

METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

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Part 9

I.—PROPERTIES OF METALS

(Continued from pp. 289-295.)

*A Study of the Fatigue Characteristics of Three Aluminium Specimens Each Containing from Four to Six Large Crystals. H. J. Gough and G. Forrest (*J. Inst. Metals*, 1936, 58, 97-112).—Three specimens of aluminium, each consisting of from 4 to 6 large crystals, were submitted to alternating torsional fatigue tests. Each specimen was tested at a constant range of applied torque throughout: two specimens fractured, one remained unbroken. The observed changes in microstructure were related to the crystalline structure—as revealed by X-rays—and to the applied stressing system, particular attention being given to the influence of the intercrystalline boundaries on the deformation and fatigue-resistance. It was found that the slip-band distribution of each specimen obeyed very closely the maximum resolved shear-stress law, calculated for each crystal as if it alone occupied the entire specimen: the influence of the boundaries on the slip-band distribution was extremely slight. Cracking occurred in regions subjected to high values of resolved shear stress. These regions were often situated in close proximity to a boundary, but the results indicate that the influence of boundaries, as such, on fatigue-cracking is very slight. In fact, it has been clearly established that fatigue-cracking is not initiated at the boundary, and also that the general course of a crack does not tend to follow a boundary. The fatigue histories of the specimens reveal a fatigue limit, on an endurance basis of 10^8 stress cycles, of about ± 1.0 ton/in.² resolved shear stress, which differs but little from that of single crystals of aluminium.—H. J. G.

*On the Mechanical Properties of Metals at High Temperatures and the Determination of Young's Modulus of Aluminium at Various Temperatures. Munetada Yamamuro (*J. Aeronaut. Res. Inst. Tōkyō Imp. Univ.*, 1935, (134), 893-902).—[In Japanese.] (1) The apparatus and the care required for high temperature tests of the mechanical properties of metals are dealt with. The need for exact control of temperature is strongly emphasized; to this end the furnace used in Y.'s experiments was doubly wound and made of large capacity. (2) The results are given of experiments on the determination of Young's modulus of aluminium at various temperatures.—S. G.

*Photoelectric Properties of Sodium Films on Aluminium [Photoelectric Threshold of Aluminium]. James J. Brady and Vincent P. Jacobsmeyer (*Phys. Rev.*, 1936, [ii], 49, (9), 670-675).—The photoelectric properties of films of sodium deposited on aluminium were investigated as a function of the film thickness. No detectable photo-current was observed until the film reached a thickness of 5 molecular layers; the sensitivity then increased with film thickness, and reached a maximum value of 80 molecular layers, remaining constant for greater thicknesses. This is in contrast to the behaviour of caesium, potassium, or rubidium films on silver, where there is a strong photoelectric effect for films less than one molecular layer in thickness, a maximum sensitivity at a few molecular layers, and then a decrease at greater thickness. The difference is due to the fact that the ionization potential of sodium is greater than the work-function of the underlying aluminium so that the photo-electrons must originate in the sodium film, in contrast to the other

* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

cases where the work-function is the greater, and the electrons come from the base metal for the early stages of film development. The photoelectric threshold for aluminium is 3020 Å.—W. H.-R.

***Evaporated Aluminium Coatings for Interferometer Plates for Use in the Ultra-Violet.** J. E. Ruedy and George Burr Sabine (*Phys. Rev.*, 1936, [ii], 49, (11), 887).—Abstract of a paper read before the American Physical Society. Partially transmitting films of aluminium evaporated on Corex and fused quartz were measured for reflection and transmission over wave-lengths 2380–4080 Å. to determine their suitability for interferometric use in the ultra-violet. Numerous samples were made having transmissions ranging from 2 to 50% in the visible region. All of these show the same general behaviour: a slow decrease in reflectivity and a nearly corresponding increase in transmissivity with decreasing wave-length. The thicker films have the higher efficiency (efficiency = reflection + transmission) with the opaque film reflectivity of about 90% throughout this entire range as the upper limit. A film suitable for use in a Fabry-Perot interferometer might have the following characteristics: at 4000 Å.: $T = 2\%$, $R = 84\%$; at 2400 Å., $T = 16\%$, $R = 70\%$. Negligible change in the behaviour of these films is produced by washing them, and no deterioration with time has been evident over the 2 months' period during which they have been under observation.—S. G.

***The Temperature Coefficient of the Photoelectric Work-Function of Barium.** R. J. Cashman and N. C. Jamison (*Phys. Rev.*, 1936, [ii], 49, (11), 877).—Abstract of a paper read before the American Physical Society. In previous work by C. and J. (*Met. Abs.*, this vol., p. 69), Fowler's method was applied to determine the photoelectric work-functions of barium and calcium surfaces. Further refinement in the technique of making measurements has increased the accuracy so that an estimation of the temperature coeff. of the work-function may be obtained from the temperature interval 20°–120° C. The results of several determinations gave a positive value of $(1.4 \pm 0.7) \times 10^{-5}$ v./° C. The extreme constancy of the photo-emission properties of the surface, even though it repeatedly experienced 100° and 140° temperature changes, was of primary importance in the work. The mean value of the work-function at room temperature was 2.5067 v., the average deviation from the mean of a series of 5 plots being 0.0004 v. That this value is not in full accord with that previously reported might well be attributed to a difference in crystal structure of the surface or to slightly different chemical purity.—S. G.

***Variation of Resistance and Structure [and Lattice Spacing] of Cobalt with Temperature and a Discussion of Its Photoelectric Emission.** Louis Marick (*Phys. Rev.*, 1936, [ii], 49, (11), 831–837).—(1) The electrical resistance of cobalt of purity more than 99.9% was measured at temperatures up to 1200° C. The $\alpha\beta$ transformation temperature was determined as 492° C., and the resistance-temperature curves showed a change in slope at the Curie point (1100° C.). No abnormality was observed in the region of 850° C., at which Cardwell (*Met. Abs. (J. Inst. Metals)*, 1932, 50, 210) found abnormal photoelectric emission. (2) A high-temperature camera was used to measure the lattice spacings of cobalt at temperatures up to 1187° C., to within ± 0.003 Å. The average coeff. of expansion up to 600° C. was 0.143×10^{-4} per ° C., which agrees well with values from ordinary measurements. The face-centred cubic modification existed at all temperatures above 492° C., and no evidence was obtained of the reversion to the hexagonal form above 1015° C. claimed by Hendricks, Jefferson, and Schultz (*J. Inst. Metals*, 1930, 43, 399). An expansion of 0.6% in the lattice spacing occurred when cobalt was heated through the Curie point. (3) M. suggests that the results of Cardwell (*loc. cit.*) were due to the presence of oxygen on the surface of the metal, and gives

evidence of oxidation taking place at 850° C. on heating cobalt in a vacuum of 10⁻⁶ mm. Hg.—W. H. R.

***Experiments on the Electrical Resistance of Copper and Some Copper Alloy Wires.** Clement Blazey (*J. Inst. Metals*, 1936, 58, 123-140; discussion, 140-141).—The electrical resistances of wires made from 7 samples of H.C. wire-bar copper, 2 samples of cadmium-copper, a furnace-refined copper, and various specially-prepared samples were measured after annealing in carbon dioxide over the range 300°-950° C. Two methods of cooling from the annealing temperature were used: quenching in water, and slow cooling in the furnace; slow cooling was sometimes replaced by reheating at a fixed temperature, such as 500° C. It was found that, in general, minimum resistance is obtained on annealing at about 500° C., and that a steady increase in resistance occurs when the wires are quenched from temperatures above 500° C. This increase, however, tends to disappear when slow cooling is adopted or when the quenched wires are reheated at 500° C. In wire-bar copper the increase due to quenching from 950° C. varies from about 0.5 to 1%. It is not greatly affected by variations in cold-drawing methods or by heat-treatment of the rolled rod before drawing. With cadmium-copper, quenching from a high temperature does not increase the resistance to an unusual degree, but with fire-refined copper it causes an increase of nearly 10%. Wires drawn from wire-bar copper that has been remelted under charcoal show a greater increase in resistance on quenching from a high temperature than those made from the original wire-bars. When, however, the remelting takes place in conditions that permit an increase in oxygen content, the resulting wires show only slight differences in resistance with variations in annealing treatment. Additions of sulphur and selenium to copper of low oxygen content cause marked increases in resistance on quenching from high temperatures. In these instances the slowly cooled samples contain numerous small inclusions, but the quenched samples are free from them. The following causes for the increase in resistance on quenching from high temperature are briefly considered: (a) nature of the furnace atmosphere, (b) alterations in dimensions of the wires, (c) quenching stresses, (d) presence of blow-holes, (e) chemical composition, and (f) grain structure.—C. B.

The Utilization of Creep Test Data in Engineering Design [Creep of Lead Tubes under Compound Stress]. (Bailey.) See p. 343.

***The Optical Constants of Liquid Gallium.** J. B. Nathanson (*Phys. Rev.*, 1936, [ii], 49, (11), 887).—Abstract of a paper read before the American Physical Society. A mirror of liquid gallium was produced by filling a previously heated glass cell with the metal, under vacuum. Polarimetric observations were made through a small Pyrex window of the glass cell. By means of suitable glass prisms placed in optical contact with the window of the cell, the phase difference and the angle of restored plane polarization were determined for angles of incidence of 45° and 60°. The optical constants were computed by means of Drude's formulæ. For wave-lengths of 4358 Å., 5461 Å., and 6708 Å., the coeffs. of absorption were found to be 7.3, 5.9, and 5.4, respectively, while the refractive indices relative to air were 0.58, 0.88, and 1.10, respectively. The reflecting powers for normal incidence varied only slightly with the wave-length, the values for the above wave-lengths being 88.7, 88.3, and 88.5%, respectively. Within the limits of experimental error there did not seem to be any variation of the above constants with respect to temperatures varying from 24° to 40° C.—S. G.

***Measurement of Certain Electrical Resistances [Gold, Silver, Iron, and Tellurium], Compressibilities, and Thermal Expansions [Lithium, Sodium, Potassium] to 20,000 kg./cm.².** P. W. Bridgman (*Proc. Amer. Acad. Arts Sci.*, 1935, 70, (3), 71-101).—Developments in the technique for measuring physical properties under high pressure in the range 12,000 to 20,000 kg./cm.²

are described. The electrical resistances of gold, silver, and iron were determined in the above range. The results can be expressed by the following equations, the maximum departure from the second degree relation being 0.14% of the maximum pressure effect in the case of iron. Gold, $\frac{\Delta R}{R_0} = -3.017 \times 10^{-8} p + 1.05 \times 10^{-11} p^2$; silver, $\frac{\Delta R}{R_0} = -3.575 \times 10^{-8} p + 1.90 \times 10^{-11} p^2$; iron, $\frac{\Delta R}{R_0} = -2.377 \times 10^{-8} p + 0.71 \times 10^{-11} p^2$; at 30° C. and p in kg./cm.². The electrical resistance of black phosphorus, and of single-crystal tellurium in the 23.5° and 86° orientations, was measured up to 20,000 kg./cm.² at 30° and 75° C. These substances show large decreases of resistance under pressure, the resistances at 20,000 kg./cm.² being less than 0.01 of those at atmospheric pressure. Extrapolation suggests that the resistances will pass through minima at higher pressures. The resistance of Cu₂S also decreases under pressure, but the results are complex. The change of volume of lithium, sodium, and potassium at 0° C. was measured up to 20,000 kg./cm.². The compressibilities drop smoothly both with respect to pressure, and with respect to each other over the entire range; the abnormalities previously reported were due to errors in converting linear into volume compressibilities (see Bridgman, *Met. Abs.*, this vol., p. 356). The thermal expansion of these metals between 0° and 95° C. was measured up to 20,000 kg./cm.². The relative effects are complex and the curves cross so that the order of the expansions at 20,000 kg./cm.² is the reverse of that at atmospheric pressure, potassium having the lowest, and lithium the highest thermal expansion above 15,000 kg./cm.². Changes of entropy are calculated and discussed.

—W. H. R.

***An Estimation of the Atomic Weights of Lithium, Potassium, and Rubidium from Isotope Abundance Measurements.** A. Keith Brewer (*Phys. Rev.*, 1936, [ii], 49, (11), 867).—Abstract of a paper read before the American Physical Society. The atomic weights computed from the abundance ratios, assuming the most probable values for the packing fractions, are: lithium 6.939; potassium 39.094; rubidium 85.46.—S. G.

***The Magnetic Properties of Manganese Heated in Nitrogen.** L. F. Bates, R. E. Gibbs, and D. V. Reddi Pantulu (*Proc. Phys. Soc.*, 1936, 48, (4), 665-671).—The combination of amorphous manganese with nitrogen was studied over the range 300°-1000° C. It was found that ferromagnetic compounds are formed at much lower temperatures than have been reported previously. The magnetic hysteresis phenomena exhibited by these compounds were studied, and their ferromagnetic Curie points were determined by a simple method. An X-ray study of their structures was also made; it was found that the existence of ferromagnetism can be associated with a γ -phase of manganese with a slightly enlarged lattice constant; the function of the nitrogen is not completely understood.—S. G.

***The Positive Ion Work-Function of Molybdenum.** H. J. Grover (*Phys. Rev.*, 1936, [ii], 49, (11), 878).—Abstract of a paper read before the American Physical Society. By use of a mass spectrograph for the measurement of positive ion currents from molybdenum as a function of temperature, a value is obtained for the positive ion work-function Φ_{+0} , which is higher than any previously reported. This value is found to balance the familiar energy cycle $\Phi_{+0} + \Phi_{-0} = V + U$, within experimental error when standard values for the electron work-function Φ_{-0} , the ionization potential V , and the latent heat of condensation of neutral atoms U are used.—S. G.

***The Variation of Young's Modulus with Magnetization and Temperature in Nickel.** Sidney Siegel and S. L. Quimby (*Phys. Rev.*, 1936, [ii], 49, (9), 663-670).—The relation between Young's modulus, magnetization, and temperature

in annealed polycrystalline nickel of 99.7% purity was determined from 23.5° to 400° C. for values of J (the intensity of magnetization) between zero and saturation. Young's modulus was measured by a modification of the piezoelectric oscillator method of Zacharias (*Met. Abs. (J. Inst. Metals)*, 1933, 53, 483). The % increase in Young's modulus is proportional to J^2 between zero and about 0.4 saturation at temperatures below 311° C. The total increase in the modulus from the demagnetized to the saturated state is 6.7% at 23° C., rises to a maximum of 18.7% at 185° C., and decreases to zero at the Curie point. The theory of Akulov (*Z. Physik*, 1933, 85, 661) is probably essentially correct, but requires modification. The experimental results also enable the coeff. of internal friction of the material to be determined.—W. H.-R.

***The Ferromagnetism of Nickel. II.—Temperature Effects.** J. C. Slater (*Phys. Rev.*, 1936, [ii], 49, (12), 931–937).—Cf. *Met. Abs.*, this vol., p. 195. Theoretical. The temperature variation of the ferromagnetism in nickel is examined theoretically for the model of a metal in which each electron moves in a stationary state throughout the whole metal, modulated by the periodic lattice. At each temperature the value of the magnetic moment for which the free energy is a minimum is the value which will actually be found, and this decreases with increasing temperature, and vanishes at the Curie point in agreement with experiment. S. finds that even at the absolute zero not quite all of the spins are parallel to each other, and suggests that this small effect becomes much more pronounced as iron is approached in the series of ferromagnetic elements; this may explain why alloys of iron and cobalt show the highest saturation moments of ferromagnetic substances, the moment decreasing in iron, and still more in its alloys with lighter elements.—W. H.-R.

***Electrical Conductivity of Thin Films of Rubidium on Glass Surfaces.** A. C. B. Lovell (*Nature*, 1936, 137, (3464), 493–494).—The electrical resistance of films of rubidium a few atoms in thickness, deposited in a vacuum on glass cooled by liquid oxygen, is a few times greater than that of the metal in bulk, but not so great as found by previous investigators.—E. S. H.

***Absolute Resistivity of Sodium.** E. Peterson and L. W. Nordheim (*Phys. Rev.*, 1936, [ii], 49, (11), 873).—Abstract of a paper read before the American Physical Society. The interaction of electronic motion and heat vibrations of the ionic lattice (responsible for the resistivity of metals) cannot be formulated without ambiguity as a perturbation problem. This is illustrated by the fact that with the usual model of deformable ions and the Wigner-Seitz eigenfunctions now available, a resistance for sodium is obtained which is 5 to 6 times the experimental value. By interpreting the transitions between progressing (exponential) electronic waves as beats between stationary (sin and cos) waves in a crystal deformed by a "frozen in" elastic wave, the problem can be attacked in a more direct way by calculating the beat frequency as energy difference between those two stationary waves. For sodium the calculations can be carried out owing to its simple properties. The eigenfunctions are formed of suitable combinations of s , p . . . Wigner-Seitz functions in the different deformed elementary cells. A preliminary computation of the resistivity gave a result within 30% of the actual value. The dominating factor for the resistivity is found to be the change of volume of the ionic cells. The volume determines the normalization since, for reasons of self-consistency, the cells have to be neutral. From this it follows that a type of disorder which does not change the volume of the cells will not cause a resistance, thus confirming a supposition of Mott (*Met. Abs.*, 1934, 1, 484) about the resistivity of liquid metals.—S. G.

***Influence of Pressure on the Linear Rate of Transformation of White Tin into Grey.** A. Komar and K. Ivanov (*Zhurnal Eksperimentalnoy i teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (3) 256–260).—[In Russian.] The rate of transformation of white into grey tin at 75°–0° C.

and at -27°C . and the effect of pressure thereon were determined. Increase in pressure reduces the linear rate of transformation.—N. A.

***The Heat Conductivity of Tungsten and the Cooling Effects of Leads on Filaments at Low Temperatures.** Irving Langmuir and John Bradshaw Taylor (*Phys. Rev.*, 1936, [ii], 50, (1), 68–87; erratum, (2), 190).—The theory and equations governing the temperature distribution, resistance, and heat-flow in a tungsten filament as affected by its leads are developed for the low temperature range ($<600^{\circ}\text{K}$.) for the general case, and for several special cases. Tables and formulæ are given from which the maximum temperature of the filament can be calculated from the current, filament dimensions, and lead and bulb temperatures. The thermal conductivity λ of tungsten was calculated from resistance measurements of fully out-gassed tungsten filaments. At 273°K ., $\lambda = 1.66$ watts cm^{-1} deg^{-1} ; λ decreases with increasing temperature according to the equation $\log \lambda = 0.9518 - 0.30 \log T$, and at 600°K ., $\lambda = 1.31$.—W. H. R.

***Some Properties of Cæsium and Oxygen Films on Tungsten.** John Bradshaw Taylor and Irving Langmuir (*Phys. Rev.*, 1936, [ii], 49, (11), 878).—Abstract of a paper read before the American Physical Society. A pure tungsten filament was coated with oxygen at low pressures (10^{-6} to 10^{-10} mm.), the oxygen being admitted by diffusion through the walls of a heated silver tube. Oxygen films prepared in this way require no "activation" to allow increased electron emission when cæsium is adsorbed on them. OW films undergo a rearrangement when heated in the presence of adsorbed cæsium, with accompanying changes in electron emission from the cæsium–oxygen–tungsten film. Measurements of the amount of cæsium adsorbed indicate that the concentration of oxygen in these films is much less than that corresponding to a single layer. The heat of evaporation of oxygen from these dilute films varies from 143 k.cal. to 168 k.cal. as the oxygen concentration approaches zero. Oxygen diffuses into tungsten at temperatures as low as 1200°K . at oxygen pressures lower than 10^{-7} mm. After such diffusion has taken place, the filament can be cleaned in the absence of oxygen and then deactivated by diffusion of oxygen to the surface. A preliminary value for the heat of diffusion is 83 k.cal.—S. G.

***A Determination and Analysis of the Thermionic Constants of Thoriated Tungsten.** Albert Rose (*Phys. Rev.*, 1936, [ii], 49, (11), 838–847).—The emission from a tungsten filament in states of activation from a flashed to a completely thoriated surface was studied from 1300° to 1800°K ., and applied fields up to 3×10^4 v./cm. The slopes and intercepts of the Richardson plots of these results are examined in terms of an assumed patch distribution of adsorbed atoms such that the concentration difference between patches decreases with increasing temperature. Precautions are described which are necessary before the temperature coeffs. of the work-functions determined photoelectrically, thermionically, and by contact potential measurements can be compared directly.—W. H. R.

