantages over standard pattern materials, with which they are also competitive for duplication, intricate work, and mass production.—V. K.

**The Application of Ethyl Silicate to Foundry Practice.** Clifford Shaw (*Proc. Inst. Brit. Found.*, 1945–46, 39, B99–B101; discussion, B101–B104).—See *Met. Abs.*, 1946, 13, 136.—J. E. G.

**Abrasive Blasting of Castings.** R. L. Orth (*Amer. Foundryman*, 1947, 12, (2), 22–25).—Blasting equipment, its selection, operation, and maintenance are discussed.—V. K.

**The Handling and Transport of Materials in a Modern Factory.** W. L. Beeby and W. Symes (*Trans. Manchester Assoc. Eng.*, 1946–47, 147–163; discussion, 164–172).—See *Met. Abs.*, this vol., p. 56.—J. L. T.

**Hampton Court Clock.** — (*Found. Trade J.*, 1947, 83, (1620), 54).—Notes regarding restoration work carried out on the Hampton Court clock and facts about early bell-founding are given.—J. E. G.

**The Present Position of Centrifugal Casting.** [—II]. Jacques Boucher (*Fonderie*, 1947, (15), 553–563).—Cf. *Met. Abs.*, this vol., p. 56. B. reviews recent developments in this field. Mention is made particularly of the casting of thin-walled tubes on horizontal slow-speed machines, with special reference to small-diameter tubes (18–25 mm.) in lengths up to 3 m. Compositions for permanent moulds in cast iron (carbon 3–3.2, silicon 1.5–2, manganese 0.9–1%; or carbon 3.2, silicon 2.3, manganese 0.7, nickel 3.5, molybdenum 0.5%) and in steel (various steels with carbon 0.25–0.4, molybdenum 0.25–0.5%, with or without chromium and vanadium) are given. The casting of bronzes in semi-permanent graphite moulds is described. Examples of centrifugal-pressure castings, e.g. gear-wheels and squirrel-cage rotors, are discussed. Speeds range up to 300 m./min.—S. M.

**The Formation of Banded Structures in Horizontal Centrifugal Castings.** H. O. Howson (*Proc. Inst. Brit. Found.*, 1945–46, 39, B110–B118; discussion, B118–B121).—See *Met. Abs.*, 1946, 13, 135, 309.—J. E. G.

**Precision-Casting Small Aluminium Impellers.** Eugene M. Cramer (*Amer. Foundryman*, 1947, 12, (2), 36–38).—The technique of casting small impellers



of an aluminium alloy containing zinc 5.25 and magnesium 0.5%, in a plaster mould, is described. A combination of centrifugal and static methods was applied.—V. K.

**Casting Reflections.** D. Howard Wood (*Proc. Inst. Brit. Found.*, 1945-46, 39, A17-A20).—See *Met. Abs.*, 1946, 13, 335.—J. E. G.

**Castings and Weldings.** (Sir) Claude D. Gibb (*Proc. Inst. Brit. Found.*, 1945-46, 39, A21-A27).—See *Met. Abs.*, 1946, 13, 335.—J. E. G.

**Technical Records in the Foundry.** R. D. Lawrie (*Proc. Inst. Brit. Found.*, 1945-46, 39, B82-B84; discussion, B84-B91).—See *Met. Abs.*, 1946, 13, 309.—J. E. G.

**Apprentice Training in the Foundry.** John B. Longmuir (*Proc. Inst. Brit. Found.*, 1945-46, 39, B66-B70).—See *Met. Abs.*, 1946, 13, 336.—J. E. G.

**Foundry Education and Recruitment.** D. H. Ingall (*Proc. Inst. Brit. Found.*, 1945-46, 39, B92-B95; discussion, B95-B98).—See *Met. Abs.*, 1946, 13, 309.—J. E. G.

## XVI.—SECONDARY METALS : SCRAP, RESIDUES, &c.

**Melting Aluminium Scrap in the Low-Frequency Induction Furnace.** Manuel Tama (*Iron Age*, 1947, 160, (10), 77-78).—T. describes low-frequency melting and explains its advantages in producing high recovery rate (96%) in melting aluminium scrap. He also discusses the characteristics of oxide-coated particles and their effect on heat transfer in the furnace.—J. H. W.

## XVII.—FURNACES, FUELS, AND REFRACTORY MATERIALS

**A Lead-Melting Furnace.** — (*Engineer*, 1947, 184, (4781), 255).—A description is given of a gas-fired lead-melting furnace for cable sheathing. The melting rate is 7000 lb./hr. when loaded in batches of 1800 lb. Constructional features such as stirrer arrangement and flame control are described.—R. Gr.

**Electronic Frequency Converters for Induction Melting Furnaces.** S. R. Durand (*Iron Age*, 1947, 160, (13), 64-67, 134).—D. describes several furnace installations, using electronic frequency-changing equipment, for melting both alloy steel and non-ferrous alloys.—J. H. W.

