# METALLURGICAL ABSTRACTS

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# METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERR CUSTSKOWY INSTYTUT

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## Volume 11

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### I.—PROPERTIES OF METALS

Recent Advances and Developments in the Field of Aluminium and Its Alloys. W. Linicus (Metallwirtschaft, 1941, 20, (20), 505-510).-A general In the reduction process, the use of layer cells has given increased review. efficiency. The development of the 3-layer process for making super-purity aluminium has resulted in greater availability of this material for reflectors and decorative work, and has provided a means of refining contaminated metal. Further advances have been made in purification by fractional solidification and distillation. The shortage of copper has caused a search to be made for alternative alloys, and the aluminium-magnesium-zinc group is being developed. Their liability to stress corrosion can be minimized by addition of manganese or chromium and by appropriate heat-treatment. Specifications have been drawn up for secondary metal, and remelting procedures standardized. Developments have been made in cladding, particularly for reflectors. In draw-press work, advances have been made in die design and the use of rubber. In processing, section rolling and incorporation of heavy-metal inserts call for mention. In riveting, age-hardening is being controlled by varying the composition of the rivets, and explosive rivets are being employed to an increasing extent. Some advances have been made in welding apparatus. For heat-treatment, salt baths are being replaced by air-circulation furnaces .- H. W. L. P.

Hardness of Aluminium Sheet (Tests and Conversion Charts). (Templin.) See p. 24.

Beryllium—Facts About the Metal, Rather than Fancies. (Metal Progress, 1943, 43, (6), 904–907, 942; also (abridged) Met. Ind., 1943, 63, (5), 71-72).-An editorial note describes the development in the U.S.A. of the commercial use of beryllium, and draws attention to the fact that the main obstacle to further development is the scarcity of beryllium ores rather than arbitrary restrictions. A summary is then given of a report to the U.S. War Production Board. The report states that the potential use of the metal exceeds the present supply. Over 90% of the beryllium produced is used for the alloying of copper, the beryllium being introduced in the form of a "master alloy "containing 4-4.5% beryllium; the proportion in the final copper-base alloy is 0.3-2.5%. The copper-beryllium alloys have high fatigue strength, elastic limit, and resistance to creep, wear, and corrosion, and they are much used in small but important control parts in marine, military, and aircraft work. Alloys of aluminium or magnesium with beryllium are in the experimental stage, more progress having been made with the former type. The report also refers to the use of metallic beryllium in X-ray work and to the value of beryllium oxide as a refractory aid in the production of fluorescent elements (" phosphors ") for lamps.—P. R.

\*Investigations of Ferromagnetic Impurities. II.-[In Copper, Brass, and Silver.] F. W. Constant, R. E. Faires, and H. E. Lenander (*Phys. Rev.*, 1943, [ii], 63, (11/12), 441-445).—Cf. Constant and Formwalt, *Phys. Rev.*, 1939, 56, 373; Met. Abs., 1939, 6, 448. The magnetic properties of copper

† Denotes a first-class critical review.

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<sup>\*</sup> Denotes a paper describing the results of original research.

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magnet wire, brass rod, and silver all showed the influence of ferromagnetic impurities. With copper and brass, heating to 900° and 750° C., respectively, in hydrogen for 2 hrs., followed by quenching, eliminated the ferromagnetism, but with silver this method was unsuccessful. With copper, reheating in an atmosphere containing oxygen caused the ferromagnetic effects to reappear. Diagrams are reproduced showing the ratio of the remanence after heattreatment to the original remanence. The cause of these effects is discussed, and it is concluded that the heat-treatment results in the ferromagnetic impurity, presumably iron, entering into solid solution in copper or brass, but not in silver. The exact compositions of the materials are not stated.

-W. H.-R.

\*Electrical Conduction and Recrystallization in Thin Lead Films Deposited at Low Temperatures. Edgar L. Armi (*Phys. Rev.*, 1943, [ii], 63, (11/12), 451-454).—Thin films of lead were deposited on glass by evaporation in high vacuum. Films deposited on glass at the temperature of liquid or solid hydrogen showed an appreciable conductivity at thicknesses as small as 7 A., whereas with glass at room temperature a thickness of the order 160 A. was required. This difference is due to the agglomeration of the film into isolated particles which takes place readily at room temperature, whereas at the low temperatures re-grouping is only possible on a very small scale. Experiments on the ageing of the films at different temperatures are described, and confirm these views; they show that there is a critical temperature below and above which ageing decreases and increases the resistance respectively.—W. H.-R.

Magnesium, Its Properties and Production. Walter B. Spellmire (Gen. Elect. Rev., 1943, 46, (7), 372–375).—Mainly a general description of the electrolytic and thermal processes in use for the production of magnesium.

-E. V. W.