***Thoriated Tungsten Activation as Revealed by the Electron Microscope.** A. J. Ahcarn and J. A. Becker (*Phys. Rev.*, 1936, [ii], 49, (11), 879).—Abstract of a paper read before the American Physical Society. An electron microscope was used to study the activation of thoriated tungsten ribbons. After flashing at 2600°K ., the electron image at 1500°K . shows that only a few small areas emit profusely, the rest of the filament being scarcely visible. By heating the filament at 1700°K . these areas first grow greatly in intensity and in size; then, as they continue to grow in size their intensity decreases. These active spots are thought to be produced by the eruption and migration over the surface of pockets of thorium. From estimates of the sizes of the spots and the current densities therefrom, the number of thorium atoms in an eruption is found to be 5×10^{10} . Optical photomicrographs of the same

filament show many pocket-like dots the size and number of which account for the known thorium content of the filament. On this basis, there are from 1×10^{10} to 200×10^{10} thorium atoms per pocket, in good agreement with that calculated from the eruptions. The experiments show that (1) a large part, if not all, of the thoriation occurs in the form of eruptions; and (2) when an eruption occurs all the thorium of a thorium oxide granule escapes.

—S. G.

***Creep and Twinning in Zinc Single Crystals.** Richard F. Miller (*Metals Technology*, 1936, 3, (3), 15 pp.; *A.I.M.M.E. Tech. Publ. No. 703*).—Cylindrical single crystals of very pure zinc were prepared by a modification of the Bridgman method, and submitted to tensile and creep tests between -175° and $+200^\circ$ C. If α is the angle between the basal plane and the axis of the specimen, the results fall into two classes. Where α is greater than about 10° , a large amount of basal glide precedes the twinning ("ductile crystals"). Continuous extension takes place at shearing stresses of less than 2.6 gm./mm.² at 200° C., and less than 2.8 gm./mm.² at 25° C. There is no measurable critical shearing stress or elastic limit in the ductile single crystals when tested in creep at or above room temperature. Even at -175° C. such crystals are remarkably ductile. Where α is less than 10° twinning is preceded by little or no basal glide, and occurs at a definite stress which is greater the smaller the angle α . Thus the larger the amount of previous basal glide, the smaller is the twinning stress. These critical twinning stresses are of the order 300–700 gm./mm.². Flexural gliding involves a new type of twinning on second order pyramidal planes.—W. H.-R.

***Photoelectric Emission from Alkali Deposits on Other Metals.** H. C. Rentschler and D. E. Henry (*Phys. Rev.*, 1936, [ii], 49, (11), 877).—Abstract of a paper read before the American Physical Society. The progressive change in sensitivity to the light through various filters was noted as the alkali distilled and deposited on sputtered surfaces of different metals prepared as previously described (*Met. Abs. (J. Inst. Metals)*, 1933, 53, 119). The long wavelength sensitivity so obtained and generally attributed to the formation of thin film of the alkali was surprisingly small. Thus, the maximum red sensitivity of potassium on a sputtered molybdenum surface was many times smaller than for a similar deposit on a molybdenum surface cleaned by electron bombardment. When the potassium was similarly deposited on a metal surface at sufficiently low temperature no red sensitivity was obtained. These tests indicate that the red sensitivity is the result of a reaction between the alkali and the residual impurity on the base metal, and is not due to the physical nature of the film.—S. G.

***On the Experimental Determination of the Linear Rate of Crystallization.** Theodor Förster (*Z. physikal. Chem.*, 1935, [A], 175, (3), 177–186).—In the usual method of measuring the rate of crystallization of non-metallic substances in tubes, the boundary surfaces are never at a constant temperature; this explains the occurrence of a range of constant rate of crystallization and a point of sudden change. It is possible at least partially to determine the temperature course of the true rate of crystallization of substances which crystallize rapidly and with which the measured values are falsified by incomplete removal of the latent heat of melting.—B. Bl.

The Utilization of Creep Test Data in Engineering Design [Creep of Lead Tubes under Compound Stress]. R. W. Bailey (*Proc. Inst. Mech. Eng.*, 1935, 131, 131–269; discussion, 269–349).—The purpose of the paper is to outline a rational treatment of the subject of creep, particularly directed to the requirements of design. Experimental data are examined, and general expressions for creep under any system of stress are given which include the case of tension, and permit the results of tensile creep tests to be utilized in the design of parts under complex stress. General relationships are suggested for creep in the

directions of the 3 principal stresses X , Y , and Z (considered positive when tensile) representing any stress system. The expressions are similar in form, e.g. the tensile creep rate C_x in the direction of X is represented by $C_x = \frac{A}{2}[\frac{1}{2}(X - Y)^2 + \frac{1}{2}(Z - X)^2 + \frac{1}{2}(Y - Z)^2]^m[(X - Y)^{n-2m} - (Z - X)^{n-2m}]$, where A , m , and n are constants. For simple tension ($Y = 0, Z = 0$) $C_x = AX^n$. Values of m and n are derived. The distribution of stress in important engineering parts under compound stress is determined, including tubes, pipes, cylinders (with and without heat transmission) under internal pressure, bending moment, and torque, and also the stress distribution in rotating discs and rotors. The paper also includes results for the axial, circumferential (twist), and diametral creep of lead pipes under combined internal pressure and axial stress, and internal pressure and axial torsion; data for steel tubes under compound stress are also given.—W. H.-R.

***On the Existence of a Creep Limit.** Munctada Yamamuro (*J. Aeronaut. Res. Inst. Tôkyô Imp. Univ.*, 1935, (129), 357-362).—[In Japanese.] The question of whether or not a metal can sustain a finite stress for an indefinitely long time without creep is treated from experimental evidence and theoretical considerations. Although short-time creep tests seem to indicate the existence of such a limiting stress, careful examination points to the inconclusiveness of the results; the same applies to long-time tests. In the theoretical treatment of the question two processes are assumed: fracture and strain-hardening; both are dependent on the time during which the metal is stressed. Creep having come to a stop, the stability of the two processes is considered. It is assumed that the process leading to fracture is stable, and only the stability of the process causing strain-hardening, on the various existing theories, is examined. It is found that theoretical considerations are equally inconclusive. Adopting a process of stress concentration similar to that recently put forward by G. I. Taylor, Y. proposes that the application of a stress places the metal in a stress field which is superposed on the atomic cohesive force, and the distribution of whose intensity is altered every time slip occurs. When the concentration of stress is sufficiently advanced, the stress available will be insufficient to cause further slip of the crystallographic planes. This lessening of the stress available is considered to be the cause of strain-hardening, which is most effective in creep. The process of fracture is explained by that of stress-concentration; therefore so long as this is assumed to be stable with time, the stress available for further slip remains unchanged, that is, a creep limit exists.—S. G.

A Method of Analyzing Creep Data. R. G. Sturm, C. Dumont, and F. M. Howell (*J. Applied Mechanics*, 1936, 2, (2), 462-66).—The authors present a method for studying creep data which has been in use for 4 years at the Research Laboratories of the Aluminum Company of America. It is shown by graphs that a linear relationship exists between the logarithm of the creep and the logarithm of the elapsed time for a given material at room temperature and constant stress. This is established by the fact that the logarithmic curves for a given material at a constant temperature have a constant slope for a relatively wide range of stresses. It is pointed out that the relative effect of cold-working on the strength of different metals seems to explain the behaviour of the metals when failure is impending, this being indicated by the tendency of the logarithmic creep-time curves to depart from straight lines. The authors conclude that when homologous stresses based on the tensile strength of the material are considered, different materials exhibit very similar characteristics in the relationship between the homologous stress and the logarithm of the time necessary for a given amount of creep to occur.

—S. G.

Review of Research in Strength of Materials. F. L. Everett and J. L. Maubetsch (*J. Applied Mechanics*, 1936, 2, (2), A67-70).—A brief review with a *bibliography* of 74 references covering the years 1933-1936.—S. G.

Notes on Nádai's Theory of Plasticity (A Study on the Partial Yielding of Hollow Cylinders Under Internal Pressure). Kikusaburô Nagashima (*Trans. Soc. Mech. Eng. Japan*, 1935, 1, (5), 368-374).—[In Japanese, with English summary in suppt., pp. 97-98.] The general solution of the partial yielding of hollow cylinders under internal pressure is considered, and solutions of three special cases are also given. These special cases are: (a) the partial yielding of a hollow cylinder under internal hydraulic pressure, when the total axial force acting on the cross-section of the cylinder is equal to the internal pressure multiplied by the internal cross-sectional area of the cylinder; (b) the partial yielding of a hollow cylinder under internal pressure due to forced fits, when the total axial force is zero; and (c) the partial yielding of a hollow cylinder placed under internal hydraulic pressure and axial tension at the same time. It is also shown that Nádai's theory of plasticity is based on a wrong assumption and on a theoretical inconsistency.—J. W. D.

***The Method of Measuring the Adsorption of Oils by Metallic Surfaces.** Jean Jacques Trillat and Renée Vaillé (*Compt. rend.*, 1936, 202, (26), 2134-2136).—The relation between the adsorption of oil by a metal, which determines the lubricating properties, and the alteration of the surface tension of the oil by the addition of pure water was investigated. A modified method with the Lecomte du Noüy balance was used, the torsion of a steel wire by a ring being substituted for the lifting of the ring. Displacement curves thus measure the alteration of the extension of the interfacial film which is in relation to the interfacial adsorption of the active molecules and their orientation. Such curves for paraffin oil, pure and containing up to $\frac{1}{100}$ of oleic acid, show a regular gradation of the activity of the mixtures. If a given oil is poured on twice distilled water, it gives up some of its molecules of oleic acid which become selectively fixed on the metal to form the limiting film. From these curves the number of molecules of oleic acid adsorbed and the thickness of the film can be calculated.—J. H. W.

***The Oiliness of Mineral Lubricating Oils.** Jean Jacques Trillat and Renée Vaillé (*Compt. rend.*, 1936, 203, (2), 159-161).—The method previously described (preceding abstract) was used to determine the effect of paraffin oil activated by oleic acid on different surfaces, such as paper, cotton wick, and various metals, and the results were applied to the control of lubricating oil technique. Simple passage through filter paper or glass wool removes the greater part of the active constituent. This confirms that it is only the oleic acid molecules that are adsorbed selectively by metallic surfaces. This method can be extended to ordinary commercial lubricating oils for their identification and control, and for studying the effect of their alteration in surface and in natural or artificial ageing.—J. H. W.

***Compressibilities [Thermal Expansion], and Electrical Resistance under Pressure, with Special Reference to Intermetallic Compounds [also Corrected Compressibilities of the Elements].** (Bridgman.) See p. 356.

***Theory of Viscosity of Liquid Metals.** D. V. Gogate (*J. Univ. Bombay*, 1935, 4, (2), 83-85; *C. Abs.*, 1936, 30, 4371).—Andrade's formula for the viscosity of liquids is modified by expressing the Debye frequency, which occurs in the derivation, in terms of the Debye characteristic temperature instead of the melting point temperature. Values of viscosity calculated from this formula agree fairly well with experimental results for cadmium, mercury, copper, tin, and lead.—S. G.

Heat Transfer. Curtis C. Snyder (*Metal Progress*, 1936, 30, (2), 41).—S. emphasizes the practical importance of the "heat transfer coefficient" of metals as against their thermal conductivity, and tabulates both for alu-

minium, a light alloy, copper (plain and tinned), iron (plain and tinned), nickel, Inconel, and stainless steel.—P. M. C. R.

Atomic Weights 1936. — (*Z. physikal. Chem.*, 1936, [A], 176, (5), 388).—See *Met. Abs.*, this vol., p. 144. International atomic weights for 1936 are tabulated. Changes are: tantalum 180.88 instead of 181.4 and radium 226.05 instead of 225.97. Protactinium, 231, is added to the table.—B. Bl.

***Use of the Image Potential for the Surface Electric Effect.** R. D. Myers (*Phys. Rev.*, 1936, [ii], 49, (12), 938-939).—Theoretical.—W. H.-R.

The Escape of Electricity from Metals: Its Practical Consequences. C. C. Paterson (*J. Inst. Metals*, 1936, 58, 313-317).—May Lecture, 1936. Summary of an experimental lecture which traced the effect which the liberation of the electron from metals has had on the trend of electrical engineering during the past 20 years.—S. G.

***A Macroscopic Theory of Metallic Conduction.** Ernst Weber (*Phys. Rev.*, 1936, [ii], 49, (11), 879).—Abstract of a paper read before the American Physical Society. Electrical conduction is conceived as analogous to the flow of a viscous compressible fluid in a tube. The theory leads to expressions for the resistance change in a magnetic field which agrees well with the experimental results of Kapitza, of Bridgman, and of W. The hypothesis of compressibility is supported by experiments from which also first numerical values for the compressibility coeff. as well as the coeff. of viscosity can be obtained. In the theory it is assumed that the viscosity effects are proportional to the square of the magnetic field strength.—S. G.

Secondary Emission of Pure Metals. R. Warnecke (*J. Phys. Radium*, 1936, [viii], 7, (6), 273-280).—The total secondary emission (*i.e.* reflected electrons + true secondary electrons) at normal incidence has been studied between 0 and 1500 v. for aluminium, nickel, copper, niobium, molybdenum, silver, tantalum, tungsten, and gold.—W. H.-R.

Lines of Constant Affinity in Phase Transitions of Pure Substances. J. E. Vershaffelt (*Bull. Sci. Acad. roy. Belg.*, 1936, 22, 252-264; *C. Abs.*, 1936, 30, 4386).—Instead of using the ordinary *p*, *T*-diagram, an *X*, *T*-diagram (*X* being a generalized force) is introduced and more general formulæ, applicable to the case of superconductivity in metals and to the phase transitions of the two liquid forms of helium, are derived.—S. G.

II.—PROPERTIES OF ALLOYS

(Continued from pp. 295-302.)

***Investigations on Aluminium Carbide Al_4C_3 and Aluminium Carbonitride Al_5C_3N .** M. von Stackelberg, E. Schnorrenberg, R. Paulus, and K. F. Spiess (*Z. physikal. Chem.*, 1935, [A], 175, (1), 127-139).—Aluminium and carbon when heated in a regulated stream of nitrogen form the compound Al_5C_3N as an intermediate stage in the conversion of the carbide into the nitride. The carbide has trigonal and the carbonitride hexagonal symmetry, otherwise they are similar in appearance and properties. At high temperatures Al_4C_3 dissolves excess of aluminium, which separates out again as a fine dispersion on cooling; the alleged compounds Al_2C_5 and Al_3C_2 actually consist of such mixtures. The "so-called" suboxide Al_3O_0 also consists at ordinary temperatures of a dispersion of aluminium in corundum. The amorphous and crystalline forms of Al_4C_3 are identical.—B. Bl.

***On the Decomposition of the Solid Solution of Copper in Aluminium as a Consequence of Plastic Deformation with Subsequent Anneal.** S. Konobejewsky and M. Sacharowa (*Metallwirtschaft*, 1936, 15, (18), 412-417).—Plastic deformation of quenched aluminium alloys with 2-5% copper causes a rapid decomposition of the solid solution due to the development of internal stress;

on subsequent heating decomposition rapidly completes itself. The progress of the decomposition is given by the expression :

$$r \log \frac{S_r}{S_\delta} = \frac{2M\sigma}{RTp}$$

where r is the radius of the precipitated CuAl_2 particles, S_r and S_δ are the molar solubilities of particles of radius r and δ , respectively, σ is the surface tension, M the molecular weight, R the gas constant, and T the absolute temperature. The value of r increases linearly with time of anneal showing that the rate of crystallization is linear and that the mechanism of crystallization of a phase of a deformed alloy is similar to that of the ordinary recrystallization process.—A. R. P.

***Endurance Strength of Duralumin at 350° C. under Alternate Bending Stresses.** G. Euringer (*Metallwirtschaft*, 1936, 15, (24), 540-541).—Rolled rods of Duralumin containing copper 4.31, manganese 1.16, iron 0.26, magnesium 1.06, and silicon 0.62% were tested under alternate bending stresses at 350° ± 20° C. for 1000 hrs. (5×10^7 reversals), the temperature being maintained by direct passage of a current through the specimen. No fracture occurred with a load of ± 2.7 kg./mm.², but with ± 3.0 kg./mm.² fracture occurred after appreciably fewer cycles; the former figure can, therefore, be taken as the endurance limit.—A. R. P.

***Plastic Deformation and Age-Hardening of Duralumin.** P. L. Teed (*J. Inst. Metals*, 1936, 58, 113-121; discussion, 121-122).—Plastic deformation of the type employed in the experiments described, produces, with the freshly normalized, cold-water quenched alloy, an acceleration of the normal age-hardening process, a marked increase in the proof stresses ultimately developed by the material after prolonged subsequent storage at atmospheric temperature, a slight decrease in its ultimate stress, and a relatively greater decrease in its shear stress. Similar deformation of specimens from the same sheet, but fully age-hardened prior to deformation, gives rise to an immediate increase in hardness which is virtually stable and increases in the proof and ultimate stresses.—P. L. T.

***The Forgeability of Different Types of Light and Ultra-Light Alloys.** Albert Portevin and Paul Bastien (*Compt. rend.*, 1936, 202, (25), 2072-2074).—For the determination of the nature and rate of deformation and the best conditions of working, static tests, consisting of bending and compression at different temperatures with stress-deformation curve registration, and dynamic tests, consisting of bending and drawing at intervals of temperature without registration, were carried out on aluminium with copper 6-12 and with magnesium 5, 10, and 15%, and on magnesium with copper 5, 10, and 15%, and with aluminium 3, 6, and 9%. The results indicated that neither static nor dynamic tests to destruction are suitable for differentiating the aptitude to hot-working of malleable light alloys. The thermal positions of the static and dynamic maxima do not coincide. The absence of a maximum shock corresponds to a practically unworkable alloy. The capacity of deformation curves in the dynamic tests have the same slope without necessarily thermal coincidence of maxima, that of the drawing tests being generally the lower. Bending tests, either static or dynamic, are more appropriate, convenient, and rapid for determining the forgeability of the light and ultra-light alloys. Magnesium alloys up to 15% copper or 6-9% aluminium can be drawn, those up to 15% copper being workable with care. The 12% copper-aluminium alloy can be worked with care, the limit of working of the aluminium-magnesium alloys being between 5 and 10% magnesium, according to the purity of the metals used.—J. H. W.

***The Ternary System Aluminium-Magnesium-Zinc. I.—The Section Aluminium- $\text{Al}_2\text{Mg}_3\text{Zn}_3$ - MgZn_2 -Zinc.** Werner Köster and Wolf Wolf (*Z.*

Metallkunde, 1936, 28, (6), 155-158).—Aluminium and the ternary compound $\text{Al}_2\text{Mg}_3\text{Zn}_3$ form a quasi-binary system with a eutectic at 489°C ., aluminium 39, magnesium 17, and zinc 44%. The solid solution range extends to aluminium 76, magnesium 7, and zinc 17% at one end of the eutectic horizontal and to aluminium 25, magnesium 21, and zinc 54% at the other end. At room temperature about 2% of aluminium separates out as eutectic from the ternary compound solid solution, and the solubility of the latter in aluminium does not exceed 3%. In the $\text{Al}_2\text{Mg}_3\text{Zn}_3$ - MgZn_2 section the ternary compound is formed by a peritectic reaction at 535°C .; its range of homogeneity towards the MgZn_2 side extends to aluminium 13, magnesium 21, and zinc 66%. In the section of the ternary system bounded by lines joining the points Al - $\text{Al}_2\text{Mg}_3\text{Zn}_3$ - MgZn_2 - Zn there are five surfaces of primary crystallization corresponding to the separation of α , $\text{Al}_2\text{Mg}_3\text{Zn}_3$, η , δ , and Zn . At 375°C . there is a point of 4-phase equilibrium: liquid (aluminium 18, magnesium 11, zinc 61%) + ternary compound solid solution (aluminium 16, magnesium 20, zinc 64%) = α (aluminium 71, magnesium 4.5, zinc 24.5%) + η (aluminium 2, magnesium 15.5, zinc 82.5%). The ternary eutectic is at 350°C ., aluminium 4, magnesium 2, zinc 94%. The following changes occur in the solid state: $\alpha' + \eta \rightleftharpoons \alpha + \delta$ at 325°C . and $\alpha' = \alpha + \delta + \text{Zn}$ at 280°C . Equilibrium diagrams and photomicrographs of characteristic structures are given; these include a peculiar formation of the zinc- MgZn_2 eutectic in which the latter is regularly distributed as fine hexagonal spirals.—A. R. P.