**"Infra-Red" Heating by Gas : Its Development and Practice To-Day.** [—II]. J. B. Carne (*Metallurgia*, 1947, 36, (215), 245-249).—Cf. *Met. Abs.*, this vol., p. 59. Illustrated descriptions are given of a few industrial, gas-fired infra-red radiant ovens.—M. A. V.

**Fuel Saving in Metal Making. Direct Operation Methods.** Leslie Aitchison (*Chem. Age*, 1946, 55, (1427), 535-537).—Report of a paper "Fuel Considerations in the Fabrication of Non-Ferrous Metals and Light Alloys", presented at the Conference on "Fuel and the Future" in October 1946.

—M. A. V.

## XVIII.—HEAT-TREATMENT

\*[Ageing of] **Aluminium Sand-Casting Alloys.** H. A. Quadt (*Amer. Foundryman*, 1947, 11, (6), 39-42).—Q. studied the effect of the time interval between the quenching and artificial ageing treatment on the mechanical properties of artificially aged aluminium casting alloys. He found that the properties of alloys containing  $Mg_2Si$  are sensitive to the length of this time interval, the

alloys having a low ductility if artificially aged immediately after the quenching.—V. K.

**Heat-Treatment of High-Tensile Aluminium Alloy Sheet.** J. G. Gwatkin (*Aircraft Prodn.*, 1946, 8, (97), 527–528).—The properties and heat-treatment of the strong light-alloy sheets covered by specifications D.T.D. 546B (Alclad), and D.T.D. 646, both of which are double heat-treated, and those of the naturally aged sheets D.T.D. 610 (Alclad) and D.T.D. 603 are discussed in relation to shop handling and routine treatment.—H. S.

**The Bright Annealing of Copper.** Ivor Jenkins and S. V. Williams (*G.E.C. J.*, 1946, 14, (2), 90–96).—The authors discuss: the normal burnt town's gas and burnt-ammonia atmospheres with reference to oxygen and hydrogen; the effect of sulphur contained in rolling oils; and the effect of steam in contact with the annealing chamber ( $\text{Fe} + \text{H}_2\text{O} \rightleftharpoons \text{FeO} + \text{H}_2$ ). Furnace pots can be sprayed with copper or aluminium to prevent hydrogenation of organic sulphur compounds which may be introduced into or formed inside the pot.

—J. B. C.

**Classification of Prepared Atmospheres.** C. C. Eeles and M. E. Shriner (*Metal Progress*, 1947, 52, (2), 256-B).—Data sheet.—J. L. T.

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## XIX.—WORKING

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**Die Design for Aluminium Alloys.** E. W. Mason (*Machinist (Eur. Edn.)*, 1947, 91, (20), 632–634).—An abstract of an address to the Toledo district of the Pressed Metal Institute. M. describes the workability of seven wrought aluminium alloys commonly used in metal forming, and discusses die design in relation to the object to be formed.—J. H. W.

**Forming of Aluminium Alloys. Use of the Rubber Die Press.** — (*Chem. Age*, 1946, 55, (1414), 137–139).—A digest of Aluminium Development Association Information Bulletin No. 11.—M. A. V.

**\*Dimpling Light-Alloy Sheet [75S].** — (*Aircraft Prodn.*, 1946, 8, (97), 536–540).—Experimental work on hot dimpling of sheets in the high-strength aluminium alloy 75S for flush riveting, at the University of California, is described. The methods include local resistance heating and forming during the last part of the heating cycle between cooled dies, and also forming between hot dies, which provide the heat required. Descriptions of the apparatus used and the operational features are given with illustrations.—H. S.

**The Use of Zinc Alloys for Blanking Dies.** J. W. Sladden and H. S. Walker (*Machinery (Lond.)*, 1947, 71, (1824), 407–408).—Summary of *Sheet Metal Ind.*, 1947, 24, (239), 567–581, 586; see *Met. Abs.*, 1947, 14, 407.

—J. L. T.

**Design and Production Technique. V.—Principles Involved in Pressing.** A. J. Schroeder (*Aircraft Eng.*, 1946, 18, (211), 320–323; (212), 357–362).—Cf. *Met. Abs.*, 1944, 11, 273. The production of components by cold and hot pressing of metals is described, as well as the pressing of ceramic materials and plastics. Design features are considered and economic aspects discussed.—H. S.

**Aluminium Alloy Machining Practice.** — (*Amer. Exporter (Indust.)*, 1946, 139, (6), s32–s33).—Wrought aluminium alloys have considerably better machining properties than commercially pure aluminium because of their complex structure. Most strong heat-treatable alloys containing fairly high percentages of copper can be machined to smooth finishes at high speeds and feeds with a low rate of tool wear.—H. PL.

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XX.—CLEANING AND FINISHING

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**Preparation of Metals for Painting : A Review.** R. E. Gwyther (*Corrosion*, 1947, 3, (4), 201–207).—Solvent degreasing, alkaline cleaning, mechanical cleaning, pickling, and flame cleaning methods are reviewed, and the pre-treatment of iron and steel, zinc, aluminium, and magnesium considered in detail.—M. A. V.

**Machining and Finishing Die-Castings. Recommendations for Magnesium Alloys.** — (*Mech. World*, 1947, 122, (3168), 348–351).—The author describes machining and surface-finishing techniques recommended for magnesium alloys by the Stewart Die-Casting Division of the Stewart-Warner Corporation, U.S.A. Finishing methods discussed include dichromate treatment, “Manodyzing”, and painting.—R. W. R.

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XXI.—JOINING

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**Induction Heating [for Soldering Fuses].** — (*Amer. Exporter (Indust.)*, 1946, 138, (6), s22).—Induction heating is used in soldering the fusing elements of plug fuses to their brass screw shells. Small wedges of solder are inserted between the fusing element and the shell of the assembled plug. The assemblies are then conveyed past an induction-heating coil, and the solder flows down into the element slot.—H. PL.

**Application of High-Frequency Heating to Silver Brazing and Silver Soldering.** Herman A. Folgner (*Western Metals*, 1946, 4, (3), 35–37; *C. Abs.*, 1946, 40, (11), 3092).—The advantages of induction heating for silver brazing are simplicity of operation, low cost, high speed, and better control of heat. The conductor is usually a coil in which cooling water can circulate. To make a good brazed joint, all surfaces must be heated above the m.p. of the brazing alloy. The coil should be spaced sufficiently far away from the surfaces to be joined to give a slow, soaking heat rather than a surface heat, since the latter causes overheating of the outer surface before the inner surface has been brought up to brazing temp.

**Aluminium Parts Assembled by Brazing.** — (*Machinist (Eur. Edn.)*, 1947, 91, (19), 585–587).—The materials and technique used in furnace and dip brazing in the assembly of aluminium and aluminium alloy components are described. The method is economical and can often be applied to parts too thin to be welded.—J. H. W.

**Surface Treatment in Fusion Welding, Pressure Welding, Brazing, and Soldering.** John J. Crowe and F. C. Saacke (*Colloid Chem.*, 1946, 6, 587–593; *C. Abs.*, 1946, 40, (9), 2431).—Chemical treatment of surfaces and the selection and use of fluxes are discussed.

**Flying-Boat Repairs.** I. W. G. Reynolds (*Aircraft Eng.*, 1947, 19, (216), 63–67).

**Welded Magnesium [Aircraft] Tanks.** —I, —II, —III. R. J. Cross (*Aircraft Prodn.*, 1947, 9, (99), 28–33; (100), 71–75; (101), 97–102).—(I.—) Low specific gravity, availability, weldability, specific strength, and other features of magnesium alloys are advantages for tank construction. An auxiliary tank for York aircraft having a capacity of 625 gal. has a weight : capacity ratio of 0.167 lb./gal. Another tank for Shetland aircraft has a capacity of 2200 gal. C. gives comparative information on aluminium and magnesium alloy tanks and describes the testing of tanks to meet the requirements. (II.—) For joints in the shell of magnesium alloy tanks, butt



welds are used to avoid risk of flux inclusions. The main members of the tanks are I-beams and other sections, one flange of which is butt-welded into the skin of the tank. The design and arrangement of these members and of baffles are described in detail. Sumps are provided, and these are fitted with inhibitor cartridges containing chromates so that adventitious water does not cause corrosion. (III.—) C. describes the weld test in which a round disc is welded into the centre of a disc firmly clamped round the edges, to gain information on weldability and weld-cracking tendency, if present, in magnesium alloy sheets. Hot pressings and gas welds are used extensively, tacking being avoided by the use of a two-operator technique. Hot hammering is applied to the welds to obtain good form, and rectification of adjoining parts is effected in the same way. The properties in and about the welds are improved by the correct technique. Flux residues have to be removed by thorough washing, after which the tanks are chromate-treated and varnished.—H. S.

**Precision Sheet-Metal Work.—II.** — (*Aircraft Prodn.*, 1946, 8, (96), 465–476).—Cf. *Met. Abs.*, 1947, 14, 29. Production of gas-turbine assemblies by Joseph Lucas, Ltd., is described and fully illustrated. Nozzle-ring assemblies and exhaust units are dealt with in some detail. High-alloy steel castings and formed pieces of sheet are used, welding being employed extensively.—H. S.