Boron Carbide. R. Sevin (*J. Four élect.*, 1936, 45, (1), 12-15).—Deals with the preparation, properties, and uses of boron carbide. The article is based on a paper by L. H. Milligan and R. R. Ridgway; see *Met. Abs.*, 1935, 2, 510, 681).—J. E. N.

***Thermal Expansion of Copper-Beryllium Alloys.** Peter Hidnert (*J. Res. Nat. Bur. Stand.*, 1936, 16, (6), 529-548; *Research Paper No. 890*).—Measurements were made on the linear thermal expansion of 12 samples of copper-beryllium alloys at various temperatures between 20° and 300°C ., in order to determine the effects of chemical composition and treatments on the expansion of these alloys. The expansion curves of the quenched samples show critical regions which may be associated with structural changes accompanying ageing. Deformation or cold-work after quenching facilitates and accelerates these changes. Stabilization of copper-beryllium alloys may be accomplished either by cold-working or by tempering. There is no simple relation between the coeffs. of expansion, chemical composition, and heat-treatment of the alloys studied. The coeffs. of expansion of the alloys do not differ from the corresponding value for copper by more than 8% of the latter value, whereas the differences for the hardness, tensile strength, elongation, and reduction of area are considerably greater; for example, the tensile strength of the alloys may be more than 4 times as great as that of copper.

—S. G.

***Investigations on the Influence of an Addition of Cadmium to Copper on the Vibration Strength of Copper.** W. Engelhardt (*Mitt. Forsch. Anst. G.H.H. Konzern*, 1936, 4, (6), 144-146).—A cast rod of electrolytic copper was drawn to 10.1 mm. diameter to produce a tensile strength of 39 kg./mm.²; its elongation was 6.8%, Brinell hardness 100, and electrical conductivity 57.0. A rod made of the same copper with 0.43% cadmium after cold-drawing to a tensile strength of 39.6 kg./mm.² had an elongation of 9%, Brinell hardness of 115, and electrical conductivity of 51.8; after drawing to the same degree of reduction as the pure copper rod it had a tensile strength of 44.4 kg./mm.², an elongation of 7%, a Brinell hardness of 122 kg./mm.², and an electrical conductivity of 51.3. These three rods gave values for the endurance limit under vibrational stresses (5×10^7 cycles) of 9.1, 11.3, and 12.4 kg./mm.², respectively, and, under a load of 12.8 kg./mm.² in the alternate bending test,

fracture occurred in 3.31, 15.16, and 37.02 million cycles, respectively. Similar tests on profiled sections also showed the great superiority of the cadmium alloy over pure copper.—A. R. P.

†**On the Systematic Classification of Bronzes [Including a Re-Examination of Parts of the Germanium-Copper System].** Friedrich Weibke (*Metallwirtschaft*, 1936, 15, (13), 299-307; (14), 321-325).—The solid solubility of germanium in copper decreases from 11.7 atomic-% germanium at 700° C. to 11.1 atomic-% at 400°-20° C. The γ -phase is formed by a peritectic reaction between primary β and liquid at 746° C., and its field of existence is bounded by a curved line between 18.7 atomic-% germanium at 746° C. and 24.3 atomic-% at 699° C. and by slightly curved lines concave to one another joining these points with 20.8 atomic-% germanium on the eutectoid ($\beta + \epsilon$) horizontal at 570° C. The γ -phase appears to be Cu_4Ge and the β phase (14-18 atomic-% germanium) to be Cu_5Ge . The ϵ -phase is homogeneous between 24.3 and 26.0 atomic-% germanium and is formed by decomposition of δ below 612° C.; it corresponds with Cu_3Ge . The δ -germanium eutectic freezes at 640° C. A systematic review of the composition of the various phases in copper alloys containing beryllium, magnesium, zinc, cadmium, mercury, aluminium, gallium, indium, thallium, silicon, germanium, and tin shows that these systems are in complete accord with the Hume-Rothery rule, the structure of the various intermetallic compounds being derived from those of the three types of brass, β , γ , and ϵ .—A. R. P.

***Alloys of Copper and Iron.** K. M. Simpson and R. J. Bannister (*Metals and Alloys*, 1936, 7, (3), 88-94).—Melts of up to 500 lb. were made in a large high-frequency induction furnace; complete exclusion of carbon was essential to obtain satisfactory castings. The physical properties of several alloys are tabulated and photomicrographs of the characteristic structures are shown.

—A. R. P.

***Some Alloys of Copper and Iron. The Tensile, Electrical, and Corrosion Properties.** Earle E. Schumacher and Alexander G. Souder (*Metals and Alloys*, 1936, 7, (4), 95-101).—Bars 0.75-1.0 in. in diameter and 20 in. long were prepared from alloys containing 37.5-75% copper and 62.5-25% iron without segregation, by melting Armco iron and electrolytic copper in a silica crucible in a high-frequency furnace. The melts were not deoxidized and the castings were hot-rolled at 800° C. The hot-rolled bars were finally drawn hot to $\frac{1}{2}$ in. diameter and then cold-drawn to produce a fibrous structure in the wire. The alloys consist of a mixture of two solid solutions the composition of which depends on the heat-treatment; they can be precipitation-hardened by suitable heat-treatment, but no drastic quench is required to retain the supersaturated iron-rich solid solution. The 50:50 alloy has the best tensile and electrical properties; after ageing at 500° C. and cold-drawing the tensile strength of 18 A.W.G. wire is 180,000-190,000 lb./in.² and the conductivity 30% of that of pure copper. Increase in the iron content reduces its resistance to corrosion. Ageing at 600° C. increases the Rockwell B hardness of the quenched 50:50 alloy from 69 to 80 in 15 minutes; ageing at 500° C. increases it to 82 in 15 minutes and to 85 in 2 hrs.—A. R. P.

***The Magnesium-Copper Alloys. V.—The Copper-Rich Alloys.** W. R. D. Jones (*J. Inst. Metals*, 1936, 58, 143-150).—The effect of 0-6% magnesium on the tensile properties and hardness of copper in the chill-cast and forged conditions was studied. The copper-rich alloys which contain magnesium do not offer much hope of being useful in view of the difficulty of obtaining sound castings and the fact that many copper-rich alloys with other metals can be obtained with much less trouble and have better mechanical properties.

—W. R. D. J.

***On the Nature of Surface Conductivity of Cuprous Oxide.** Léon Dubar (*Compt. rend.*, 1936, 202, (15), 1330-1332).—The conductivity of cuprous

oxide was measured for surfaces degassed under the action of heat and of a vacuum, and for fresh and clean surfaces obtained by fracture *in vacuo*. In the range of temperature investigated (17°–230° C.), the internal conductivity

follows the law: $\sigma = Ae^{-\frac{u}{RT}}$. Under the action of prolonged degasification the surface conductivity becomes negative. Within the limits of sensitivity of the method of measurement, the conductivity of a fresh surface is unappreciable. The high values of the surface conductivity previously recorded for specimens left for some time in the atmosphere are due to contamination of the surface by adsorption.—J. H. W.

A Copper-Silicon-Manganese Alloy. Properties and Applications of Everdur.—(*Met. Ind. (Lond.)*, 1936, 48, (23), 638).—The physical properties and industrial applications of Everdur are described, recommended foundry practice is given in detail, and a brief note is added on welding.—J. E. N.

***Further Study of the Copper-Tin Alloys by X-Ray Analysis.** E. A. Owen and E. C. Williams (*J. Inst. Metals*, 1936, 58, 283–297).—Cf. *Met. Abs.*, 1935, 2, 674. An account is given of a further study of copper-tin alloys by X-ray analysis. Attention is particularly directed to the δ and η phases. The δ region was examined at temperatures below 550° C. and it was found to be a solid solution, the range of solution increasing from zero at the eutectoid point which occurs at a composition of 67.4% copper and a temperature of 330° C., to 0.4% composition by weight at 550° C. The η -phase was also found to be a solid solution, the range of solution at 250° C., extending from 61.68 to 62.10 and at 530° C. from 61.68 to 62.20% copper by weight. Observations are also recorded which confirm the conclusion that the δ -phase transforms to ($\alpha + \eta$) at a temperature of 330° C. approximately. [*Note*: The δ - and η -phases were termed the γ - and ϵ -phases, respectively, in the previous paper, but as this alteration caused difficulty to some readers, the ordinary nomenclature is here reverted to.]—E. A. O.

***Inverse Segregation in Ingots and Gas Solubility Studied on Tin-Bronzes.** (Claus and Bauer.) See p. 374.

Nickel-Containing Tin-Bronzes. B. Trautmann (*Giesserei-Praxis*, 1936, 57, (27/28), 289–290).—The substitution of nickel for part of the tin in tin-bronzes causes a displacement of the α -solid solution limit, owing to the precipitation of a new structural constituent. The alloys containing >2% of nickel and 2–10% of tin can be age-hardened in the cast as well as in the cold-worked conditions, the most satisfactory hardening occurring with equal amounts of nickel and tin (5%). With large castings, slow cooling from the quenching temperature (furnace cooling for the prevention of cracks) has a favourable effect on the final hardness of low (2½%) nickel alloys. The addition of nickel has little effect on the corrosion-resistance.—J. H. W.

***Copper-Nickel-Zinc Alloys.** J. Schramm (*Würzburg: Konrad Triltsch*, 1935, 129 pp.).—The equilibrium diagram of the system copper-nickel-zinc was determined in great detail by thermal and microscopic methods supplemented by X-ray crystal analysis. The α (face-centred cubic) phase, which extends from 0–100% nickel in the binary copper-nickel alloys, forms a wide ternary solid solution with zinc. The temperature of the $\beta \rightleftharpoons \beta'$ transformation in the system copper-zinc is raised by the addition of nickel until it coincides with the solidus, and disappears. The β' phase of the system nickel-zinc which has a body-centred cubic structure, and is stable only at high temperatures, forms a continuous series of solid solutions with the β' copper-zinc phase of the same structure. The transformation temperature at which the nickel-zinc β' phase changes to the β_1 phase with body-centred tetragonal structure is lowered by the addition of copper. The phases with the “ γ brass” structure in the two binary systems form an unbroken series

of solid solutions in the ternary system. The nickel-zinc δ phase with hexagonal lattice forms an unbroken series of solid solutions with the copper-zinc δ phase which is stable only at high temperatures. The copper-zinc ϵ phase with close-packed hexagonal lattice takes up only very small amounts of nickel into solid solution. Interesting examples are given of the gradual change from a peritectic reaction to a eutectic reaction as the composition of the ternary alloy is varied.—W. H.-R.

German Silver : Properties, Manufacture, Working, Defects Due to Faulty Production (Erzeugungsfehler), and Uses. Rudolph Krulla (*Forschungsarbeiten Metallkunde u. Röntgenmetallographie*, 1935, (17), 1-63).—K. gives a general review of the properties of the German silver type of alloy, the effects produced by the addition of further elements to the standard copper-nickel-zinc alloys, and of common defects due to faulty casting, rolling, annealing, pickling, &c. Diagrams are given showing the effect of composition on the melting points, mechanical properties, thermoelectric force, electrical conductivity, and thermal conductivity of German silver alloys. The effects of iron, lead, tin, aluminium, oxygen, sulphur, carbon, silicon, phosphorus, magnesium, silver, arsenic, antimony, and alkali metals are indicated briefly. The book contains a great deal of general information, and of numerical data in graphical form, but references to original sources are only occasionally given.—W. H.-R.

***The Physical Properties and Annealing Characteristics of Standard Nickel Silver Alloys.** Maurice Cook (*J. Inst. Metals*, 1936, 58, 151-165; discussion, 165-171).—A detailed study has been made of the hardness and mechanical properties as affected by progressively increasing amounts of cold-work, and of the annealing characteristics of 7 nickel silver alloys with a constant copper content and containing 10-30% nickel. The increase in hardness occurring on rolling reductions up to as much as 90% was determined for all 7 alloys, and for the 3 alloys of highest, intermediate, and lowest nickel content the effect of cold-work on the mechanical properties was studied in detail. Similarly, the annealing characteristics were determined for all the alloys by means of hardness tests, whilst in the case of the three alloys already mentioned this information is supplemented by data on the mechanical properties. The modulus of elasticity increases progressively with nickel content, and in the annealed condition the hardness also increases with the nickel content. This difference in hardness, however, is not maintained when the materials are cold-worked, and after a reduction of 90% in thickness by cold-rolling the order of hardness is reversed, i.e. the highest value is obtained with the 10% nickel alloy and the lowest with the 30% nickel alloy. In other words, the extent to which the alloys can be work-hardened decreases with the nickel content. The temperature at which softening commences on annealing increases with the nickel content. In common with other copper-rich alloys, the temperature at which softening commences in an alloy of given composition decreases with increasing amount of cold-work and the extent to which hardening occurs immediately prior to the commencement of softening also increases with the amount of cold-work. Information is given on the density, electrical and thermal conductivity, and thermal expansion of the alloys.

—M. C.

***Experiments on the Electrical Resistance of Copper and Some Copper Alloy Wires.** (Blazey.) See p. 339.

***The Transformation in the Copper-Gold Alloy Cu_3Au .** C. Sykes and H. Evans (*J. Inst. Metals*, 1936, 58, 255-280; discussion, 281).—The effect of the transformation in the alloy Cu_3Au on the electrical resistance, X-ray structure, and specific heat was investigated experimentally, and it is shown that the general character of the transformation is satisfactorily predicted by the Bragg-Williams theory of the formation of super-lattices by atomic re-

arrangement. The atomic rearrangement process involves first the formation of small nuclei having a relatively high degree of order. These nuclei then grow to a size approximating to that of the individual crystals, if a constant temperature is maintained. If, however, the alloy is continuously cooled before it attains equilibrium, two processes proceed simultaneously, the nuclei tend to grow, and at the same time the degree of order in the nuclei increases owing to the reduction in the temperature. The existence of such nuclei is not considered in the statical theory of super-lattices, so that it is not surprising to find that the theoretical predictions regarding the rate of relaxation into the equilibrium state are not in agreement with experiment.

—C. S.

*Investigation of Elastic After-Effects in CuAu Alloy with a Regular Space-Lattice (First-Order Elastic After-Effect). V. S. Gorsky (*Zhurnal eksperimental'noy i teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (3), 272–277).—[In Russian.] To verify G.'s theory (*Met. Abs.*, 1935, 2, 338), the elastic after-effect in CuAu with a regular space-lattice was investigated. In polycrystalline specimens 60–100%, and in single crystals 10–60% of after-effect from elastic deformation was found, depending on orientation. This is of the order predicted.—N. A.

*The Anodic Behaviour of Gold-Copper Alloys in 5*N* Hydrochloric and in Sulphuric Acids. W. J. Müller, H. Freissler, and E. E. Plettinger (*Z. Elektrochem.*, 1936, 42, (7a), 366–371).—A colorimetric investigation showed that all the alloys from pure gold to pure copper go into solution in 5*N*-hydrochloric acid with an average applied current density of 2 amp./dm.² without the appearance of any passivity. From pure gold to about 50 atomic-%, the alloys go into solution in proportion to their composition. Between 50 and 30 atomic-%, the composition of the solute falls sharply in favour of copper, and below 30 atomic-% gold, only copper goes into solution. The solubility is approximately parallel to the value of the decomposition voltage, but the falling off of the latter occurs at a somewhat lower gold content (40 instead of 50 atomic-%). The break in the colorimetric curves does not coincide with the lowest melting point in the equilibrium diagram of the gold-copper alloys, but lies in the region of maximum hardness and minimum conductivity. There is a fairly sharp anodic resistance limit at 30 atomic-% gold, but it does not coincide with the break in the potential curve. In 1*N* sulphuric acid, only alloys up to 10 atomic-% gold go into solution. From 10 to 30 atomic-%, the amount of copper going into solution decreases rapidly, above 40 atomic-%, only traces of copper go into solution. Gold does not go into solution in any of the alloys. The passivity of these alloys is doubtless limited because the sulphuric acid, unlike 5*N*-hydrochloric acid, cannot remove the oxide layer from the gold.—J. H. W.

*Influence of the Conditions of Test on the Shrinkage [of Antimonial Lead and Aluminium Castings].—II. O. Bauer and H. Sieglerschmidt (*Metallwirtschaft*, 1936, 15, (24), 535–540).—Cf. *Met. Abs.*, 1935, 2, 576. The shrinkage (*s*) of a metal casting depends on the ratio of the weight of mould to weight of casting (*n*), on the rate of casting, and on the initial (*t*₀) and final (*t*₁) temperature of the mould. Thus for 16% antimonial lead when *t*₀ = 20° C., *t*₁ = 65° C., and *n* = 6.2, *s* = 0.52%; when *t*₀ = 139° C., *t*₁ = 168° C., and *n* = 6.1, *s* = 0.48%; and when *t*₀ = 135° C., *t*₁ = 193° C., and *n* = 2.5, *s* = 0.45. For aluminium when *t*₀ = 20° C., *t*₁ = 123° C., and *n* = 24, *s* = 1.69%; when *t*₀ = 453° C., *t*₁ = 520° C., and *n* = 25, *s* = 1.56%; and when *t*₀ = 450° C., *t*₁ = 555° C., and *n* = 8.1, *s* = 1.50%. In general, *s* is lower the lower the value of *n* and it is recommended that the test mould should give an ingot 100 × 18 × 12 mm. and should weigh 1.2 kg. The mould should be well insulated and covered immediately after casting and for 2 minutes thereafter.—A. R. P.

***The Solubility of Lithium in Magnesium.** Wilhelm Hofmann (*Z. Metallkunde*, 1936, 28, (6), 160-163).—From X-ray examination of lithium-magnesium alloys it is shown that the solid solubility of lithium in magnesium is 17.6 atoms-% (5.7 weight-%). The sp. gr. of the alloys decreases from 1.741 (magnesium) to 1.589 (4.85% lithium), while the Brinell hardness varies only slightly from 32 to 35 within the same range.—A. R. P.

***Researches on the Magnesium-Copper-Aluminium System Especially on the $MgCu_2$ - $MgAl_2$ Section.** F. Laves and H. Witte (*Metallwirtschaft*, 1936, 15, (1), 15-22).—A preliminary thermal, X-ray, and micrographic examination was made of alloys formed by melting together $MgCu_2$ and $MgAl_2$ in various proportions. Up to about 35 mol.-% $MgAl_2$ the primary crystallites are cubic and consist of a solid solution of $MgAl_2$ in $MgCu_2$. With 35-65 mol.-% $MgAl_2$ hexagonal tablets of the $MgNi_2$ type separate as primary crystallites and with more than 70 mol.-% $MgAl_2$ the primary crystallites consist of hexagonal columns of the $MgZn_2$ type. The $MgNi_2$ -type crystals appear to be stable only above about 650° C., reverting to crystals of the $MgZn_2$ type at lower temperatures. The solidus and liquidus of the system reach a maximum at 905° C. for alloys containing 25-30 mol.-% $MgAl_2$. X-ray examination of alloys with a high $MgAl_2$ content affords evidence of the existence of several ternary compounds, notably $Mg_2Cu_3Al_5$ and $Mg_3Cu_7Al_{10}$. Bastien's compound, $Mg_2Cu_3Al_2$, appears, however, to be one member of the homogeneous series of solid solutions which extends at room temperature from 0 to 30 mol.-% $MgAl_2$.—A. R. P.

High-Resistance Copper-Nickel Containing Aluminium. K-Monel. W. A. Mudge and P. D. Merica (*Métaux*, 1935, 10, (124), 336-340).—The physical and mechanical properties of Monel metal containing 3-5% aluminium are given.—J. H. W.

†**On the "Permalloy" Problem.** J. L. Snoek (*Nature*, 1936, 137, (3464), 493).—Lichtenberger's explanation of the high magnetic permeability of Permalloy is supported by published work on the influence of a magnetic field applied during cooling, and the influence of grain-size and crystal orientation on the permeability of iron and silicon-iron.—E. S. H.