**Oxy-Arc Cutting [of Nickel and Copper].** — (*Engineer*, 1947, 184, (4784), 317).—A stream of oxygen is fed through the hollow core of a coated electrode to augment the energy in a high-temp. arc. It is claimed that there is little distortion in the heat-affected zone and that the process has been successfully applied to the piercing and cutting of Monel metal, nickel, and copper, among other metals.—R. GR.

**Inert-Arc Welding with Direct Current.** R. P. Wyer (*Iron Age*, 1947, 160, (8), 68–70).—W. describes the technique of inert-arc welding for stainless steel, copper, aluminium, and magnesium, and gives details of current, welding speed, helium consumption, electrode size, type of gas, welding generator, electrode and electrode holders, and other equipment best suited to the process.—J. H. W.

**Contact Welding.** P. C. van der Willigen (*Philips Techn. Tijdschr.*, 1946, 8, (6), 161–163).—W. describes the development of arc contact electrodes, which are permanently held in actual contact with the work-piece. The core is arranged to melt away in advance of the coating. Self-ignition is obtained by incorporating part of the metal, in the form of powder, in the coating.—S. M.

**Industrial Electronics. Visit to B.T.H. Rugby Works.** — (*Chem. Age*, 1946, 55, (1413), 105–106).—A brief reference is made to an electronically controlled 390-kVA. spot-welding machine.—M. A. V.

**Powder Welding.** — (*Amer. Exporter (Indust.)*, 1946, 139, (5), s28).—Mixtures of powdered metals, together with suitable fluxes, are projected through the flame cone of a torch on to the work surface. Fuel gas, oxygen, and a processing gas are used together to control the temp. of the flame.

—H. PL.

**\*Metal-Ceramic Vacuum Seals.** Neal T. Williams (*Rev. Sci. Instruments*, 1947, 18, (6), 394–397).—For certain types of electrical equipment (e.g. magnetrons), insulating vacuum seals having electrical characteristics at least equal to those of glass-metal seals, but more refractory and mechanically more robust, were required. A method of joining a steatite-type ceramic to metal was developed. In order to keep the ceramic always under compression, a 50 : 50 nickel-iron alloy was chosen for ceramic-inside-metal, and a 42% nickel, 5.5% chromium, 52.5% iron alloy for metal-inside-ceramic seals. The ceramic was metallized as follows: the clean material was dipped into

1 : 1 nitric acid and washed, and then painted with a paste containing metal 30 wt.-% (molybdenum 96, iron 4%, both of 3- $\mu$  grain-size) and binder 70 wt.-% (10% nitrocellulose in ethylacetate). The parts were then fired at 1400° C. in an atmosphere containing 70% nitrogen and 30% hydrogen. The oxygen contained as an impurity in the commercial nitrogen was an essential feature of the process, in that it oxidized a small proportion of the molybdenum, which then formed the bond. After cooling, the parts were painted with a nickel paste, which was then fired on at 1000° C. in hydrogen for 15 min. After this second firing, the ceramic was hard-soldered to the metal components. Nickel-iron components were previously nickel plated. Hydrogen brazing is the preferred jointing method.—S. M.

**A New Jointing Compound.** A. T. B. P. Squires (*Aircraft Eng.*, 1946, 18, (213), 379–384).—After making tests and trials of proprietary jointing compounds, the Rolls-Royce Laboratory developed one for use in sealing joints against the action of oil and petrol at 100° C. Tests of various joints in Merlin engines sealed with the new preparation showed it to be effective. The substance retains its elasticity and does not become brittle or hard when maintained for long periods at temp. below its m.p. (195° C.), and is non-corrosive to steel and aluminium and copper alloys. It is insoluble in petrol, paraffin, engine lubricating oils, trichlorethylene, and the more common industrial organic solvents.—H. S.

**The British Welding Research Association. Planned Research in the Welding Industry.** F. A. Fox (*Metallurgia*, 1947, 36, (215), 264–267).

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\***American Welding Society. Recommended Practices for Resistance Welding. (Tentative.)** Med. 8vo. Pp. 47, with diagrams. 1946. New York: The Society, 33 West 39th Street. (50 cents.)

[A collection of recommended practices for the spot- and seam-welding of low-carbon, stainless, and hardenable steels, nickel, Monel metal, and Inconel. Each recommended practice comprises a table of machine settings for current, voltage, time, pressure, and other factors, which will produce welds of specified strength in various thicknesses of materials. Explanatory text on each of the factors is included. There is a section on standard methods for testing resistance welds, which covers tests for tensile properties, shear strength, impact strength, fatigue properties, and hardness. The section includes a description of the test specimens, the equipment to be used, and the procedure to be followed. There is also a section on the control of weld quality by statistical methods.]

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## XXV.—BOOK REVIEWS

**Les Bases de la Résistance Mécanique des Métaux et Alliages.** By P. Laurent, J. Valeur, and S. Bogroff. 25 × 16 cm. Pp. xiv + 288, with numerous illustrations in the text. 1947. Paris: Dunod.

In a rapidly developing field such as that of strength and plasticity, the need for an up-to-date text-book is particularly acute; at the same time, the vast number of poorly connected facts makes the writing of a book very difficult. This is the reason why Schmid and Boas's classical "Kristallplastizität" of 1935 has so far remained the only detailed text-book available. A sizable book on the subject was published in Germany by Kochendörfer in 1941; however, its value is much reduced by the large space given to theoretical speculations resting on a slender experimental basis. Since the boundary between the two is often insufficiently emphasized, Kochendörfer's book may be dangerous to beginners and to theoreticians seeking factual information.

The authors of the present book studied the German literature on strength and plasticity as prisoners of war in Oflag XVIIA; they lectured about the subject in the camp university, and wrote there much of the present work. This begins with a general introduction into crystallography, elasticity, and the dynamics and thermodynamics of crystal lattices (pp. 1-42); it deals with the plasticity and strength of metal single crystals (pp. 43-101); theories of plasticity and strength (pp. 102-130); fatigue and strain-hardening of single crystals (pp. 131-140); plasticity of polycrystals (pp. 141-159); Kuntze's theory of cohesive strength (pp. 160-173); plasticity and strength in technical testing; tensile, hardness, and impact testing (pp. 174-212); creep, plasto-elastic effects, and fatigue (pp. 213-265); and textures in metals (pp. 266-282). The usefulness of the book would be greatly enhanced by the inclusion of an index.

The book is well written and illustrated. Owing to the circumstances in which it arose, it contains mostly second-hand knowledge, and nobody, however able, can be expected to separate the wheat from the chaff in this field after a book-study of 4 or 5 years. Accordingly, the quality of the chapters depends greatly on the source from which they are drawn. The general discussion of crystallography, elasticity, and thermodynamics is good; so is the experimental part of single-crystal plasticity which is based on Schmid and Boas. After this, the influence of books by Kochendörfer, Smekal, and Kuntze becomes prevalent, and inaccuracies abound. It is impossible to give here a complete list of these, but a few instances ought to be mentioned.



It is stated (pp. 66-67) that plastic glide in crystals is always discontinuous (jerky). Actually, jerky extension has been observed only with a few crystals. The treatment of X-ray effects is inadequate; the fundamental difference between phenomena observed with white and with monochromatic radiation is not emphasized. The fact that aluminium shows little line broadening at room temperature is regarded as implying that aluminium crystals do not show Laue-asterism (p. 90). Two chapters on strength are devoted to Kuntze's theories, which have suffered total eclipse as a consequence of recent British and American work. Notch brittleness is attributed to the speed of the deformation, a view that was popular towards the end of the last century, but had to be abandoned when it became clear that brittle fracture also occurs in slow bending. There is no mention of the Ludwik-Davidenkov theory and of the role of tri-axial tension, which are dominating the field at present. In the treatment of creep, the basic distinction between transient (crystalline, "cold") and viscous (amorphous, "hot") creep is ignored, and the fundamental work of Andrade and R. Becker not mentioned. Instead, hazy speculations, based on Kuntze and Kochendörfer, are presented.

These examples could be multiplied for pages. A great part of the book being based on recent German literature, it reflects a sad picture of the decline which German scientific research suffered after 1932.

Throughout the book the term "acrochage" is used for "dislocation"; it has been fashioned after Dehlinger's "Verhakung". The German term, however, means hooking-on after a displacement, while this essential meaning is missing from "acrochage". Since the English "dislocation", introduced by A. E. H. Love, has been taken from geology, where the same expression is used in French, it would have been better to retain this word rather than to adopt an imperfect translation of a German word.

Many authors will find, on reading the book, that some of their best-known achievements have been ascribed to writers of text-books. Thus, Bausch's discovery that pure shear does not give rise to asterism, and Czochralski's observation that asterism is reduced by reverse deformation, are attributed to Kochendörfer (p. 90). The most striking instance, however, is that Griffith's theory of strength, the first classic in this field, as well as the famous formula of Griffith, are attributed to Snehal (pp. 106-108).

The authors apologize in the foreword for the omission of much British and American work to which they had no access in the camp. After reading the book, one wishes that they had deferred publication until after consulting English literature. As it is, the book contains much valuable material for experts who can read it with a critical eye; beginners, and scientists working in other fields, should use it with caution.—E. OROWAN.

**Surface Stressing of Metals.** Lectures by H. F. Moore, W. M. Murray, J. O. Almen, O. J. Horger, and P. R. Kisting. Med. 8vo. Pp. [iv] + 197, illustrated. 1947. Cleveland, O.: American Society for Metals, 7301 Euclid Avenue. (\$3.50.)