***Effect of Annealing on the Properties of Hard-Worked Permalloy.** J. F. Dillinger (*Phys. Rev.*, 1936, [ii], 49, (11), 863).—Abstract of a paper read before the American Physical Society. An alloy containing nickel 70 and iron 30% was hard-worked until its original cross-section was reduced 96%, and the changes in various properties were observed after annealing for various periods of time between 200° and 1100° C. The properties measured were initial and maximum magnetic permeabilities, the "magnetic hardness" in high fields, the electrical resistivity, and the mechanical hardness. The changes are practically complete after annealing for 1 hr. at 650° C., and are exponential with time and the reciprocal of the absolute temperature. The results are interpreted in terms of the energy which atoms must have in order to diffuse in the crystal lattice, and this energy is found to be 1.7 electron volts, in agreement with that found in alloys having superstructure. The results are correlated with the relief of internal strains as measured by X-rays (see Hawarth, *Met. Abs.*, this vol., p. 360).—S. G.

***The Variation of Young's Modulus with Magnetization in Permalloy.** Sidney Siegel and Seymour Rosin (*Phys. Rev.*, 1936, [ii], 49, (11), 863).—Abstract of a paper read before the American Physical Society. Data are reported which show the variation of Young's modulus with magnetization in 3 specimens of 81 Permalloy. The specimens were prepared by subjecting a single rod of the material consecutively to the following processes: (1) annealing at 1100° C. in hydrogen and slow cooling; (2) stretching beyond the elastic limit with a resultant permanent elongation of 2%; (3) quenching in

water at 1050° C. The % increase in Young's modulus between zero and saturation magnetization was 0.26% for the first specimen, 0.15% for the second, and 0.11% for the third. The magnitude of this effect in annealed 81 Permalloy is thus very nearly the same as in annealed Armeo iron, and so is larger than might have been predicted, on the basis of Akulov's theory, from the known absence of magnetostriction in this material.—S. G.

***Preliminary Note on the Phase Relationships in the Nickel-Tin System.** Erich Fetz and Eric R. Jette (*J. Chem. Physics*, 1936, 4, (8), 537).—A complete study by X-rays has been made of the system nickel-tin. A brief summary of the results is given; a complete description will appear later. The study of this system was extended beyond the solubility limit of tin in nickel already reported by F. and J. (*Met. Abs.*, 1935, 2, 283). The next phase to the nickel solid solution phase occurs at the composition Ni₃Sn; this phase has a very narrow composition range. The Ni₃Sn phase is in equilibrium with a phase having a typical NiAs structure between approx. 25.0 and 37.5% tin. The NiAs structure first appears alone at about 37.5 atomic-% tin, but extends as a homogeneous phase only up to 45 atomic-% tin; it thus requires excess nickel atoms to stabilize the lattice. At 40 atomic-% tin, or the composition Ni₃Sn₂, a new phase forms from the NiAs-like phase below 500° C. Its diffraction pattern appears to be closely related to the NiAs structure and it may be a deformed modification. The range of homogeneity must be quite small since it is not found at 38.0 nor at 42.5 atomic-% tin. The homogeneity range of the NiAs-structure is independent of temperature on the high tin side, but increases slightly at higher temperatures on the nickel side. In the remainder of the system there are 3 new phases provisionally called η , θ , and ζ ; η and θ have very narrow homogeneity ranges at approx. 51 and 54 atomic-% tin, respectively. The η -phase forms by a peritectoid reaction between the NiAs-structure and θ . The ζ -phase extends between approx. 56 and 62 atomic-% tin, although this range may possibly be more complicated. The ζ -phase coexists with the tin phase from 62% up to practically 100% tin. The diffraction patterns indicate that the solubility of nickel in tin is very low.—S. G.

***Binary Systems of the Alkali Metals.—II. [Sodium-Cæesium; Potassium-Cæesium; Rubidium-Cæesium].** Carlo Gorla (*Gazz. chim. ital.*, 1935, 65, (12), 1226-1230; *Brit. Chem. Abs.*, 1936, [A], 558).—Cf. *Met. Abs.*, this vol., p. 249. Thermal diagrams for the systems sodium-cæesium, potassium-cæesium, and rubidium-cæesium are recorded. The first shows the formation of the compound Na₂Cs, a eutectic at -28° C. with 7.0 weight-% sodium, and no solid solution formation. The second suggests the formation of the compound KCs, melting at -45° C. In the third system there is a eutectic at -30° C. (13 weight-% rubidium), but neither a compound nor a solid solution formation is indicated.—S. G.

***Solidification Diagram and Electrical Conductivity of the Potassium-Cæesium Alloys.** E. Rinck (*Compt. rend.*, 1936, 203, (3), 255-257).—A continuation of an investigation into the constitution of binary alloys of the alkali metals (cf. *Met. Abs.*, 1935, 2, 283). Potassium and cæesium form an uninterrupted series of solid solutions, the liquidus and solidus having a minimum at -37.5° C. for an equimolecular mixture of the metals. No evidence of a compound K₂Cs, analogous to Na₂Cs was observed. The electrical conductivity was found to be a minimum at the composition corresponding to KCs, and hence the eutectic at this composition is a simple mixture of the two metals. These results do not quite confirm those of Gorla (preceding abstract), who found a metallic compound with a melting point of -45° C. R. considers that this is due to the fact that G. used an inert atmosphere instead of a high vacuum which R. states is necessary to prevent an alteration to the molten cæesium.—J. H. W.

***The Potential of Silver-Zinc Alloys.** G. I. Petrenko and E. E. Tscherskaschin (*Z. Elektrochem.*, 1936, 42, (7a), 398-400).—Read before the Charkower Section der Mendeljew Chemischen Gesellschaft der Gesamten Union. The potential curve of the silver-zinc alloys prepared without a slag 30 years ago for thermal analysis shows the same compounds as the thermal equilibrium diagram. After annealing, only two compounds, Ag_2Zn_5 and AgZn , appear on the potential curve. Characteristic curves of the potential were observed for the single phase region in this system. The variation obtained on the potential-composition curves by annealing has also an effect on the change of potential with time. The results of the present alloys made without slag and those of alloys prepared with slag by G. Petrenko and A. Dobrovolski (*Met. Abs. (J. Inst. Metals)*, 1931, 47, 378) show that the slag has no obvious effect on the potential of these alloys.—J. H. W.

***The Constitution of the Tin-Rich Antimony-Tin Alloys.** D. Hanson and W. T. Pell-Walpole (*J. Inst. Metals*, 1936, 58, 299-308; discussion, 308-310).—The constitution of the tin-rich alloys of the system antimony-tin was investigated by means of thermal analysis, microscopical examination, and electrical resistivity measurements. The liquidus and solidus of the tin-rich phase and the temperature of the peritectic reaction are in general agreement with the results obtained by Ivasé, Aoki, and Ôsawa. The solubility of antimony in tin is shown to decrease from 10.5% at 246° C. to 3.5% at 100° C.—D. H.

***The Precipitation-Hardening of Austenitic Cobalt-Tungsten-Iron Alloys.** H. Cornelius and F. Bollenrath (*Metallwirtschaft*, 1936, 15, (25), 559-568).—The precipitation-hardening of 3 alloys with cobalt 38.2-40.1, tungsten 40.7-36.0, aluminium 0-0.4%, traces of carbon, silicon, and manganese, and iron the remainder was investigated by dilatometric and micrographic methods and by hardness measurements made at constant annealing temperatures between 500° and 900° C. for periods of up to 300 hrs. In alloys quenched from 1276° C. in water very little hardening occurs on reheating at 500° C. At 600° C., however, there is a continuous increase in hardness during 80-120 hrs., a maximum value of over 680 (Brinell) being obtained; this maximum is followed by a very slow decrease in hardness, showing the extreme reluctance of the precipitated δ -phase to coagulate. At 650°-700° C. a maximum hardness of over 600 is obtained in 10-12 hrs., and this again is followed by a slow decrease on prolonged heating. At 900° C. practically no hardening occurs owing to the rapid coagulation of the precipitated δ at this temperature and to its greater solubility in γ which commences at 750° C. The time required to produce maximum hardening at 650° C. depends on the quenching temperature and the rate of quenching. Hardening is accelerated by cold-working of the quenched alloy but, after this treatment, softening at 900° C. is much more rapid. Minimum hardness is obtained by quenching from 1300° C.; after this quenching hardening at 650° C. is accelerated by an intermediate heating at 900° C. Hardened alloys have a remarkably high hot-strength; thus after quenching from 1275° C. and ageing at 650° C. for 16 hrs. the alloys have a tensile strength of more than 37 kg./mm.² at 750° C. Numerous characteristic structures obtained by various heat-treatments are shown.—A. R. P.

Non-Ferrous Casting Alloys of High Strength. A. J. Murphy (*Trans. Amer. Found. Assoc.*, 1935, 43, 369-400; discussion, 400-403).—See *Met. Abs.*, 1935, 2, 582.—J. E. N.

***Diffusion of Solid Metals and Its Relation to Other Properties.** W. Seith and E. A. Peretti (*Z. Elektrochem.*, 1936, 42, (7b), 570-578; discussion, 578-579).—Read before the Deutsche Bunsen-Gesellschaft für angewandte physikalische Chemie. In confirmation of the results obtained in the case of diffusion of metals into lead (*Met. Abs.*, this vol., p. 78), it was found that the

rates of diffusion of copper, cadmium, indium, tin, and antimony into silver are dependent on the place of the metals in the periodic table and on their ability to form solid solutions with silver.—J. H. W.

*Compressibilities [Thermal Expansion] and Electrical Resistance under Pressure, with Special Reference to Intermetallic Compounds [also Corrected Compressibilities of the Elements]. P. W. Bridgman (*Proc. Amer. Acad. Arts Sci.*, 1935, 70, (7), 285-317).—The effect of pressures up to 12,000 kg./cm.² on the volume and electrical resistance of the following substances has been studied at 30° and 75° C.; the results also indicate the mean coefficient of thermal expansion, and the mean temperature coefficient of resistance between these temperatures: Ag₅Cd₈, Ag₅Zn₈, Cu₅Cd₈, Cu₅Zn₈, Cu₃₁Sn₈, CuZn, AgCd, AuZn, AgZn, Cu₅Sn, Ag₂Al, Mg₃Al₂, magnesium-aluminium alloy containing 50% by weight of magnesium, Mg₂Pb, MgZn₂, SbSn, AuSb₂, Sb₂Tl₇, metallic germanium, Ag₂S, PbSe, and PbTe. In general, the compounds were prepared by melting in argon, and were annealed near the melting temperature for periods up to 10 days. Compared with pure metals the compounds usually show greater pressure hysteresis, more pronounced creep phenomena, and a tendency to show changes after the specimen has been rested for some months. These irregularities suggest an internal equilibrium shifting under pressure, and sometimes with time. The observed compressibilities are nearly always much smaller than those calculated from the atomic volumes of the constituent elements. This is to be expected if there is important chemical affinity; a high chemical affinity meaning a high internal pressure and a low compressibility. The specific resistances are nearly always larger than those expected from the rule of mixtures, but CuZn and AuSb₂ are exceptions. The pressure coefficients of resistance are almost always negative, but are less numerically than those of metals. *Corrected compressibilities of the elements.*—B.'s early results for compressibility contain errors owing to the use of a wrong sign in the correction term applied for reducing change of length to change of volume. The compressibilities at low pressures are unaffected, but at 12,000 kg./cm.² the early volume changes are too large by amounts which vary from 1% for iron to 14% for potassium. A table of corrected values is given. Results later than 1925 are not affected by this error, but all results since 1925 should strictly be corrected by a small additive term because of a change in the fundamental compressibility of iron, for which the original must be consulted.—W. H.-R.

†Non-Ferrous Alloy Systems. E. S. Hedges (*Ann. Rep. Prog. Chem.*, 1935, 32, 165-180).—A review of recent work on the constitution of non-ferrous alloy systems and the methods of investigation involved, with particular reference to the formation of intermetallic compounds.—E. S. H.

General Remarks on the Application of Thermodynamics to Chemical Equilibria in Homogeneous Systems. M. W. Mund (*Ann. Soc. sci. Bruxelles*, 1936, [B], 56, 15-34; *C. Abs.*, 1936, 30, 4383).—Among the proofs given are those for Le Chatelier's principle (without the use of thermodynamic functions), and for the independence of the affinity from temporary variations of pressure and temperature which may occur during the course of a reaction at "constant pressure and temperature."—S. G.

†Two-Dimensional Diagrams.—Supplementary Note. L. Grenet (*Métaux*, 1936, 11, (129), 118-122).—See *Met. Abs.*, this vol., p. 75. Some further details in the interpretation of binary equilibrium diagrams are considered.

—J. H. W.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 303-306.)

The Preparation of Metal Specimens for the Microscope. R. C. Stockton (*Metallurgia*, 1936, 14, (81), 57-58).—A few simple precautions in the selection and preparation of specimens, which will give reliable information regarding their structures, are discussed with reference to the shape of the specimen; special mounting for polishing in the case of small specimens, wire, or strip; polishing on the buff, and preparation of the buff. The polishing of soft non-ferrous alloys is specially referred to.—J. W. D.

***On the Electrolytic Polishing of Copper, Tin, and Their Alloys and Its Application in Metallography.** P. Jacquet (*Bull. Soc. chim. France*, 1936, [v], 3, (4), 705-723).—Cf. *Met. Abs.*, this vol., p. 202. When copper is electrolyzed anodically in phosphoric acid solution (530 gm./litre) and the potential gradually increased the current increases rapidly to a maximum then falls sharply to a constant value; at this point a smooth bright surface develops rapidly which is superior to that produced by mechanical polishing. The best voltage is 1.9 v.; at 1.7 the surface becomes milky and at 2.1 v. gas bubbles and pits are formed. For α -brass 13-15 amp./dm.² at 1.9 v. are used and the electrolyte contains 43 gm./litre of phosphoric acid. Scratches can be removed from ($\alpha + \beta$)-brass at 9-11 amp./dm.² (1.9 v.) in acid of 53 gm./litre concentration, but a bright surface cannot be obtained. The heterogeneity of α -bronze and the (α - δ)-eutectoid are revealed by anodic polishing-etching at 1-2 amp./dm.² in acid of 990 gm./litre concentration. Lead and tin can be polished anodically in a mixture of 650-750 c.c. of glacial acetic acid and 350-250 c.c. of perchloric acid (d 1.61) using 20-25 amp./dm.² for lead and 15-17 amp./dm.² for tin. Tin-lead alloys may be etched similarly but at a low current density; heterogeneous alloys do not give a bright surface. The theory of the process is discussed and effects of varying the conditions are described.—A. R. P.

Tests to Insure Tube Quality [Microstructure of Tungsten]. Harry F. Dart (*Electronics*, 1936, 9, (2), 32-33).—D. mentions the use of metallographic inspection as an aid to the production, for use in radio valves, of tungsten filaments having controlled crystal structure.—J. C. C.

***An Etching Reagent for Zinc and Zinc Alloys.** Jakob Schramm (*Z. Metallkunde*, 1936, 28, (6), 159-160).—The reagent is prepared by mixing 51 c.c. of concentrated potassium hydroxide solution with 50 c.c. of water and 20 c.c. of concentrated copper nitrate solution and stirring in 25 gm. of powdered potassium cyanide; the solution is filtered and treated with 2.5 c.c. of concentrated citric acid solution before use. Etching takes 10-20 seconds, in which time the zinc phase is coloured dark brown to black. When used on commercial zinc the iron phase appears as white rods or feathered dendrites and the lead phase as round white dots.—A. R. P.

†**Some Phenomena of Recrystallization.** A. E. van Arkel (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 1, 423-428; and *Rev. Mét.*, 1936, 33, (3), 197-202).—Reviews the results of investigations on the nature of recrystallization centres, the mean orientations of crystals formed by the deformation of a larger crystal, and the nature of "primary" and "secondary" recrystallization.—J. C. C.

***The Effect of Sudden Heating on the Recrystallization of Metals.** Usaburo Yoshida, Saburo Nagata, and Chikara Mitsuki (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1936, [A], 19, (3), 169-180).—[In English.] In recrystallizing thin aluminium plates the effect on the number of grains of sudden heating to a recrystallization temperature in the germinative temperature range was

investigated. It was found that the number of grains is much greater in this case than when the plate is gradually heated to the same recrystallization temperature. In the case of gradual heating a few seeds or crystal nuclei which are to be grown to tolerable size afterwards in the germinative temperature range seem to be formed among an immense number of the recrystallized metal crystals already in the recrystallization range lower than the germinative temperature.—S. G.

*On the Collective Recrystallization of Metals. A. A. Botchvar, N. M. Below, and B. A. Granovskiy (*Zvetnye Metally (Non-Ferrous Metals)*, 1936, (3), 86–89).—[In Russian.] The maximum grain-growth in zinc, aluminium, and copper is observed at definite temperatures, namely 320°–360°, 595°–630°, and 950°–1000° C., respectively. Between these temperatures and the melting point the grains are smaller. The existence of an optimum temperature is ascribed to layers of impurities between the grains.—N. A.

*Determination of the Non-Metallic Inclusions in the Surface of Polished Metal Specimens. J. Czocharlski and W. Sznuk (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, 3, (1), 5–6).—[In Polish, with German summary.] A sharp needle connected through a rheostat to a 4 v. accumulator and milliammeter is drawn across the surface of the metal; every drop in current is counted as an inclusion, the size of which is greater the greater the throw of the galvanometer.—A. R. P.

*On the State of Electrodeposited Metals. G. Tammann and H. Jaacks (*Z. anorg. Chem.*, 1936, 227, (3), 249–260).—The crystallites of electrolytically deposited copper have rhombic dodecahedral facets parallel to the cathode surface. On annealing grain-growth starts at 300° C. and the grains at 500° C. have double the original cross-section; at 600° C. new grains begin to form at the expense of the old. Electrolytic iron has a similar fibrous structure, but the fibres are thinner than those of copper; recrystallization starts at 700° C. The fibrous structure of electrolytic zinc remains unchanged up to 400° C. The superior hardness of electrolytic metals is not due to occluded hydrogen since this is removed on heating at 400° C. (nickel), 250° C. (iron), or 350° C. (chromium), whereas at these temperatures there is only a very slight fall in hardness; appreciable softening of nickel occurs at 600° C. and of electrolytic iron at 550° C. Electrolytic zinc dissolves more slowly in acids than does pure melted zinc but it loses this passivity after annealing at 415° C.—A. R. P.

X-Ray Methods of Diffraction Analysis as Applied to Electroplating Problems. Herbert R. Isenburger (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (6), 13–24).—Modern practice and apparatus is described in simple language.

—A. R. P.

*Determination of the Number of Microcrystals by X-Ray Diagrams. G. S. Shdanov and V. I. Iveronova (*Zavodskaja Laboratoria (Works' Lab.)*, 1935, 4, (10), 1235–1242).—[In Russian.] The relative numbers of crystals were calculated in unit volumes of copper and 5–10% zinc brass, consisting of microcrystals (10^{-1} – 10^{-3} mm.) and free from texture, from the expression $n = N_0 \int p dV = N_0 p_v V$, where n is the interference number, p_v the average probability of reflections per volume, and N_0 the number of microcrystals per unit volume, V ; p_v and V are determined by the dimensions of the diaphragm, the focal length, and the shape and dimensions of the specimen, and depend on the angle of incidence of the X-rays. Under uniform conditions of photography p_v and V are constant. The number of spots on the Debye ring derived from the hkl plane was determined under the microscope. As the annealing temperature is raised from 275° to 475° C. the increase in the number of crystals is greater the higher the zinc content. To calculate the absolute quantity of micro-crystals it is necessary to know the volume V illuminated and the average probability of reflection p_v ; V is calculated from the cone of spread of the primary pencil, and p_v from the distribution of the

convergence cones. Geometrical constructions are given for calculating the necessary data for flat-plate specimens for a given apparatus and camera set-up. The absolute number of crystals C (number of recrystallization centres) and W (linear recrystallization velocity) can be determined by v. Göler and Sachs' formulæ (*Met. Abs. (J. Inst. Metals)*, 1932, 50, 671) if the time of complete annealing and the number of crystals per unit volume are determined experimentally. The calculated values for C and W for the alloys examined are in good agreement with those obtained by Karnop and Sachs (*J. Inst. Metals*, 1930, 43, 523).—D. N. S.