At the Twenty-Seventh National Metal Congress of the American Society of Metals held at Cleveland in February 1946, a series of five educational lectures was delivered on the effect of surface stressing on the endurance of metals under repeated loadings. These lectures have now been recorded in book form and make a useful addition to the literature on the subject. H. F. Moore first discusses the general features of fatigue failure and the effects of cold working of the surface upon the properties of the surface zone. From the fact that shot peening increases the life of fatigue specimens even when the fatigue crack starts in a region of compressive stress, it is concluded that the simple picture of residual compressive stresses resisting applied tensile stresses is not adequate, and that cold working by shot peening must actually strengthen the metal in the surface zone.

W. M. Murray gives a useful descriptive summary of the methods available for the measurement of surface stress, while J. O. Almen discusses the effect of design and internal stresses upon the fatigue of metals. It is refreshing to find that this author, an engineer, commences his article with the categorical statement that fully 90% of fatigue failures are due to faulty design and production defects, and that only the remaining 10%, due to defective material, material specifications, or heat-treatment, can be regarded as the responsibility of the metallurgist. As might be expected, he takes the engineer's viewpoint that the only satisfactory fatigue tests are those done in the full-scale machine parts, and emphasizes the importance of checking the results of such laboratory tests by comparison with service experience. He is fully aware of the difficulties encountered in attempting to apply the results of such tests in design, and the treatment which he gives will be read with interest by those who are concerned with this aspect of the subject.

In the article on "Stressing Axles and Other Railroad Equipment by Cold Rolling", O. J. Horger gives a most interesting account of the methods by which surface compressive stresses can be developed in a wide variety of parts, ranging from axles and connecting rods to threads and oil holes, in which high fatigue resistance is required. Excellent illustrations make the method of working the surface in different cases quite clear.

In the final article, P. R. Kesting describes the "Progressive Stress Damage" which is associated with the initiation and propagation of cracks in gun barrels as a result of the mechanical stresses imposed by repeated firing. During firing, the surface fibres at the bore interface are generally stressed beyond the endurance limit of the material, and a crack system develops during the normal life, which is seldom more than 10,000–20,000 rounds. The conditions in gun barrels have been simulated by hydraulic fatigue tests, and these, together with repeated bending tests, have shown that the sloping curve of the S-N diagram is moved in the direction of shorter life if the impact resistance of the steel is low, although no correlation is possible at lower stresses. Higher impact resistance not only gives increased, though still finite, life, but causes the gun barrel to fissure instead of failing by fragmentation.

The emphasis of all five lectures is on the engineering rather than the metallurgical aspect of fatigue, and most of the examples quoted refer to steel. The series as a whole, however, makes a useful survey of the field, and to the metallurgist it will be of value chiefly because the engineer's viewpoint is expressed so clearly.—A. G. QUARRELL.

**Histoire de l'Aluminium. Métal de la Victoire.** By Robert Pitaval. Med. 8vo. Pp. 207. 1946. Paris: Publications Minières et Métallurgiques, 86 rue Cardinet (17e). (300 francs; foreign price, 325 francs.)

From the publisher's preliminary announcement, that the history of aluminium is recounted "comme un film passionnant d'intérêt, dont l'apothéose se situe dans un ciel parsemé d'escaladilles" one would naturally expect a sensational, not to say flamboyant, presentation. Actually, the book is a balanced and well written account of the development of the industry, and is moreover scrupulously fair, giving due credit to the pioneers, of whatever nationalities, and to their successors who manage the industry to-day. It makes no attempt to cover the applications of the metal and its alloys, gives no account of alloy developments, and contains merely the briefest summary of the more important chemical and physical properties.

So far as the reviewer is able to judge, the account given of the development in the various countries is correct and unbiased, and, for so small a book, contains a surprising amount of detail. Statistics are, of course, included, but the pill is well sugared by the interest of the narrative.

The only criticism that can be made is that the spelling of the place names is occasionally in need of revision: one learns, for instance, that the British Isles contains such places as Montmoutshire and Dolgarrod. These, however, are minor blemishes in an excellent presentation.—H. W. L. PHILLIPS.

**Conoscere l'Alluminio.** By G. Simoni. 1947. Pp. 99, illustrated (lire 380); **Conoscere l'Acciaio.** By I. Bartoli and F. Masi. 1945. Pp. 94, illustrated (lire 350). 23.5 × 17 cm. Milano: Poligono Società Editrice, Via Cesare Battisti 1.

These books give a brief account of the history of the respective industries, followed by a copiously illustrated description of modern fabrication processes, covering all stages from the mining of the ore to the finished product. Sections are included on testing, typical properties, micrography, and applications. The presentation is necessarily brief and is "popular" in character, and the information given is, in general, accurate. A few of the figures quoted should be revised in later editions, as for instance 678° C. for the melting point of aluminium.

—H. W. L. PHILLIPS.

**Electronic Methods of Inspection of Metals.** Lectures by H. F. Hamburg, J. L. Saunderson, R. S. Segsworth, E. O. Dixon, C. M. Lichy, C. S. Barrett, and H. T. Clark. Med. 8vo. Pp. iii + 189, with 22 illustrations. 1947. Cleveland, O.: American Society for Metals, 7301 Euclid Avenue. (\$3.50.)

This book contains the substance of a series of seven lectures given to members of the American Society for Metals during the Twenty-Eighth National Metal Congress held at Atlantic City in November 1946. A very free interpretation has been given to the term "Electronic Methods", and the subjects covered range from the resistance wire strain-gauge to the Cyclograph and the measurement of steel bath temperatures by quick-immersion techniques. The treatment throughout is purely descriptive, and the most complete chapters are those on "Spectrochemical Analysis of Metals and Alloys by Direct Intensity-Measurement Methods", by J. L. Saunderson, and "The Electron Microscope and Its Application to Metals", by C. S. Barrett. The first of these, after outlining the basis of spectrochemical analysis and the advantages to be gained by replacing the photographic plate by a direct-recording method, describes the electron-multiplier photo-cell and its use in both the scanning and integrating methods of analysis. Details are given of the performance of the direct-recording equipment used by the author at the Dow Chemical Company.

In his well illustrated article, C. S. Barrett gives a review of current practice in the application of electron microscopy to metals, and his clear descriptions of the various replica methods should prove useful to many who wish to know more about the technique without practising it. The author does not attempt to minimize the difficulties associated with electron metallography, but discusses many of the applications to date and gives a useful selected *bibliography*.

Articles on the Cyclograph, supersonic methods of testing, and the determination of seams in steel by magnetic analysis consist chiefly of examples of the successful use of these techniques rather than of descriptions of the methods themselves. No doubt some readers will find this useful because it may suggest possible methods of investigating their own problems, but the general reader is left with the feeling that this is an ill-assorted collection of articles which is unlikely to fill any real need, and which, for the most part, do not justify the excellent production standard usually associated with A.S.M. publications.—A. G. QUARRELL.

**Cold Working of Brass, with Special Reference to Cartridge (70 : 30) Brass.**

By L. E. Gibbs. Med. 8vo. Pp. vi + 104, with 54 figures, including 6 illustrations in colour. 1946. Cleveland, O.: American Society for Metals. (\$2.00.)

This book is published in a neat and good binding. The printing is on good paper, in a bold and clear type, and the book is well furnished with diagrams and illustrations. The micrographs, which include some Kodachrome photography, are particularly clear. The index is comprehensive, but it might lead the reader to expect much more complete treatment than is given in the 104 pages which comprise the book. The style of writing is good, and the English clear and precise.

Coming now to the subject of the book, the reader who expects to find detailed information upon the cold working of brass, or even especially of 70 : 30 brass (as indicated in the subtitle), will be disappointed. No information at all is given on the details of cold working, although the principles underlying that subject are very clearly dealt with. It is somewhat difficult to see for what class of reader the book was intended, as the metallurgical student will already have access to the information in general metallurgical text-books.

On matters of detail, the influence of ready-to-finish grain-size is well brought out, and its importance very properly insisted on. The most interesting chapter is No. 3, dealing with 20-mm. cartridges. The micrographs, in this case, are particularly good, but the magnification is not always stated.

In Chapter 5, on Season Cracking, the detailed statement on the effect of amines on the cracking of 70 : 30 brass seems hardly suitable for this type of book.

In Chapter 6, the reference to Fig. 28 should be omitted, as it does not refer to that Figure in the present book.

The colour photographs are very good, but in some cases they appear to have been inserted more because of their excellence than because of their relevance to the subject of the book.

While the publication of this book could be justified in the United States, where paper and materials are more plentiful, this would hardly be the case in England, under our own austerities.—E. A. BOLTON.

**Dictionary of Machine-Shop Terms.** By Arthur C. Telford.  $5\frac{1}{4} \times 3$  in. Pp. [vi] + 292. 1946. Chicago, Ill.: American Technical Society, Drescel Avenue and 58th Street; London: Technical Press, Ltd., Gloucester Rd., Kingston Hill, Surrey. (5s. net.)

The definitions in this American dictionary are terse and generally very clear, but many of the words included are by no means peculiar to the engineering trade. The omission of such commonplace words as "period", "perfection", and "perform", to quote three that appear on the same page, would have made room for the inclusion of genuine engineering terms such as "toolmakers' button", "tommy bar", and the apparently contradictory "taper parallel".

In the preface to the dictionary, stress is laid on the fact that every trade has a language of its own; it is equally true that, although English is the common tongue of America and Britain, the engineering terms in the two countries are often vastly different. For example, the American use of "bulldozer" for "forging press", "frozen" for "seized", and "hay" for "swarf" would confuse the English reader.