***The Structure of Aluminium Carbonitride.** M. v. Stackelberg and K. F. Spiess (*Z. physikal. Chem.*, 1935, [A], 175, (1), 140–153).— $\text{Al}_2\text{C}_3\text{N}$ has an hexagonal structure, $a = 3.280$, $c = 21.55$ Å., 2 molecules in the unit cell, space group C_{6v}^4 , atomic positions (a) $0\ 0\ u$, $0\ 0\ \frac{1}{2} + u$, (b) $\frac{1}{3}\ \frac{2}{3}\ \frac{1}{2} + u$. The lattice constants bear a simple relation to those of Al_4C_3 and AlN ; the latter has $a = 3.104$, $c = 4.965$ Å. Apparently AlN can dissolve a small amount of Al_4C_3 with a corresponding broadening of the lattice.—B. Bl.

***On the State of Rare-Earth Elements in a Metallic Space-Lattice.** V. I. Drojjina and R. I. Janus (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (3), 250–255).—[In Russian.] The temperature relation of magnetic susceptibility of cerium and praseodymium was investigated. For cerium the magnetic moment (p) is 11.4 Mw. and the Curie point $\Theta + 6^\circ$ K.; for praseodymium p is 16.0 Mw. and $\Theta + 2^\circ$ K. From comparison of the actual with the theoretical values of p it is concluded that the lattice structure of these metals is similar to that of trivalent chemical compounds.—N. A.

***Theory of Metallic Crystal Aggregates [Density and Energy Changes in Cold-Worked Copper and Iron].** Charles G. Maier (*Metals Technology*, 1936, 3, (3), 50 pp.; *A.I.M.M.E. Tech. Publ. No. 701*; and (summary) *Light Metals Research*, 1936, 4, (17), 276–277).—(1) Copper wires were cold-worked in different ways (drawing, rolling, and twisting) and the density measured after different amounts of deformation. The results are complex, and the density may either increase or decrease on working according to the method of deformation and the preliminary annealing temperature. An initial decrease in density may be followed by an increase at higher deformations, or *vice versa*. At 20° C. the density of copper melted and solidified in a vacuum was 8.94153, but when helium pressure was applied during solidification the density was 8.94331, and a single crystal sample gave the value 8.95285. These values are greater than that of 8.9291 required by the lattice spacing measurements of Owen and Yates (*Met. Abs. (J. Inst. Metals)*, 1933, 53, 130) who, according to M., used too low annealing temperatures to obtain complete recrystallization. There are inconsistencies between the directly determined "stored" energy in torsional cold-working, and the changes of energy and heat content calculated thermodynamically from considerations of lattice distortion. (2) Changes in density and coercive force in cold-worked iron were also investigated. (3) Attempts are made to explain these results by assuming that worked metal contains a new phase existing at internal crystal surfaces, and of greater density than that of normal metal. The observed density changes are then the net result of two internal changes of density. This is termed the "idemsorption hypothesis," and the new phase is regarded as partly resembling an adsorbed film.—W. H.-R.

***Deformation and Lattice Constants [Gold-Silver Alloy].** Arthur Phillips and R. M. Brick (*Metallwirtschaft*, 1936, 15, (24), 541–542).—The lattice constants of a gold-silver alloy with 75 atomic-% of gold after drawing to various degrees of reduction (2–95%) and annealing at 900° C. vary only within a range of 0.0011 Å., but mostly come within the value of 4.0676 ± 0.0003 Å. (Cf. Wassermann, *Met. Abs.*, 1935, 2, 594, and Wiest, *ibid.*)—A. R. P.

***Analysis of Broadening of X-Ray Reflections by Strain.** S. O. Rice (*Phys. Rev.*, 1936, [ii], 49, (11), 862).—Abstract of a paper read before the American Physical Society. In the interpretation of X-ray measurements of the reflection of "monochromatic" radiation from a crystal plane it is often desirable to separate two effects, one due to variations in the lattice spacing of the planes and the other due to variations of the wave-length. In the present case it was desired to know the distribution of lattice spacings in a material, having given (1) the function relating X-ray intensity to the angle of reflection, and (2) the distribution of intensity in the X-ray line, which is given by reflection from a material having constant lattice spacing. This involves solution of the integral equation $F(0) = \int_{-\infty}^{+\infty} f_{\lambda}(0-u)f_d(u)du$ for $f_d(u)$ when the other two functions are given. The solution may be written as a Fourier integral, which for the special case $f_{\lambda}(0) = q/[1 + r\theta^2 + s\theta^4]$, and $F(0) = Q/[1 + R\theta^2 + S\theta^4]$ becomes

$$f_d(u) = \frac{(M+N)n}{\pi(m+n)N} \times \sum_{k=0}^{\infty} z^k \left[\frac{p+2kn}{(p+2kn)^2 + u^2} - \frac{Z(p+2N+2kn)}{(p+2N+2kn)^2 + u^2} \right].$$

Here $q = 2ms^4/\pi$, $r = 2(m^2 + n^2)s$, $s = 1/(m^2 - n^2)$, $z = (m-n)/m+n$; Q , R , S , and Z are similar expressions in M and N ; and $p = (M-N) - (m-n)$. The mean square values of the functions $f_{\lambda}(0)$, $F(0)$, and $f_d(0)$ are, respectively, $m^2 - n^2$, $M^2 - N^2$, and $(M^2 - N^2) - (m^2 - n^2)$. The fact that the mean square value of $F(0)$ is the sum of the mean square values of the other two functions is also given by a more general argument previously known.—S. G.

***Energy and Lattice Spacing in Strained Solids.** G. R. Stibitz (*Phys. Rev.*, 1936, [ii], 49, (11), 862).—Abstract of a paper read before the American Physical Society. If an elastically isotropic substance is strained by means of principal stresses F_x , F_y , F_z , the distance d between a pair of planes having direction angles θ and ψ will become $d + \Delta d$, where $E\Delta d/d = (F_x - \nu F_y - \nu F_z) \sin \psi \cos \theta + (F_y - \nu F_x - \nu F_z) \sin \psi \sin \theta + (F_z - \nu F_x - \nu F_y) \cos \psi$. E is Young's modulus and ν Poisson's ratio. From this formula a relation may be deduced between the distortion of the lattice and the potential energy of internal strain in cold-worked crystals. In particular, if the stresses are assumed independent, and oriented at random (which implies that $\overline{F_x^2} = \overline{F_y^2} = \overline{F_z^2} = \overline{F^2}$ and $\overline{F_x F_y} = \overline{F_x F_z} = \overline{F_y F_z} = 0$, and also that the mean values of the trigonometric functions are all zero), the mean square percentage change in spacing comes out at once to be $E^2 \overline{\Delta d^2}/d^2 = \overline{F^2}(1 + 2\nu^2)$; but under these conditions the potential energy due to the strain is $V = 3\overline{F^2}/2$. Hence $\overline{\Delta d^2}/d^2 = (2V/3E)(1 + 2\nu^2)$. As the broadening of X-ray lines, due to strain, is deducible from $\overline{\Delta d^2}/d^2$, this formula is equivalent to a relation between such broadening and the potential energy of strain acquired in the process of cold-working.—S. G.

***Energy of Lattice Distortion in Hard-Worked Permalloy.** F. E. Haworth (*Phys. Rev.*, 1936, [ii], 49, (11), 863).—Abstract of a paper read before the American Physical Society. By using a focussing camera and Fe radiation, the lattice distortion produced by severe cold-working of Permalloy (70% Ni) was studied by measuring the broadening of the reflection of the K_{α} doublet by the (311) planes. The broadening decreases on annealing and recovery is complete at 650° C., when the breadth of the X-ray intensity curve at half-maximum is as small as that obtained by use of the two-crystal spectrometer. The mean square distortion in the lattice spacing due to cold-work is derived from the X-ray measurements after photometering the X-ray film, converting the curve into an X-ray intensity curve, fitting the latter with an empirical

equation and using the analysis given by Rice (abstract above). The energy of the distortion is then calculated by using Stibitz's equation (preceding abstract). The root-mean-square distortion was found to be 0.31% of the lattice spacing after the material had been reduced 96% in area by cold-working. After annealing at 650° C. no distortion was detectable (accuracy about 0.01% of the lattice spacing). The energy of distortion in the hard-worked condition is found to be 23×10^6 ergs/cm.³ or 0.068 cal./gram.—S. G.

*The Determination of the Size and Shape of Crystal Particles by X-Rays. A. L. Patterson (*Phys. Rev.*, 1936, [ii], 49, (11), 884).—Abstract of a paper read before the American Physical Society.—S. G.

Atomic Dimensions from the Coefficients of Compressibility and Thermal Expansion. G. F. Djang (*J. Chem. Physics*, 1936, 4, (8), 530-532).—Starting from the equation of state $p - K(V - V_0)/V_0 = RT/V - V_0$, the relation $\alpha_a/\beta = R/(V - V_0)$ is derived, where V_0 is identified with the actual volume occupied by one mole of atoms or molecules. Values of the radii of atoms for different elements are calculated from this relation and compared to the values obtained from crystal analysis. The possibility of using the relation $\alpha_a/\beta = R/(V - V_0)$ to estimate molecular dimensions in the liquid state is also referred to.—S. G.

*Theory of Brillouin Zones and Symmetry Properties of Wave-Functions in Crystals. L. P. Bouckaert, R. Smoluchowski, and E. Wigner (*Phys. Rev.*, 1936, [ii], 50, (1), 58-67).—Theoretical. The theory of Brillouin zones is developed from the point of view of group theory. The simple cubic, and the face-centred and body-centred cubic lattices are investigated, and the different possible types of zones are described.—W. H.-R.

*Structure of the Extremely Soft X-Ray Absorption of Solids [Lithium and Magnesium]. H. M. O'Bryan (*Phys. Rev.*, 1936, [ii], 49, (12), 944).—A note. Typical microphotometer curves of the absorption bands of films of lithium and magnesium metal on celluloid are reproduced and discussed.—W. H.-R.

*On the Theory of the Reflection of X-Rays by Crystals. Ch. Mauguin (*J. Phys. Radium*, 1936, [vii], 7, (6), 233-242).—A theoretical investigation of the reflection and transmission of X-rays by crystals in continuation of the theory of Darwin (*Phil. Mag.*, 1914, 27, 325, 675).—W. H.-R.

The New Crystallography. W. L. Bragg (*Proc. Roy. Soc. Edinburgh*, 1935, 55, 62-71).—A general lecture, in which one section deals briefly with alloy structures.—W. H.-R.

IV.—CORROSION

(Continued from pp. 307-310.)

*The Corrosion of Equipment [Iron and Brass] in Synthetic Rubber Plant No. 2. Yu. A. Beletzkii and E. A. Puchnina (*Sintet. Kauchuk*, 1936, (2), 23-26; *C. Abs.*, 1936, 30, 4717).—[In Russian.] Experiments with iron and brass are described. Both were attacked by various liquids.—S. G.

*Corrosion of Magnesium and Magnesium Alloys.—II. Hachie Sawamoto (*Suiyokwai-Shi (Trans. Min. Met. Alumni Assoc.)*, 1936, 9, (1), 39-46).—[In Japanese.] The rates of corrosion of magnesium and magnesium alloys in dilute acid and aqueous sodium chloride solutions were compared by measurement of the gases evolved. The addition of cadmium to magnesium improves the corrosion-resistance, though not to so great an extent as manganese or zinc (cf. *Met. Abs.*, this vol., p. 157).—S. G.

†Some Recent Investigations on the Corrosion of Tin. D. J. Macnaughtan and E. S. Hedges (*Congrès Internat. Min. Mét. Géol., Section de Métallurgie*, 1935, 2, 177-183; also *Rev. Mét.*, 1936, 33, (7), 431-437; and (in English) *Tech. Publ. Internat. Tin Res. Develop. Council, Series A*, 1936, (34), 1-13).—

Read at the International Congress of Mining, Metallurgy, and Applied Geology, Paris. A review of research on the atmospheric corrosion of tin, the dissolution of tin in aqueous electrolytes, the electrochemical relations of tin and iron and their influence on the corrosion of tinplate, with special reference to defects in the tin coating.—E. S. H.

*On the Corrosion of the Zinc Gutters and Sheets on Bitumen-Coated Roofs. E. Deiss (*Mitt. Material., Sonderheft 27*, 1936, 93-105).—Four cases of corrosion were investigated. Under the action of sunlight and moisture the bitumen becomes partly oxidized and the surface layers develop an acid reaction; the acids are washed away by the action of dew and rain-water and the resulting solution attacks the zinc. The mechanical action of the falling raindrops, the presence of smoke, flying ashes, or dust, and the composition of the zinc play no part in the corrosion.—B. Bl.

*The Influence of Light on Electrode Potential and Corrosion Phenomena of Certain Non-Ferrous Metals. C. O. Bannister and R. Rigby (*J. Inst. Metals*, 1936, 58, 227-244; discussion, 245-253).—A review is given of previous work on the effect of light on the corrosion of non-ferrous metals. A simple apparatus is described for the examination of the effects of light on zinc, lead, copper, aluminium, &c., under corroding conditions in conjunction with which a continuous record of changes in e.m.f. is made by the use of a thread-recorder. The influence is shown to be considerable in the case of lead and zinc, but only in the presence of oxygen, the aerated and illuminated electrode becoming more markedly cathodic. A more elaborate apparatus is then described arranged to allow perfect control over the oxygen supply to the metals under examination, and very marked response to illumination is shown in the case of zinc and aluminium. In the case of the latter metal records showing activity over 5 days are given. The maximum effect is obtained with light in the violet and near ultra-violet region, and the mechanism of the action suggested is the catalysis of the formation of protective oxide films.

—C. O. B.

On Erosion and Corrosion of Water Wheels in Turbines and Pumps. Saiichirô Uchimarû (*Trans. Soc. Mech. Eng. Japan*, 1935, 1, (4), 282-283).—[In Japanese and in English in suppl. pp. 82-83.] Erosion in turbine runners and pump impellers is traced to the rubbing action of solid matters contained in the waters, while corrosion is due to chemical action on the wall metal and always follows the appearance of cavitation in flow. Different positions in the wheel vane and wall surface, where such cavitation is likely to occur, are considered with reference to a slow-running low-pressure turbine, a centrifugal impeller, an aerofoil, and a propeller pump, and it is shown that cavitation and corrosion seem to occur along the back of the blade, while erosion always appears on the front face of the blade both in pump and turbine.

—J. W. D.

*Corrosion-Resistance of Welds. — Bürgel (*Autogene Metallbearbeitung*, 1936, 29, (10), 148-154).—An introductory discussion of corrosion phenomena and the effects of the chemical and physical properties of a material on its resistance to corrosion, is followed by an account of corrosion tests on welded test-pieces of a special bronze, Admiral (copper 50, zinc 38, nickel 10, manganese 2, iron 0.25%, and aluminium); Monel metal; 98-99% aluminium; and Hydronalium (silicon 0.3, manganese 0.4, magnesium 7-8%). The welds were made by the oxy-acetylene process, and no hammering or heat-treatment was carried out. The test-media were: oils, liquid fuels, alcohol, acetone, acids, dye-, mordant-, and bleach-solutions of different types, cooling tower conditions, and atmosphere. The amount of attack was estimated by inspection, 5 degrees being recognized from "scarcely attacked" to "completely destroyed." The results are expressed graphically and some photographs of the corroded test-pieces are given. It was found that good-quality welds

had, in all cases, a corrosion-resistance at least as high as that of the parent metal, and, in some cases, even higher. The most vulnerable part was often the zone of large grain-size at the weld boundary.—H. W. G. H.

Researches Relating to the Work of the French Commission on the Corrosion of Aeronautical Metallurgical Products. [C.] Grard, R. Legendre, and R. Lecœur (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 1, 399-409; and *Rev. Mét.*, 1936, 33, (3), 178-188).—The work of the Commission, set up in 1926, is confined to a study of the corrosion of aeronautical ferrous and non-ferrous materials in marine atmospheres and sea-water. Importance is attached to heterogeneity in the materials. Attention has been directed to the study of solution potentials, the establishment of laboratory corrosion tests and their correlation with service tests. A list of completed researches, with notes on work in progress, is appended.—J. C. C.

***The Measurement of Stray Currents.** — Böniger (*Gas- u. Wasserfach*, 1936, 79, (1), 5-13).—Methods of measuring stray currents in underground pipes are critically reviewed. A systematic investigation has been made to discover the sources of, and methods of avoiding errors.—B. Bl.

The Drop Test. U. R. Evans (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 1, 419-422; and *Rev. Mét.*, 1936, 33, (4), 217-220).—In the drop test, observations are made of the corrosion produced by drops of liquid placed on the metal surface under examination. Temperature and atmosphere can be controlled, and the value of protective coatings investigated. Statistical analysis of the results provides information on both rate and probability of attack. Investigations by U. and his collaborators, using this method, are briefly reviewed.—J. C. C.

The Modern Testing of Motor Fuels for the High-Speed Type of Automotive Diesel Engine. A. Hagemann and T. H. Hammerich (*J. Inst. Petrol. Tech.*, 1936, 22, (153), 515-539).—The method of carrying out corrosion tests on copper or zinc strip is described. Investigations with 17 oils on strips of copper, iron, aluminium, and zinc resulted in very slight attack on iron and aluminium, whilst the copper was attacked by sulphur and the zinc was dissolved as a metallic soap. The influence of temperature on the rate of attack is shown graphically in the cases of copper and zinc.—P. M. C. R.

V.—PROTECTION

(Continued from p. 310.)

***Study of the Hardness of Aluminium Oxide Obtained in Anodic Oxidation.** André Hache (*Métaux*, 1936, 11, (129), 116-117).—Since the usual methods of measuring the hardness are not possible with anodically formed aluminium oxide owing to its extreme tenacity, the load necessary to make a tungsten carbide pointer penetrate the skin is taken as the measure. When the skin is punctured, an electric circuit is completed with the aluminium base. The hardness, thus defined, is found to depend at low temperatures and bath compositions solely on the number of coulombs which have crossed the electrolytic bath and which determine the thickness of the aluminium oxide film.—J. H. W.

The Pylumin Process for the Protection of Aluminium. — (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (9), 434-436).—Immersion of aluminium for 3-10 minutes in a boiling solution of "Pylumin" powder (composition not stated) produces a coating to which paint and lacquers adhere firmly, and which has definite corrosion-resisting properties of its own.—J. C. C.

***Influence of Surface Cuprous Oxide Inclusions on the Porosity of Hot-Tinned Coatings on Copper.** W. D. Jones (*J. Inst. Metals*, 1936, 58, 193-198).—A study of the causes of porosity of tin coatings on copper shows

inclusions of cuprous oxide to be one of the most important. Amalgamation is suggested as a rapid means of estimating probable porosity. Various methods for reducing porosity are discussed; these include cathodic treatment in caustic soda solution, and treatment with hypophosphorous acid. Oxygen-free copper is recommended as the best material to employ if non-porous coatings are to be obtained.—W. D. J.

***The Hot-Tinning of Copper: The Attack on the Basis Metal and Its Effects.** Edward J. Daniels (*J. Inst. Metals*, 1936, 58, 199-205).—A study was made of the nature and extent of the attack of copper by tin and solder during hot-dipping. It is shown that the compound layer is invariably duplex, consisting of Cu_3Sn and Cu_6Sn_5 . This layer breaks up under solvent attack and is removed from the basis metal almost as fast as it is formed. Contamination of the bath and coating owing to this action increases rapidly with increase in temperature and causes important effects on the smoothness of tin coatings to an extent that is influenced by the degree of the contamination and the quality of the basis metal.—E. J. D.

Joint Discussion [on the Hot-Tinning of Copper]. — (*J. Inst. Metals*, 1936, 58, 205-210).—Discussion on the papers by Jones and Daniels (preceding abstracts).—S. G.

The Automatic Grading of Tinplates. — (*Mech. World*, 1936, 99, 271-272).—A new machine, wherein time and gravity devices control the sorting of tinplates according to their weight, is illustrated and described.—F. J.

A Comparison of Galvanizing Processes. Richard Saxton (*Mech. World*, 1936, 99, 269-270, 272).—Briefly describes the four processes in use to-day for zinc-coating iron or steel. The hot process, which has the widest application, is dealt with more fully than the other methods. It is cheaper than the electrodeposition method, which, however, is gradually superseding it, where strength and ductility are required to be unimpaired. Other disadvantages of the hot process are lower corrosion-resistance, due to non-uniformity and porosity of the coating; less adherent coating; higher spelter consumption for weight of metal treated; and high waste by dross formation. Sherardizing and spraying also have their practised applications. The features bearing on the economics of each process are discussed.—F. J.

The Development and Control of Spangles on Galvanized Iron.—IX. Wallace G. Imhoff (*Metal Cleaning and Finishing*, 1936, 8, (3), 143-146, 156).—Additions of antimony and cadmium to the molten zinc used in galvanizing produce a pearly spangle with a dull finish, the crystals produced by antimony being much smaller than those produced by cadmium. Excess of antimony must be avoided as it produces a yellow smear, but this can be obviated if a little tin, cadmium, or aluminium is also added. Addition of 0.1-0.2% of cadmium to the galvanizing bath produces a large fern-like crystal and a more ductile coating.—A. R. P.

***The Action of Molten Zinc on Iron and on Ordinary and Special Steels [in Galvanizing Baths].** I. Musatti and A. La Falce (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 2, 121-129; and *Metallurgia italiana*, 1936, 28, (1), 1-17; *C. Abs.*, 1936, 30, 4448).—The corrosion of various types of steel by molten zinc at 460°-520° C. was measured. Corrosion is little affected by the addition of carbon up to 0.2-0.3%, but increases rapidly with greater carbon content, becoming very severe for 0.5% or more carbon. Silicon has a much greater effect on corrosion, 0.2% silicon giving about 3 times and 0.87% silicon about 15-20 times the amount of corrosion of silicon-free steel. Manganese in the amounts normally present (0.03-0.37%) has practically no influence. Chromium has very little influence, 0.56% causing about 50% more corrosion than for a chromium-free steel. Nickel (about 5%) improves the resistance so that it practically counterbalances the effect of chromium. The corrosion-resistance of stainless steel and chromium-nickel steel (18:8)

is about equal to that of low-carbon steel; sulphur up to 0.080% and phosphorus up to 0.055% do not affect corrosion appreciably. Increased temperature increases corrosion in all cases, temperatures of 480° C. or more causing a marked increase, the corrosion of 18:8 steel at 520° C. being 3 times that at 460° C.—S. G.

***An Electrolytic Test for Zinc Coatings on Wire.** S. C. Britton (*J. Inst. Metals*, 1936, 58, 211–222; discussion, 223–225).—A test for zinc coatings on wires has been designed to overcome the objections to tests based on chemical dissolution. Two tests are proposed: a stripping test designed to estimate the weight of coating which must be removed by uniform attack before the iron base is exposed, and a wrapping treatment followed by a stripping test designed to gauge the liability of a coating to crack. The stripping test is carried out by electrolysis in a specially designed cell, a fixed current density being employed so that each unit of testing time corresponds to a known weight of coating; at the end of the test, a short dip in copper sulphate solution serves to show whether the iron base has been exposed. The test is primarily intended to ascertain whether a coating meets a specification, but it can also be used to determine the actual thickness of coatings. Potential measurements made during strippings provide information as to the structure of coatings. Thus, it has been shown that close-wiped coatings and galvannealed coatings consist almost entirely of zinc-iron alloy. Field tests are demonstrating that the test described gives satisfactory results for conditions of atmospheric exposure while the Preece test has marked shortcomings.—S. C. B.

†Protective Finishes on Zinc. S. W. K. Morgan and L. A. J. Lodder (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (7), 5–20).—The following processes are critically reviewed: electroplating, electrolytic filming, painting, enamelling, lacquering and varnishing, and chemical colouring.—A. R. P.

[Non-Ferrous Metal] Clad [Steel and Iron] Sheets of Large Dimensions—A New Constructional Material. E. Schöne (*Metallwirtschaft*, 1936, 15, (10), 232–236).—Recently a process has been developed in Germany for the manufacture of very large iron or steel sheets clad on one or both sides with a corrosion-resistant non-ferrous metal such as nickel, Inconel, or Monel metal. The thickness of the coating can be regulated to any desired extent to meet the conditions arising in use. Large vessels for chemical use have been constructed of these materials, the joints being made by welding. To obtain a satisfactory weld the two edges are placed together and a V-shaped groove made from the inside and from the outside; one groove is then welded using a filler rod of the ferrous metal and the other is finally filled up by means of a filler rod of the non-ferrous cladding metal. Many examples are given of the uses of these materials.—A. R. P.

Pouring-On of Metal Coatings—A New Metal Coating Process. Kurt Nischk (*Oberflächentechnik*, 1936, 13, (10), 111–114).—Metal bands, e.g. broad iron strips, may be coated with brass, tin, zinc, lead, &c., by passing them through two pairs of rolls and casting the desired metal in a broad thin stream on the upper surface while the lower is heated by a series of burners, the operations being conducted as the metal passes between the two sets of rolls. The necessary apparatus is described with reference to diagrams and illustrations.—A. R. P.

Metal Spraying. A. E. Phipps (*J. Incorporated Brewers' Guild*, 1936, 22, (260), 156–161).—An account is given of the molten metal process, using the Mellozing pistol.—H. W. G. H.

Aluminium in Transformer Oil. F. J. Matthews (*Mech. World*, 1936, 99, 72).—The painting of a transformer with aluminium paint was found to be the cause of failure of the oil in the transformer. It is suggested that any

equipment liable to interior damage in this way should be kept closed when painting by means of a spray gun.—F. J.

Paint in the Petroleum Industry. H. B. Footner (*Petrol. Times*, 1936, [N.S.], 35, (898), 399-408).—Aluminium paint is recommended for use with a priming coat in the protection of petroleum tanks: it is not satisfactory when applied direct to the metal. Its special value lies in its high reflecting power, which is retained for a longer period than is that of most white paints. A specification is suggested for aluminium powder intended for use as pigment.—P. M. C. R.

VI.—ELECTRODEPOSITION

(Continued from p. 311.)

Estimation of Free Cyanide in Cadmium Plating Solutions. J. Dawson. E. E. Halls (*Metallurgia*, 1936, 14, (81), 75-76).—In correspondence resulting from an article on the analytical control of cadmium electroplating solutions (cf. *Met. Abs.*, 1934, 1, 307) D. states the difficulties experienced in estimating free cyanide in plating solutions, and gives the results of experiments carried out to determine the reason for such wide variations. These criticisms and experimental results are carefully examined and dealt with by the author (E. E. Halls) after a re-examination of the original data, a new search of available literature, and further experimental work along lines pertinent to the criticisms made. This latter work is included in the correspondence.

—J. W. D.

***The Theory of Electrolytic Chromium Plating.** Robert Weiner (*Z. Elektrochem.*, 1936, 42, (7a), 377-397).—Earlier work and the present situation as regards chromium plating are reviewed, and the results of current density-potential measurements in the chromium plating of the platinum and non-platinum metals are described. The effect of the amount of sulphate in the electrolyte, the rate of increase of potential, pre-treatment of the cathode, the cathode film, the chemical effect of sulphate additions, and chloride-containing electrolytes are discussed.—J. H. W.

Some Recent Developments in Chromium Plating. Herbert R. Simonds (*Iron Age*, 1936, 138, (3), 38-42, 114).—The claims made for recent developments in chromium plating baths and brush plating outfits are set out, and the methods are described.—J. H. W.

***Determination of Trivalent Chromium in Chromium Plating Baths.—I.** (Young.) See p. 369.

***Plating Copper, Nickel, and Zinc Alloys from Cyanide Baths.** Charles L. Faust (*Metal Cleaning and Finishing*, 1936, 8, (6), 319-324, 334).—From a solution of the double cyanides of nickel, copper, and zinc containing not more than 0.1-0.3% of free potassium cyanide alloy deposits can be obtained containing nickel 0-27, copper 97-20, and zinc 3-68% according to the temperature, current density, and bath composition. From a bath containing copper cyanide 18.1, nickel cyanide 14.4, zinc cyanide 5.8, potassium cyanide 36, and potassium carbonate 4 grm./litre the deposit contains at 25° C. nickel 4-12 and copper 73-20%, and at 70° C. nickel 0-9 and copper 97-67% as the current density is raised from 0.8 to 6 amp./dm.². Deposits of a high copper, low nickel alloy with an intermediate zinc content are harder than those of ordinary brass.—A. R. P.

Gold Control in Electrogilding. Joseph B. Kushner (*Metal Cleaning and Finishing*, 1936, 8, (3), 117-120, 142).—Practical hints are given for the control of the amount of gold plated and the losses during plating.—A. R. P.

Bright Nickel Plating. Eugen Werner (*Oberflächentechnik*, 1936, 13, (4), 40-42).—Various processes which have recently been proposed for obtaining bright deposits of nickel are briefly described.—A. R. P.

Nickel Plating Procedure. W. A. Koehler (*Metal Cleaning and Finishing*, 1936, 8, (5), 243-246).—The composition of some standard plating baths is given together with hints on their operation.—A. R. P.

Some of My Experiences in High Current Density Nickel Plating. Paul Amundsen (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (6), 34-39).—Practical hints.—A. R. P.

Some Remarks on Platinum, Palladium, and Rhodium Baths. A. Wogrinz (*Metallwaren Ind. u. Galvano-Tech.*, 1936, 34, (9), 174).—A review of recent patents.—A. R. P.

Improvements in Silver Plating. B. Egeberg (*Metal Cleaning and Finishing*, 1936, 8, (6), 327-332, 334).—Addition of sodium carbonate (6 oz./gall.) to freshly prepared silver plating baths allows good deposits to be obtained from the start, but more than 9 oz./gall. produces blackening of the anodes. About 12-16 oz./gall. of the potassium salt must be present in the solution before this occurs. E. recommends the following composition for a new bath: silver (as cyanide) 3 oz. troy, potassium carbonate 6-12 oz. av., and potassium cyanide 5-6 oz. av. per gallon; the bath is operated at 75°-80° F. (about 25° C.), and the solution is kept moving at 10 ft./minute. Addition of carbon bisulphide as a brightener improves the lustre of the deposits, but reduces the throwing power of the bath; an increased current density can, however, be used and the throwing power thus improved. More than 30 amp./ft.² of anode area produces blackening.—A. R. P.

***Electrodeposition of Tungsten from Aqueous Solutions.** L. N. Goltz and V. N. Kharlamov (*Zhurnal Prikladnoi Khimii (J. Applied Chem.)*, 1936, 9, (4), 631-639).—[In Russian.] Fink's results on the electrodeposition of tungsten from alkali carbonate baths were confirmed, thin metallic deposits being obtained, and the current yield being less than 1% at the beginning of electrolysis and rapidly decreasing to zero. Experiments on the effect of passing carbon dioxide into, and of circulating, the electrolyte, indicated that the p_H has no influence, and that the exhaustion of the bath is due to the precipitation of tungsten-iron compounds. The decrease in current yield is affected by the surface of the cathode deposit.—N. A.

***Electrodeposition of Tungsten-Nickel and Tungsten-Nickel-Copper Alloys from Aqueous Solutions.** L. N. Goltz and V. N. Kharlamov (*Zhurnal Prikladnoi Khimii (J. Applied Chem.)*, 1936, 9, (4) 640-652).—[In Russian.] Experiments on the deposition of tungsten-nickel alloys from ammoniacal baths containing ammonium tungstate, nickel sulphate, and ammonium sulphate showed that at 50°-75° C. and with a tungsten : nickel ratio of 3 : 1 the deposits had the maximum tungsten content and the best chemical and mechanical properties, variations in the ammonia concentration between 37 and 87 gm./litre having no effect. The current density for maximum current yield is 30 amp./dm.². The deposition potential shows that the deposits are solid solutions. By adding copper sulphate to the bath a ternary alloy containing tungsten 4.63, copper 45.51, and nickel 49.86% was obtained. The deposits are resistant to sulphuric acid and caustic soda.—N. A.

Bright Zinc Plating. R. O. Hull (*Metal Cleaning and Finishing*, 1936, 8, (4), 169-173).—To obtain bright zinc deposits from a cyanide bath it should contain zinc 4.5-6.7, sodium hydroxide 10-15, and free cyanide 18-21 oz./gall.—A. R. P.

Plating to Specifications. F. C. Mesle (*Metal Cleaning and Finishing*, 1936, 8, (7), 387-392).—To test the adherence of an electroplated deposit a piece of metal is soldered to it and then pulled off; if the plate comes off the adherence is poor, but if the solder breaks the adherence of the plate is satisfactory. Melting solder on the plate should not produce blisters and no flaking should occur when the plated article is bent. Tables are given for determining the plating time for obtaining specified thicknesses of silver,

gold, and copper from cyanide baths, and copper, nickel, cobalt, and zinc from sulphate baths, and for the time required to plate thicknesses of 0.0001–0.0005 in. at 1–60 amp./ft.² for the same metals.—A. R. P.

Efficiency in Electrodeposition versus Electrochemical Equivalents. Oscar E. Serris (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (7), 22–30).—The paper contains useful tables showing the weight of nickel, silver, zinc, copper, and gold deposited in 1–60 minutes by 1–100 amp.—A. R. P.

Avoiding Current Losses in the Plating Shop. W. M. Phillips (*Metal Cleaning and Finishing*, 1936, 8, (7), 381–385).—The maintenance in proper working order of the motor generator set, the bus-bars, tank linings, racks, and rheostats is described and modern methods of insulation are briefly outlined.—A. R. P.

Spectrographic Analysis as Applied to Electroplating. (Ewing.) See p. 369.

The Determination of the p_H Value of Plating Baths. R. Springer (*Metallwaren Ind. u. Galvano-Techn.*, 1936, 34, (11), 213–214).—Special standardized papers containing streaks of indicator and a comparative colour are recommended for determining the p_H of plating baths; several examples of their preparation and use are given.—A. R. P.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from pp. 311–313.)

***The Cathodic Effect in the Electrolysis of Cadmium Salts.** O. Kudra (*Z. physikal. Chem.*, 1936, [A], 175, (5), 377–382).—In the electrolysis of aqueous solutions of cadmium salts the deposition of a loose black deposit on the cathode does not occur immediately the current is switched on but only after an interval of t seconds. At constant current density (σ) t varies with the concentration (C) according to the expression: $\log C = \alpha \log \sigma + \beta \log t + \gamma$. This equation is useful in the rapid determination of the cadmium concentration in a solution from the time required to produce the cathode effect.—B. Bl.

The Oxidation-Reduction Potential (τH); Its Application to Mechanical Industry. M. Dérivé (*Pratique Indust. mécan.*, 1936, 19, (4), 143–145).—The conception of oxidation-reduction potential is discussed, and the definition based on Clark's analogy with Nernst's formula is reproduced. Possible applications of the conception to metallic corrosion are briefly indicated.

—P. M. C. R.

IX.—ANALYSIS

(Continued from pp. 312–314.)

†**On the Applications of Microchemistry to Metallurgical Studies.** Carl Benedicks and Ragnar Treje (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 1, 429–434; and *Rev. Mét.*, 1936, 33, (3), 203–208).—A well-annotated review of microchemical methods for examining inclusions (particularly in steels) and for studying variations in the distribution of alloying elements. There is a selected *bibliography* of 60 references relating to the microchemical determination of elements in ferrous materials.

—J. C. C.

Spectrographic Analysis as Applied to Electroplating. D. T. Ewing (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (6), 27-34).—A lecture on the elementary principles of qualitative and quantitative spectrographic analysis applied to electroplates.—A. R. P.

***On a Qualitative Reaction for Bivalent Copper.** B. M. Bogoslovskiy and V. S. Krasnova (*Zhurnal Prikladnoi Khimii (J. Applied Chem.)*, 1936, 9, (4), 751-753).—[In Russian.] The solution (200 c.c.) is treated in a measuring cylinder with 1-2 c.c. of a 0.5% solution of *p*-amidophenyl hydrochloride and 25-30 c.c. of saturated NaCl solution; a violet colour gradually becoming brown indicates Cu²⁺.—N. A.

***Separation of Copper and Nickel from Iron.** P. Spacu (*Bull. Soc. chim. France*, 1936, [v], 3, (6), 1061-1063).—The Fe is removed by addition of C₅H₅N to the HCl solution and the Cu or Ni is then precipitated with NH₄CNS.—A. R. P.

***On the Electrochemical Reduction of Europium.** W. Kapfenberger (*Z. anal. Chem.*, 1936, 105, (5/6), 199-205).—An apparatus and procedure are described for the fractional separation of Eu from the other rare earths by electrolytic reduction of the sulphate solution.—A. R. P.

***The Colorimetric Determination of Aluminium with the Aid of Alizarin.** S. A. P. Mussakin (*Z. anal. Chem.*, 1936, 105, (9/10), 351-361).—The best p_{H} is 3-6; the colour curve follows the law: $(C_1 + a)h_1 = (C_2 + a)h_2$, where a is the concentration of the excess of alizarin. Fe should first be removed by shaking with NH₄CNS and C₅H₁₁OH.—A. R. P.

Determination of Chromium in Nickel-Chromium and Nickel-Chromium-Iron Alloys. Fred P. Peters (*Chemist-Analyst*, 1936, 25, (3), 52-55).—Detailed descriptions are given of the following 4 methods: (a) KMnO₄ oxidation, (b) (NH₄)₂S₂O₈-AgNO₃ oxidation, (c) HClO₄ oxidation followed by (NH₄)₂S₂O₈-AgNO₃ treatment, (d) HClO₄ oxidation at 205° C.—A. R. P.

***Determination of Trivalent Chromium in Chromium Plating Baths.**—I. Philena Young (*Metal Cleaning and Finishing*, 1936, 8, (7), 397-400).—The Cr₂O₃ is oxidized to CrO₃ by adding Ce(SO₄)₂ and the excess is titrated potentiometrically with NaNO₂.—A. R. P.

***On the Separation and Determination of Gallium.** V.—**The Separation of Gallium from Beryllium, Titanium, Zirconium, and Thorium, and the Determination of Gallium Thus Separated.** Sunao Ato (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, 1936, 29, (631), 71-77).—W. H.-R.

***On the Determination of Small Quantities of Germanium.** N. S. Poluektov (*Z. anal. Chem.*, 1936, 105, (1/2), 23-26).—The element is separated from other metals by distillation of GeCl₄ from the mixed chloride solution. The distillate is neutralized with NaOH (*p*-nitrophenol indicator), mannitol is added, and the titration continued with 0.1N-NaOH until the phenolphthalein end-point is obtained. A delicate test for Ge consists in treating the solution with H₂S, dissolving the washed precipitate in KOH and H₂O₂, acidifying with CH₃CO₂H, and adding a mixture of (NH₄)₂MoO₄, FeSO₄, and CH₃CO₂Na; a blue colour indicates Ge.—A. R. P.

***Volumetric Determination of Nickel in the Presence of Cobalt.** G. Charlot (*Bull. Soc. chim. France*, 1936, [v], 3, (2), 324-326).—The neutral solution is treated with KCN until the precipitate first formed just redissolves, half as much KCN again is added, and the solution cautiously treated with Br to oxidize the Co to K₃Co(CN)₆ and precipitate the Ni as Ni(CN)₂ and Ni₂[Co(CN)₆]₂. The solution is then treated with KOH to convert the precipitate into black hydrated NiO₂, acidified with HCl and boiled, a small amount of H₂C₂O₄ being added until the liquid ceases to effervesce. After cooling the solution is made feebly ammoniacal and the Ni titrated as usual with KCN and AgNO₃.—A. R. P.

***Titration of Silver with Potassium Iodide.** Albert Bloom and Wallace M. McNabb (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1936, 8, (3), 167).—The nitrate solution is treated with sufficient H_2SO_4 to make it 0.2–3.0N with respect to that acid, then with 3 c.c. of 0.5% starch solution, and finally with 0.1 c.c. of 0.1N- $CeNH_4(SO_4)_2$ solution. The mixture is then titrated with 0.1N-KI solution until a permanent blue colour is obtained. Cu^{++} and Fe^{+++} do not interfere.—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from pp. 314–315.)