However, despite these few criticisms, this pocket-sized volume covers a wide field and should be of considerable help to a newcomer to the American engineering trade.—T. R. OAKLEY.

**Welding Symbols.** By Vincent C. Gourley. Demy 8vo. Pp. ix + 115, illustrated. 1947. Milwaukee, Wis.: Bruce Publishing Company. (\$2.50.)

The review of any book, whether technical or otherwise, should consider first the plot or subject matter, and second the style or method of presentation, the latter, in the case of



technical books, duly taking into account illustrations, examples, tables, &c., supplementary to the text. In the present case, however, the subject matter is purely the use of an already-existing American system of nomenclature, the merits and disadvantages of which have been frequently reviewed in the past; and it is, therefore, logical for the method of presentation to be considered as the primary object of the review.

The book is divided into three parts, the first consisting only of one brief chapter summarizing the "dos and don'ts" for draughtsmen, the second dealing with arc- and gas-welding symbols, and the third being devoted to symbols used in resistance welding. Being an American publication describing an American system, it is no doubt primarily intended for American use, which explains why some of the "dos and don'ts" are at variance with British practice, at any rate in so far as structural work is concerned; at the same time, this can scarcely be a cause of criticism, for the same reason.

The addition of two Appendices, clearly showing the difference between welds and joints, would appear to indicate that there is, in this respect, some confusion in the U.S.A. as well as in this country; and the author is to be congratulated on clarifying the position and thus removing the main source of frequent misunderstandings. The inclusion of an index, an uncommon feature in a volume of this size, is another welcome addition which will make this work a reference book as well as a text-book.

The subject matter is described in simple and direct language and the text is profusely illustrated throughout. The illustrations, moreover, are invariably in two parts: the first showing how the welds and joints will be seen on the drawing, and the second providing a visual explanation by means of an isometric sketch. There is thus no possibility of misunderstanding the way in which the symbols are intended to be used, and there is little doubt that this method of presentation will be welcomed by all the many different types of students for whom the book is intended.

The welding symbols, a description of which forms the subject of this book, have been put forward by the American Welding Society and are said to be accepted in the U.S.A. as a standard for mechanical and structural drawings. The system has been in existence for some time and has often been described, criticized, and referred to in the technical press in this country as well as in the U.S.A. Its merits and disadvantages are still distinctly controversial matters so far as this country is concerned, and it seems doubtful whether this system would be acceptable in England because of the complete re-education of both drawing-office and shop personnel which such acceptance would necessarily entail. This opinion would appear to be substantiated by the fact that a somewhat similar system, introduced in this country as a British Standard in 1933, has found only a very limited application, and the whole subject of welding symbols and nomenclature is at present under revision by the British Standards Institution.—S. M. R.

**Modern Assembly Processes: Their Development and Control.** By J. L. Miller. With a foreword by E. A. Watson. Second edition, revised. Demy 8vo. Pp. xii + 199, with 170 illustrations. 1946. London: Chapman and Hall, Ltd. (18s. net.)

It is encouraging to find that a revised edition of this excellent primer, reviewed originally in *Met. Abs.*, 1941, 8, 355-356, has been needed. The opportunity has been taken to incorporate an account of some recent developments in welding and riveting methods and to enlarge all the chapters slightly. The sections on soft and hard soldering and brazing, though now more detailed, are still perhaps not treated so extensively as they should be for engineering students. In general, the book remains an excellent introduction to the study of mass-production methods of joining small parts, clearly written, and noteworthy for the attention given throughout by the author to first principles.—J. C. CHASTON.

**Vocabulaire Technique Anglais-Français et Français-Anglais: Métallurgie, Mines, Électricité, Mécanique, Sciences.** By Francis Cusset. Second edition. Foolscap. 8vo. Pp. 591. 1947. Paris: Éditions Berger-Levrault, 5 rue Auguste-Comte. London: H. K. Lewis and Company, 136 Gower Street, W.C.1. (12s. 6d.)

The compiler has done a useful service in preparing this small dictionary of technical terms, and the ground it covers is probably adequate for the majority of users. Unfortunately, however, it lacks completeness. For instance, in a dictionary published after the war it is strange to find no mention of "isotopes", "neutrons", or "fission"; such commonly used terms as "filage à la presse", "alliage mère", and "sidérurgique" are overlooked; and that stumbling block of our youth, "hydrogen peroxide", is ignored. The reader will also be surprised to learn that the only kind of "phial" recognized is the "Leyden jar", and that the normal English equivalents of "être en équilibre" are "to be in equipoise" or "to librate". Proof reading also leaves a little to be desired; we are, for instance, given such phonetic renderings as "clockwise" and "bleaching".—H. W. L. PHILLIPS.