***The McLachlan Machine for Drawing Pole-Figures.** Wheeler P. Davey (*Phys. Rev.*, 1936, [ii], 49, (11), 886).—Abstract of a paper read before the American Physical Society. A very simple machine has been developed by D. McLachlan, Jr., at the Pennsylvania State College, by which pole-figures showing the preferred orientation of crystals in rolled metal sheets may be drawn directly from the X-ray diffraction patterns. It is inherent in the design of the machine that all the conditions for stereographic projection are fulfilled and that the actual experimental set-up of the diffraction experiment can be simulated, thus taking account of (a) the angle between the X-ray beam and the sheet, and (b) the orientation of the sheet itself. All the contributions of a single diffraction pattern to a given pole-figure may be charted mechanically within 5 minutes from the time the diffraction pattern is inserted into the machine. Any of the 3 customary planes of projection may be employed, *i.e.* normal-transverse, normal-rolling, or rolling-transverse. The finished pole-figure is of ample size (about 9 in. in diameter). [Note: No other details are given; a fuller description will no doubt be published in due course.]—S. G.

A Seeman-Bohlin X-Ray Camera for High Temperatures. R. F. Boyer and C. Nusbaum (*Phys. Rev.*, 1936, [ii], 49, (11), 884).—Abstract of a paper read before the American Physical Society.—S. G.

New Types of Powerful X-Ray Tubes with Rotating Anti-Cathode. V. Linnitzki and V. Gorsky (*Tech. Physics U.S.S.R.*, 1936, 3, (3), 220–222).—[In English.] See *Met. Abs.*, this vol., p. 314.—S. G.

XI.—PHYSICAL AND MECHANICAL TESTING, INSPECTION, AND RADIOLOGY

(Continued from pp. 315–316.)

***Metallic Wear [in the Presence of Lubricants].** H. W. Brownsdon (*J. Inst. Metals*, 1936, 58, 15–27; discussion, 28–38).—The extent to which metallic wear takes place between two metallic surfaces in frictional contact and in the presence of a lubricant is dependent on a number of factors, the relative importance of some of which are briefly reviewed in the light of experimental results obtained on a simple machine described in the paper.

—H. W. B.

***A Deep-Drawing Test for Aluminium.** A. G. C. Gwyer and P. C. Varley (*J. Inst. Metals*, 1936, 58, 83–90; discussion, 90–96).—A new test for estimating the deep-drawing quality of aluminium is described and figures are given illustrating its application to normal commercial purity metal in various tempers. The test consists essentially of two drawing operations of which the first, or cupping, operation does not alone distinguish clearly between different grades and tempers of the metal. The addition of a re-drawing

operation, however, makes the test much more sensitive and distinguishes clearly between the drawing properties of the various grades. The application of the test to aluminium of commercial purity has shown that the various medium tempers have surprisingly good drawing properties and might well be used more extensively for this purpose.—A. G. C. G.

Progress in the Methods of Testing Sheet Metal. A. Karsten (*Illust. Zeit. Blechindustrie*, 1936, 65, (25), 741-743).—The relative advantages of vertical and horizontal microphotographic apparatus are discussed. An apparatus is described which can be adapted for examination by reflected or transmitted light, and for either ordinary or dark-field illumination. Simultaneous observations through the eye-piece and on an illuminated screen are possible, and a reflector attachment facilitates the preparation of drawings.

—P. M. C. R.

Remarks on the Conduct of Endurance Tests. W. Späth (*Metallwirtschaft*, 1936, 15, (4), 91-93).—Arguments are advanced for preferring, instead of the usual Wöhler test, an endurance test in which the load is gradually increased until the specimen breaks, since this takes into account the effects of internal stresses and the damping capacity of the metal.—A. R. P.

Fatigue Tests on Metals. Roger Cazaud (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 1, 385-398; *Rev. Mét.*, 1936, 33, (3), 164-177; and (abstract) *Light Metals Research*, 1936, 4, (23), 400-401).—Methods of fatigue testing are briefly surveyed and a comprehensive account given of the effect of such factors as speed of testing, the presence of notches, holes, and fillets, the condition and nature of the surface, temperature, and corrosive action on the endurance of rotating-beam specimens. Tables of the static and fatigue characteristics of a number of steels and non-ferrous alloys are included. There is a *bibliography* of 20 references.—J. C. C.

***The Strength of Materials under Combined Alternating Stresses [Combined-Stress Fatigue Testing Machine].** H. J. Gough and H. V. Pollard (*Proc. Inst. Mech. Eng.*, 1935, 131, 3-54; discussion, 54-103; and (summary) *Light Metals Research*, 1936, 4, 235-236).—A machine is described for carrying out fatigue tests using combinations of reversed bending and reversed torsional stresses. A detailed study is made of the behaviour of two ductile steels, and a brittle silicon cast iron. The fatigue limits under plane bending and torsional stresses, and under five combinations of these are determined, together with results of static and other supplementary tests. The results for the brittle cast iron agreed closely with the criterion of maximum principal stress. For the ductile steels the results of the combined stress fatigue tests can be expressed by the simple relation $f^2/f_1^2 + q^2/q_1^2 = 1$, where f and q refer, respectively, to the applied bending and torsional stresses at the fatigue limit of the combination, and f_1 and q_1 are the fatigue limits under simple bending and pure shear.—W. H.-R.

A Method of Analyzing Creep Data. (Sturm, Dumont, and Howell.) See p. 344.

***Method of Measuring the Dynamic Resistance of a Metal to Torsion.** G. Welter and J. Kucharski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, 3, (1), 21-24).—[In Polish, with German summary.] The method consists in attaching a lever to the middle of a notched-bar of the specimen which is clamped below an Izod or a Charpy pendulum and measuring the energy absorbed when the pendulum is allowed to fall against the lever thus twisting the specimen until it fractures. The results obtained are characteristic of the resistance of the metal towards dynamic torsional stresses, and are comparable and reproducible if constant conditions are always maintained in the test. Values are given for different cross-sectional specimens of aluminium, brass, Duralumin, and R.R. alloy.

—A. R. P.

*Fifth Report of the Wire Ropes Research Committee. W. A. Scoble (*Proc. Inst. Mech. Eng.*, 1935, 130, 373-449; discussion, 450-478).—Further tests are described in which wire ropes of different types were submitted to repeated bending over pulleys under different conditions of load, pulley diameter, rope speed, lubrication, and surface conditions. Tests were also made on a new machine designed to represent ropeway conditions; in this a rope under tension was traversed by a pulley taking a lateral load which caused the rope to bend through a small angle at the pulley. The results refer to steel wire ropes, and are very complex. In general, trouble arises from the use of pulleys which are too small. The correct pulley diameter is related more closely to the diameter of the rope as a whole than to that of the individual wire strands. The more simple types of rope construction are to be preferred; the more complicated constructions give greater flexibility, but this is only advantageous when pulleys are too small, and involve severe treatment leading to a short life. Conflicting results were obtained for the effect of lubrication on rope life. S. suggests that in some cases the lubricant may carry small particles of abraded metal from the outside to the inside of the wire, and that this effect is responsible for the shortened life of ropes under some conditions of lubrication.—W. H.-R.

*On the Knicking of Wires under Their Own Weight. A. Leon and E. Erlinger (*Ann. Physik*, 1934, [v], 20, (6), 635-645).—When a metal wire is clamped vertically at its lower end there is a definite length for every metal and cross-section at which the wire will remain vertical; as this length is exceeded the wire will gradually bend over. The length at which a permanent kink occurs is given by the expression $l_K = \sqrt[3]{(EI/dF)}$, where E is the modulus of elasticity, d is the specific gravity, F the cross-section, and I the least moment of inertia of this cross-section. The dynamic method of determining l_K tends to give results which are 2.3-7.5% too high while the static method where it can be used, gives results which are 1.4-3.7% too low. As the length of the wire is increased above that required to produce a permanent set the degree of bending increases and eventually the metal passes from the elastic to the plastic range; in the case of aluminium bending will continue through a very wide angle during about a week without increasing the length once the plastic range is reached. The value of l_K determined from the above formula lies within the elastic range for iron, steel, and copper, and within the plastic range for aluminium.—A. R. P.

*On the Non-Existence of an Upper and Lower Yield-Point and on the Resistance to Rupture of Soft Steel and Other Metals. G. Welter (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1935, 2, (1), 38-45).—[In Polish, with French summary.] Cf. *Met. Abs.*, this vol., p. 169. In load-elongation curves for plastic metals tested in the ordinary types of tensile machines there is always a fall immediately the yield point is passed. Tests by a method in which the load is applied by adding weights to a device suspended from the lower end of the specimen show that this behaviour must be due to a deficiency in the testing machine since the direct loading method gives a relatively smooth curve with a single kink at the yield point; also in the latter method the end of the curve does not bend downwards, i.e. the load does not diminish after rupture of the specimen.—A. P.

The Rockwell and Vickers Apparatus for the Determination of Hardness. A. Golassini (*Industria meccanica*, 1936, 18, 117-127; *C. Abs.*, 1936, 30, 4447).—Hardness measurements by the Rockwell and Vickers methods are explained, with the manner of their application and which apparatus to select in given conditions, and their numerical relations are described at length.

—S. G.

Hardness Testing. Geo. F. Tanner (*Post Office Elect. Eng. J.*, 1936, 29, (2), 110-118).—Illustrated descriptions are given of the construction and use

of the Avery Direct Reading and Patent hardness testing machines, the Firth Hardometer, and the Vickers Pyramid hardness testing machine.—J. C. C.

The Testing of Rubber-Insulated Wires and Cables. Dean Harvey (*Amer. Soc. Test. Mat. Preprint*, 1936, 13 pp.).—Methods used by U.S. Government Department, cable manufacturers, public utility companies, and railways are briefly outlined.—A. R. P.

RADIOLOGY.

†**The Application of X-Rays to Metallurgy.** Hubert Plant (*Metallurgia*, 1936, 14, (81), 71-73).—The first of a series of articles designed to familiarize the average worker with the working of X-ray apparatus and to show its application to metallurgy. P. deals with the development of X-rays, discusses radiation in general, deals with the diffraction grating and its function, and considers diffracting X-rays and the theory on which the whole of the principles of X-ray analysis have been built.—J. W. D.

***Determination of Elastic Stresses by X-Ray Methods.** G. L. Aksenov (*Zhurnal Tehnicheskoy Fiziki (J. Tech. Physics)*, 1936, 5, (4), 721-724).—[In Russian.] Elastic stresses in the specimen deform the Debye ring by blurring and by distortion. In certain cases, e.g. for the plane (100), only distortion occurs. The distribution of the blurring on the Debye ring from a certain plane and the new shape of the ring are directly related to the magnitude, sign, and direction of the principal stresses on the surface of the specimen. In cases of linear stresses, determination of their magnitude is easy but in the case of plane stresses this is more difficult, although theoretically not insoluble.—N. A.

Technique of the Radiography of Welds. Robert Schmidt (*Bull. Soc. Ing. Soudeurs*, 1936, 7, (38), 2069-2082).—A general discussion, without practical details.—H. W. G. H.

Radiography as Applied to Welded Boiler Drums. E. C. Chapman and W. L. Martin (*Combustion (N.Y.)*, 1936, 7, (12), 18-23).—In the X-ray examination of materials, by interposing between the photographic film and the work a "Bucky grid" composed of alternate thin slats of wood and lead, and oscillating it during exposure, secondary radiation from the back of the object is prevented from reaching the film, and clear-cut images of defects are obtained. The application of this device in the X-ray inspection of welded boiler drums is discussed.—J. C. C.

XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from p. 316-317.)

Recording Potentiometer. — (*Chem. and Met. Eng.*, 1936, 43, (1), 40).—In a new recording potentiometer pyrometer the construction is said to eliminate backlash, making it possible to amplify almost imperceptible galvanometer deflections. The pen movement being directly proportional to the magnitude of the galvanometer deflection, makes for speed in recording temperature changes and in restoring the balance of the system.—F. J.

High-Speed Potentiometer. — (*Chem. and Met. Eng.*, 1936, 43, (3), 151-152).—A feature of this photo-electric, electronically balanced potentiometer is the extremely high balancing speed. Temperature variations of a sheet of steel, passing through a rolling mill are recorded by this instrument. The balance, normally secured by the mechanical adjustment of a rheostat, is attained almost instantaneously by electronic means.—F. J.

Automatic Temperature Control. — (*Chem. and Met. Eng.*, 1936, 43, (1), 41).—New temperature control instruments are described. There is no mechanical connection between the indicating and control systems, reliance being placed on a vacuum tube in a tuned circuit to do the work normally carried out by depressor bars or other mechanical contrivances.—F. J.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 317-320.)

***Pouring of Aluminium into Rotors in Short-Circuited Electric Motors in a Rotating Magnetic Field.** N. M. Tuchkevitch and V. S. Rutes (*Vestnik Elektropromishlenosti (Messenger Elect. Ind.)*, 1936, (3), 6-10).—[In Russian.] The metal is poured as rapidly as possible at 740° C., into a mould of non-magnetic steel or cast iron and is subjected during casting to a rotating (950 r.p.m.) magnetic field created by the stator, the inner surface of which is coated with asbestos. The method ensures more rapid and compact filling of the mould, a reduction in the number of subsequent operations, and improved electro-magnetic properties of the rotor.—N. A.

***Inverse Segregation in Ingots and Gas Solubility Studied on Tin-Bronzes.** W. Claus and Fr. W. Bauer (*Metallwirtschaft*, 1936, 15, (26), 587-600).—Bronzes containing 10 and 20% tin were melted in various atmospheres both with and without additions of phosphorus, lithium, zinc, and aluminium, and the difference in tin content between the outer layers and the core of chill- and sand-cast ingots determined. With rates of cooling up to a certain critical value, which, however, is very low, no inverse segregation occurs since the rate of diffusion of the components is sufficient to prevent the formation of a residual tin-rich liquid in the last stages of solidification. With higher rates of cooling the rate of diffusion is insufficient to suppress formation of this tin-rich liquid and to equalize the tin content of the primary crystallites, so that these show intercrystalline segregation ("coring") and the tin-rich liquid tends to be expelled through the primary dendrites by shrinkage pressure and by capillarity, thus giving rise to "inverse segregation," or it collects in the upper part of the core of the ingot, giving rise to "true segregation." The presence of dissolved gas in the metal accentuates inverse segregation since its pressure tends to drive the residual liquid outwards. The experimental results show that hydrogen is the most deleterious gas in this respect since it has a relatively high solubility in molten bronze. Addition of about 0.2% phosphorus increases the fluidity of the molten metal and thus permits a more ready escape of the hydrogen on cooling and consequently reduces the degree of inverse segregation. Lithium has a similar effect but aluminium and zinc are relatively useless in this respect. Phosphorus additions and, to a smaller degree, lithium additions also have a very beneficial effect on the density of the ingots.—A. R. P.

Modern Casting of Bearing Bushes. M. Schied (*Giesserei-Praxis*, 1936, 57, (27/28), 291-294).—Describes the preparation of the bearing, tinning the bearing, melting and casting the bearing metal, the preparation and temperature of the mould, the mechanical, centrifugal, and pressure casting of bushes.—J. H. W.

Directions for the Running of Bearings. E. T. Richards (*Werkstatt u. Betrieb*, 1936, 69, (13/14), 183-184).—A description is given of the preparation (surface finishing, degreasing, etching, and tinning) of the casing; directions for pouring include a discussion of appropriate temperatures for casings, bearing metals, and journals of various types.—P. M. C. R.

A New Process for the Production of Dense Magnesium Alloy Castings. — (*Giesserei-Praxis*, 1936, 57, (31/32), 334).—Describes the scheme of gates and risers and the method of casting a magnesium alloy, containing aluminium 4.5, zinc, cadmium, lead, and thallium each 0.5%, which is claimed to give castings with a compact structure (Patent 441,797).—J. H. W.

Permanent Mould for Casting Screw Knobs. — (*Mech. World*, 1936, 99, 88).—A permanent mould of nickel cast iron, for the production of aluminium-capped steel screw knobs is illustrated and described. Sodium

silicate solution is sprayed on to the mould surface as a protection against the action of the molten aluminium alloy on the cast iron.—F. J.

Rationalization and Normalization of Die-Casting Moulds. V. M. Pljazkiy (*Liteinoe Delo (Foundry Practice)*, 1936, (3), 24–28).—[In Russian.] The rationalization and normalization of die-casting moulds and their various components are examined. Examples are given of rationalization measures and structural alterations in the dies, cores, ejectors and cutters, &c.—N. A.

Die-Casting at the "Injecta" Works in Switzerland. M. A. Zeldin (*Liteinoe Delo (Foundry Practice)*, 1936, (3), 29–32).—[In Russian.] The die-casting process at the "Injecta" works in Switzerland is described.—N. A.

***An Investigation of the Durability of Moulding Sands.** Earl H. Casberg and Carl E. Schubert (*Univ. Illinois Bull.*, 1936, 33, (34), 1–52; and (summary) *Met. Ind. (Lond.)*, 1936, 49, (5), 106, 119).—During continuous use natural moulding sands and silica-sand-bentonite mixtures gradually decrease in both green and dry strengths and both permeabilities increase. With silica-sand-Ohio clay mixtures, however, the green strength increases at first then decreases, due to breaking down of the larger-sized clay particles. In general, the dry strength of a moulding sand is independent of particle size and depends chiefly on the resistance to dehydration of the major mineral constituent while the initial dry strength can be determined from the base-exchange capacity of the bonding substance. It appears to be more economical to add clay or bentonite to used sand after a certain number of heats rather than to attempt to keep the strength constant by frequent additions of bonding substance. The green strength of a sand depends on the physical properties of the constituent minerals and on the particle size.—A. R. P.

Mechanical Handling as Applied to Industry. R. B. Lister (*Proc. Inst. Mech. Eng.*, 1935, 130, 283–291).—A general account of the application of mechanical handling to industrial processes; examples of applications to foundry practice are included.—W. H.-R.

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

(Continued from p. 273.)

Protective and Refining Agents in the Melting of Aluminium Scrap. Edmund R. Thews (*Giesserei-Praxis*, 1936, 57, (31/32), 331–334).—Describes the precautions to be observed, the fluxes to be used, and the procedure to be adopted in the use of aluminium scrap for making castings.—J. H. W.

XV.—FURNACES AND FUELS

(Continued from pp. 320–321.)

On Electric Tinning and Galvanizing Furnaces. Helmut Finnern (*Elektrowärme*, 1936, 6, (1), 27–30).—Continuous furnaces for tinning and zinc-coating iron or copper wires by drawing them through an electrically heated bath of the coating metal in a controlled atmosphere are illustrated and described. A table is included giving the electrical data for furnaces holding 75–1250 kg. of tin.—A. R. P.

Electric Melting Furnaces for Light Alloys. U. Schwedler (*Elektrowärme*, 1936, 6, (1), 20–24).—Various types of furnaces for melting aluminium alloys are illustrated and briefly discussed. Electric melting is much superior to gas or oil melting since the metal absorbs much less gas and, therefore, produces sounder castings.—A. R. P.

Modern Electric Furnaces for Melting Light Metals. H. Dicks (*Elektrowärme*, 1936, 6, (3), 162-170).—[In German, with summaries in English, French, and Italian.] The construction and operation of crucible, open-hearth, and low-frequency induction furnaces are described with reference to illustrations. The advantages and disadvantages of each type are discussed.—A. R. P.

Furnaces of High Thermal Efficiency or of Variable Power for the Manufacture of Aluminium and the Utilization of Current. Louis Ferrand (*Bull. Soc. franç. Élect.*, 1936, [v], 6, (67), 741-766).—Furnaces of the closed type can be operated either at constant power and high thermal efficiency or at varying power under forced draught. The methods for effectively utilizing and grouping furnaces of the latter type, and especially of minimizing anode losses, are discussed in relation to economic conditions.—P. M. C. R.

Heat-Treatment of Metals. W. Y. Anderson (*Elect. Rev.*, 1936, 118, (3055), 873-874).—Advantages of electric heating for heat-treatment furnaces are outlined and some figures given for power consumption in annealing coiled brass strip and small non-ferrous articles. Furnaces for annealing brass and aluminium alloy tubes are illustrated.—J. C. C.

Heat-Treatment of Light Metal Alloys in Electric Furnaces. — Knoops (*Elektrowärme*, 1936, 6, (1), 24-27).—Salt-bath and tunnel-type furnaces, electrically heated, for the solution anneal and high temperature ageing of light alloys are described and illustrated.—A. R. P.

Shaft Annealing Furnace with Forced-Air Circulation for the Heat-Treatment of Band-Rings of Light Metal. O. Gengerbach (*Elektrowärme*, 1936, 6, (2), 113-122).—A large vertical cylindrical furnace with a rotor fan for the even distribution of the hot air in the furnace is described and illustrated. Curves are given showing the temperature distribution.—A. R. P.

Electric Annealing and Heat-Treatment Furnaces for the Light Metal Industry. U. Schwedler (*Elektrowärme*, 1936, 6, (3), 171-177).—[In German, with summaries in English, French, and Italian.] A shaft furnace is described having a forced-air or inert-gas circulation and lined with a special heat-insulating powder to prevent heat losses in the walls. For annealing long objects a similar type of horizontal trough furnace has been constructed.—A. R. P.

Electric Annealing Furnaces and Their Heating Elements. W. Rohn (*Elektrowärme*, 1936, 6, (1), 17-20).—Cf. *Met. Abs.*, this vol., p. 216. Five groups of heating elements are recognized for use, respectively, at (1) up to 800° C.; (2) 800°-950° C.; (3) 950°-1100° C.; (4) 1150°-1250° C.; and (5) 1250°-1400° C.; the best alloys for wires or strips to operate at these temperatures consist of (1) chromium 15-20, nickel 30-20, iron 55-60%, (2) chromium 15-20, iron 10-20, nickel 75-60%, (3) 80 : 20 nickel-chromium, and (4) chromium 20-30, aluminium + silicon 6-4, and iron 74-66%. For temperatures above 1250° C. only "Silite" or similar rods can be used. Alloys of groups (1)-(3) must always be operated in an oxidizing atmosphere, and all are rapidly destroyed in a sulphurous atmosphere.—A. R. P.

†**The Real and Mean Specific Heats of Technically Important Gases.** Horst Brückner (*Gas- u. Wasserfach*, 1935, 78, (33), 637-639).—B. Bl.

XVI.—REFRATORIES AND FURNACE MATERIALS

(Continued from p. 321.)

***Evaluation of Refractory Materials. II.—The Absorption Capacity of Refractory Argils and Kaolins.** L. Belladen (*Metallurgia italiana*, 1936, 28, 59-64; *C. Abs.*, 1936, 30, 4638).—The sorption capacities (*T*) of 7 refractories were determined and compared with various physical properties. Plasticity,

measured according to Rieke, increased with T . There is no relation between T and resistance to compression. The modulus of rupture by bending increases linearly with T . In general, shrinkage in drying increases with T , but some exceptions are noted.—S. G.

XVIII.—WORKING

(Continued from pp. 322-323.)

*†A Research into Tests for Materials Used in Cold-Pressing Operations, with Special Reference to the Fluid-Pressure Cupping Test. H. J. Gough and G. A. Hankins (*J. Roy. Aeronaut. Soc.*, 1935, 39, (299), 1047-1076).—See *Met. Abs.*, 1935, 2, 630.—H. S.

†Cold-Pressing and Drawing—the Metallurgical Aspect. C. H. Desch (*J. Roy. Aeronaut. Soc.*, 1935, 39, (299), 1077-1080).—See *Met. Abs.*, 1935, 2, 630.—H. S.

†New Researches on the Drawing of Cylindrical Shells. G. Sachs (*J. Roy. Aeronaut. Soc.*, 1935, 39, (299), 1081-1091).—See *Met. Abs.*, 1935, 2, 630.

—H. S.

Three Papers on "Cold-Pressing and Drawing." — (*J. Roy. Aeronaut. Soc.*, 1935, 39, (299), 1092-1122).—Discussion on papers by H. J. Gough and G. A. Hankins, C. H. Desch, and G. Sachs; see preceding abstracts and *Met. Abs.*, 1935, 2, 630.—H. S.

*The Forgeability of Different Types of Light and Ultra-Light Alloys. (Portevin and Bastien.) See p. 347.

Manufacture and Use of Silver Bronze Powders. Leo J. Mitchell (*Metal Cleaning and Finishing*, 1936, 8, (6), 345-346).—The manufacture of fine aluminium flakes for use in lacquer paints is described; 1 grm. of the metal may be ground so finely and thinly that it will effectively cover 2.2 m.² of surface.—A. R. P.

*Researches on the Cutting of Metals. I.—Durability Test of Some Tungsten Carbide Tools. Yaekichi Sekiguchi, Keikichi Ebihara, and Takashi Nakada (*Trans. Soc. Mech. Eng. Japan*, 1935, 1, (5), 427-436).—[In Japanese, with English summary in suppt., pp. 110-111.] Experiments are described on the cutting action and the durability of Widia and Tungaloy tools in turning mild steel and cast-iron cylinders. With a newly designed S.S.N. optical tool dynamometer, in which the tool is rigidly fixed on the actual tool rest, it was found that the cutting force diagrams vary according to the abrasion of the tool, being initially a smooth line and finally severely vibrating curves. Cutting chips which at first are in long strips change in form corresponding to the vibration of the cutting force and are finally small vortical pieces. The durabilities of Tungaloy tools (Japan) and Widia tools are nearly the same, the former having a longer life at a cutting speed under 100 m./mm. and the latter a longer life over that speed. In discontinuous turning of cast-iron cylinders with three grooves of 50 mm. width, Widia tools are a little better than Tungaloy tools, and it is also shown that the cutting resistance at the edge of grooves is not especially high.—J. W. D.

XIX.—CLEANING AND FINISHING

(Continued from pp. 323-324.)

Improved Solvent Degreasing. M. B. Pickett (*Metal Cleaning and Finishing*, 1936, 8, (3), 113-116).—Three types of modern solvent degreasing plants are illustrated and described.—A. R. P.

The Practical Application of Polishing Grain. Henry R. Power (*Metal Cleaning and Finishing*, 1936, 8, (7), 423-426).—Discusses the relation of

particle size, capillarity, surface tenacity, particle shape, and crystal structure of abrasive grains to their practical application in polishing.—S. G.

The Finishing of Small Objects by the Tumbling Process. — (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (9), 443).—Discusses the operation of barrel-tumbling articles with small amounts of lacquer.—J. C. C.

XX.—JOINING

(Continued from pp. 325-327.)

***The Effect of Molten Solder on Some Stressed Materials.** G. Wesley Austin (*J. Inst. Metals*, 1936, 58, 173-185; discussion, 185-192).—Breakages of steel and non-ferrous parts during assembly by soldering whilst subjected to stress, led to this investigation on the effect of molten solder on stressed tensile test-pieces of many of the metals and alloys used in engineering. The materials studied were: steels, Armco iron, nickel, copper, silver, aluminium, zinc, Monel metal, cupro-nickel, bronzes, aluminium-bronze, silicon-zinc-bronze, brasses, Duralumin, and Elektron. Although the phenomenon was found to be very general, certain materials proved less susceptible than others; a selection of materials which will offer resistance to the simultaneous action of stress and solder is thus possible.—G. W. A.

***Silver Soldering by Electricity.** P. H. Ryan (*J. Amer. Soc. Naval Eng.*, 1936, 48, (2), 239-248).—The results are given of an investigation on the soldering of fittings consisting mainly of copper tubing and composition flanges with low melting point silver solder using (1) an electrical induction method, (2) an indirect resistance method, and (3) a direct resistance method of heating. Tensile and hydrostatic tests show the strength and tightness of the joints obtained to be comparable with those obtained using the oxy-acetylene flame, and point to the possibility of regularly obtaining full-strength, pressure-tight joints in one cycle of operation. The grain-size of heavy copper tubing or flange material is not affected by electric soldering, and the effect on thinner tubing only results in partial annealing. Danger of overheating is also reduced by electric heating, and there is less tendency towards warping and cracking, while the method is also more economical.

—J. W. D.

Electric Brazing. A. G. Robiette (*Elect. Rev.*, 1936, 118, (3054), 816-817).—Brass and nickel alloys can be brazed with silver solder in a continuous electric furnace in an atmosphere of burnt and purified coal-gas in the same way as steel articles are joined by copper brazing. The process and its applications are briefly discussed.—J. C. C.

Rebuilding Hydraulic Rams. — (*Mech. World*, 1936, 99, 159).—Corrosion or erosion of the working parts of hydraulic machinery leads to water loss, destruction of packing, and reduced efficiency. The bronze-welding of worn parts is illustrated and described.—F. J.

***Corrosion-Resistance of Welds.** (Bürgel.) See p. 362.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 327-331.)

Aluminium Powder, Its Manufacture and Uses. I. I. Tolmachev (*Legkie Metalli (Light Metals)*, 1936, (3), 50-54).—[In Russian.] A review.

—D. N. S.

British Standard Specification for Silicon-Aluminium Alloy Castings for General Engineering Purposes. — (*Brit. Stand. Inst.*, No. 702, 1936, 10 pp.).—S. G.

British Standard Specification for Y-Alloy Castings (As Cast) for General Engineering Purposes. — (*Brit. Stand. Inst.*, No. 703, 1936, 10 pp.).—S. G.

British Standard Specification for Y-Alloy Castings (Heat-Treated) for General Engineering Purposes. — (*Brit. Stand. Inst.*, No. 704, 1936, 12 pp.).—S. G.

Non-Ferrous Alloys Available for the Use of Industry. Hiduminium and Magnesium Alloy Extruded and Drawn Sections. — (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (9), 417-418).—See *Met. Abs.*, this vol., pp. 98, 133. Describes the characteristics of the alloys Hiduminium R.R. 56, D.U., 72, R.R. 66, and Magnuminium 266.—J. C. C.

Development of Aluminium for Aircraft. C. F. Nagle, Jr. (*Aero Digest*, 1936, 28, (2), 27-29).—General.—S. G.

Petrol Feeding Mechanism for Aeroplane Motors. J. Bally (*Rev. Aluminium*, 1936, 13, (82), 261-268).—Describes the applications of Duralumin in the construction of the petrol feed in aeroplane engines.—J. H. W.

The Largest Diesel Trains. Chas. F. A. Mann (*Oil Engine*, 1936, 4, (39), 92-95).—An account of four new Diesel trains of the Union Pacific Railroad (U.S.A.). Light alloys are used in the bodywork of nearly all the coaches (Duralumin), in the engine pistons (nickel-copper-aluminium alloy) and almost throughout the coachwork, whilst ordinary curtains are replaced by aluminium sheet.—P. M. C. R.

Antimony as a Raw Material for the Chemical Industry. Charles Hardy (*Chem. Industries*, 1936, 38, (4), 363-365).—Production (by countries, 1925-1933), price (1926-1935), import, export, and consumption (U.S.A.) statistics are given and briefly discussed.—A. R. P.

Materials for Chemical Pumps. C. H. S. Tupholme (*Chem. Industries*, 1936, 38, (6), 575-576).—The properties demanded of a suitable metal for chemical pumps are briefly discussed and the value of certain steels, bronzes, and copper-nickel alloys for various chemical purposes is examined.

—A. R. P.

The Manufacture of Steam Valves for Modern High-Pressure Boiler Plant. — (*Mech. World*, 1936, 99, 105, 107, 120).—The manufacture of Handor steam valves at the Dumbarton factory of Babcock and Wilcox, Ltd., is described and illustrated. The combined effects of high temperature and pressure in steam plant have led to the use of new materials and principles of design. The bronze manufactures cover a wide range, and 14 different alloys are regularly handled; four of these are described as of "the cupro-nickel series." The Handor valve contains 104 parts. In the brass machine shop, tungsten carbide tools are used exclusively for brass-finishing.—F. J.

Phosphor-Bronze Bearings. — (*Metallurgia*, 1936, 14, (81), 67-69).—The composition of phosphor-bronze for bearings, and the careful adjustment of the tin and phosphorus contents in accordance with the service the bearing has to give are discussed, and consideration is given to the functions of the hard and soft constituents, and to the influence of alloy additions, particularly lead and nickel, on the mechanical, frictional, and wearing properties of the alloy.—J. W. D.

***Investigations on Sliding Bearings with a New Type of Lubrication at Very High Pressures.** G. Welter and W. Brasch (*Metallwirtschaft*, 1936, 15, (10), 227-229).—An apparatus for the high-pressure lubrication of bearings is described, and curves are given showing the effect of this method of lubrication in reducing the wear of bearings in high-speed motors, &c.—A. R. P.

The Facing of Bearing Shells of Cast Iron, Steel, or Bronze. J. Nappée (*Mécanique*, 1936, 20, (267), 146-149).—Successful facing depends on securing proper adhesion between the casing and the bearing metal. The impurities present in ordinary cast iron necessitate special precautions, which are enumerated. Preliminary tinning is recommended in all cases, and diagrams of suitable plant are given, with a list of the necessary equipment. The method of running the bearing is described, and three typical analyses of bearing metal are given, with appropriate applications.—P. M. C. R.

Brass Wire Gauze for Straining [Rubber] Latex. B. J. Eaton (*J. Rubber Res. Inst. Malaya*, 1935, 6, 47-48; *C. Abs.*, 1936, 30, 4719).—The detrimental effect of copper compounds on rubber is such that sieves with corroded wire gauze should not be used for straining latex. In no case should latex to which ammonia has been added be passed through brass-wire sieves.—S. G.

Failure of Metals and Alloys in Service on Overhead Lines. — (*Mech. World*, 1936, 99, 420).—Abstract of a publication issued by British Insulated Cables, Ltd.—F. J.

***Substitute Materials for Lead as Packing for Pipe-Lines.** E. Landel (*Gas- u. Wasserfach*, 1936, 79, (10), 145-148).—Aluminium wool or foil is recommended.—B. Bl.

Acid Filter. — (*Chem. and Met. Eng.*, 1936, 43, (1), 41).—For the filtering of plating solutions, &c., an American firm has developed a lead-lined vessel housing a manufactured porous-stone filtering element. The filter is illustrated and briefly described.—F. J.

Nickel and Its Alloys in Petroleum Refining. R. W. Müller (*Petroleum Z.*, 1936, 32, (29), 3-6).—The applications of nickel alloys in the petroleum refining industry are described.—P. M. C. R.

Silver and Its Uses in Chemical Plant. Arthur Haslam (*Metallurgia*, 1936, 14, (81), 59).—The applications of silver in the chemical industry are briefly discussed.—J. W. D.

The Production of Silver Mirrors by Cathodic Sputtering. E. Gwynne Jones and E. W. Foster (*J. Sci. Instruments*, 1936, 13, (7), 216-219).—A simple apparatus is described for the preparation of silver mirrors by cathodic sputtering in an atmosphere of argon. An important factor for the production of good mirrors is the cleanliness of the apparatus and specimen, and the necessary precautions and cleaning operations are described.—W. H.-R.

Materials for Exhaust Valves. E. Schmidt and H. Mann (*Automobiltech. Z.*, 1936, 39, (12), 303-312).—Deterioration in valve materials may be set up through thermal, chemical, or mechanical conditions, singly or in combination. The structure, composition, thermal conductivity, and corrosion-resistance of the materials are of fundamental importance. A list is given of suitable materials (some non-ferrous) for aviation engine valves. The possible initiation of grain-growth as a result of Stellite valves or valve seats is discussed. The properties of metallic cooling agents (mercury, sodium, sodium-potassium, lithium, &c.) are tabulated, as are those of suitable materials for valve seats.—P. M. C. R.

Standard Materials and Their Applications. Erich Eichwald (*Automobiltech. Z.*, 1936, 39, (12), 297-301).—The system of nomenclature adopted for ferrous and non-ferrous alloys by the German Standards Committee is explained; a list of appropriate materials for machine parts is given, with their respective reference marks. Tables show the corresponding analyses and mechanical properties for a number of light alloys and for certain brasses, in various states of thermal and mechanical treatment.—P. M. C. R.

XXII.—MISCELLANEOUS

(Continued from pp. 331-332.)

Presidential Address. W. R. Barclay (*J. Inst. Metals*, 1936, 58, 61-82).—Deals with the main lines and features of the "development" movement in the non-ferrous metallurgical industry, and refers particularly to the organizations in the nickel, aluminium, tin, and copper industries. The aims of these organizations are discussed, and factors essential to future progress and success are emphasized.—S. G.

Metallurgical Literature and the Technical Library. A. D. Roberts (*Metallurgia*, 1936, 14, (81), 77-78).—The various reviews, technical journals,

abstracts, and indexes dealing with metallurgy are given; the value of technical libraries in London and Provincial towns for tracing information by means of such publications and for obtaining access to basic literature is dealt with, and a plea is made for a wider use of the facilities available in such institutions.—J. W. D.

A Survey of Engineering and Metallurgical Progress. G. E. Wolstenholme (*Proc. Inst. Mech. Eng.*, 1935, 131, 625-629).—An abbreviated address dealing mainly with developments of alloy steels, and machinery for working metals.
—W. H.-R.

A Cruciform Brooch from Benwell, Newcastle-upon-Tyne. Parker Brewis (*Archæologia Æliana*, 1936, [iv], 13, 117-121).—A description is given of a bronze brooch, $5\frac{3}{8}$ in. long, found in the Roman fort of Condercum. The analysis, according to J. A. Smythe, is copper 82.00, tin 12.23, zinc 1.24%, iron and nickel small quantity, oxygen and loss 4.53%.—S. G.

A Roman Skillet from South Shields. Robert Carr Bosanquet (*Archæologia Æliana*, 1936, [iv], 13, 139-151).—A full description of a fine Roman skillet or *patera* found about 100 years ago among what was taken to be the "wreckage of a sailing ship." No metallographic examination of the specimen has been made, but from visual examination the handle and base appear to have been cast (probably by the *cire perdue* method) in heavily leaded bronze containing 10-12% tin; the bowl appeared to be of the same metal.—S. G.

Excavations of Two Bronze Age Barrows at Kirkhaugh, Northumberland. Herbert Maryon (*Archæologia Æliana*, 1936, [iv], 13, 207-217).—Among the objects found was a gold ear-ring, which is described. Reasons are given for the belief that this ear-ring was obtained from Ireland in the ordinary course of trade, and that it is another link between the metal crafts of Spain and the British Isles in the Bronze Age.—S. G.

An Inscribed Openwork Gold Ring from Corstopitum. John D. Cowen (*Archæologia Æliana*, 1936, [iv], 13, 310-319).—A full description of a ring weighing 183 grains and its inscription, with a discussion of its possible origin. It is considered to be work of the fourth century.—S. G.

Five Cases of Poisoning by Arsine [in Zinc Works]. Jean Firket (*Ann. méd. légale criminol. police sci.*, 1936, 16, 122-129; *C. Abs.*, 1936, 30, 4585).—The cases occurred in a metallurgical (zinc) works; two were fatal.—S. G.

Molybdenum in U.S.A. I. M. Krasnopolski (*Redkie Metalli (Rare Metals)*, 1936, (1), 42-47).—[In Russian.] The operations of several American works producing calcium molybdate and ferro-molybdenum, are briefly described.
—D. N. S.

Means for Detecting Iron in Alloy Equipment. F. H. Hoyt (*Chem. and Met. Eng.*, 1936, 43, (3), 150).—By applying a thick water paste of plaster of Paris in a layer $\frac{1}{4}$ to $\frac{1}{2}$ in. thick over metal surfaces, a yellow stain will appear, when the plaster has dried, over any part consisting of iron. Brass, stainless steel, nickel, and other materials not affected by water when similarly covered will remain white.—F. J.

Chart Aids to Management. M. L. Yates (*Mech. World*, 1936, 99, 1-2, 37-38, 61-62, 83-84, 108-109, 135-136, 157-158, 181-182, 222-223).—A series of articles describing the various charts so far developed, by the use of which the same degree of success can be obtained for business organization and management as for the presentation and recording of technical data.
—F. J.

Patenting in the United States. John Johnston (*Mech. World*, 1936, 99, 217-218).—There is so much evidence of interchange of products between British and American manufacturers that, in the case of a new project, it may be desirable to consider protection in America at an early stage. A general explanation is given to permit some understanding of the fundamental conditions.—F. J.

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(Continued from pp. 284-286.)

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