\*The Effect of High Electrostatic Fields Upon the Vaporization of Molybdenum. G. B. Estabrook (*Phys. Rev.*, 1943, [ii], **63**, (9/10), 352–358).—The effects of electrostatic fields on the vaporization of molybdenum were studied by measuring the electrical resistance of wires mounted in evacuated glass tubes so that a radial field could be applied while the wire was heated by the passage of a current. The wire was made electro-positive to avoid emission of electrons. Field strengths below about  $0.52 \times 10^6$  v./cm. had no effect on the rate of vaporization, but on increasing the field strength above thisvalue, the rate of vaporization decreased, at first slowly and then more rapidly, until it became nearly zero at field strengths of the order  $1.8 \times 10^6$ v./cm. The effect is least pronounced as the temperature is increased. The effect may be due to the evaporated atoms becoming dipoles in the strong fields, and so being attracted back to the wire. In the range where the field does affect the rate of evaporation, there is a sudden increase in resistance when the field is applied.—W. H.-R.

\*The Effect of High Electrostatic Fields Upon the Vaporization and Resistance of Molybdenum Filaments. Walter P. Reid (*Phys. Rev.*, 1943, [ii], **63**, (9/10), 359-366).—Theoretical. The effects observed by Estabrook (abstract above) are explained on the assumption that the decrease in the rate of evaporation caused by the application of an electrostatic field is due to the formation of an adsorbed gas layer on the filament.—W. H.-R.

Remarks on Salvador Velayos' Paper : "Effect of Elastic Compression on the Maximum Magnetic Susceptibility of Nickel." Heinz Bittel (Z. Physik, 1940, 116, (5/6), 349–351; Chem. Zentr., 1940, 111, (II), 3450).—Cf. ibid., 340–348; Met. Abs., 1941, 8, 255. V.'s experimental results on the effect of elastic compression on the maximum permeability of nickel rods may be described, not only by V.'s own formula, but also in general terms by B.'s theory, since according to V.'s results both the coercive force and the magnetic field at the maximum permeability are proportional to the internal stresses. B. rejects V.'s empirical formula on account of its limited validity.

\*On the Phenomenon of Overheating a Solid Body. [Tin Wires.] S. E. Khaykin and N. P. Benet (Compt. rend. (Doklady) Acad. Sci. U.R.S.S., 1939, [N.S.], 23, (1), 31-35).—[In English.] Experimental evidence is given to show that tin wires of 8-10 mm. diameter and 10-12 cm. length behave differently on melting by careful electric heating, according to whether they are single-crystal wires or not. In polycrystalline wires the melting process starts in the centre of the wire, and penetrates to the surface. On the other hand, single-crystal wires melt first at the surface. Since the temperature increases with depth (an effect intensified by the air-cooling of the surface), it has to be assumed that the internal temperature exceeds the melting point by up to  $2^{\circ}$  C. Thus, a single crystal may not melt, even though its temperature exceeds the melting point, and the more perfect the single crystal, the greater is the superheating it can undergo. It is concluded that for a solid to melt, not only must the melting point be reached, but certain other specific conditions must be fulfilled.—N. B. V.

\*The Effect of High Electric Fields on the Conductivity of Tungsten. Peter Louisa Vissat (*Phys. Rev.*, 1943, [ii], **64**, (3/4), 119–125).—A grounded tungsten wire, 0.0078 mm. in diameter, was mounted co-axially with a cylinder which was made negative to the wire. A potential difference was then applied between the cylinder and the wire, and the change in resistance of the wire was measured. With a vacuum of the order of  $10^{-6}$  mm. of mercury, and fields of the order of  $10^{6}$  v./cm., an increase in resistance was observed when the field exceeded a certain value, and this increase became greater as the field increased. Possible causes of the phenomenon are discussed, and it is concluded that it is due to ionization currents in the space between the wire and the cylinder passing to the filament, and so heating it and increasing the resistance.—W. H.-R.

\*Energies for Self-Diffusion in Zinc. H. B. Huntington (*Phys. Rev.*, 1943, [ii], **63**, (9/10), 383–384).—A note. Experiments by Miller and Banks (*Phys. Rev.*, 1942, **61**, 648; *Met. Abs.*, 1942, **9**, 235) show that in the self-diffusion of zinc, the energy of activation is always smaller for diffusion along the hexagonal axis than for diffusion in the basal plane. If the hypothesis of vacancy diffusion is accepted, the diffusing atom half-way between two vacancies in the same basal plane would appear to be in a position of higher energy than an atom half-way between vacancies in adjoining planes. Calculations of the electrostatic energy of the two situations have been made on the assumption that the two valency electrons per atom are uniformly distributed in space, and give qualitative confirmation of the difference in activation energies.—W. H.-R.

\*Investigation of Electrocapillary Phenomena on Various Liquid Metals. S. Karpatschoff and A. Stromberg (*Acta Physicochim. U.R.S.S.*, 1942, 16, (5/6), 331–335; *C. Abs.*, 1943, 37, 3322).—Cf. K. and S., *ibid.*, 1940, 12, 523; *Met. Abs.*, 1941, 8, 342. Electrocapillary curves for silver, antimony, bismuth, aluminium, gallium, and tellurium were obtained, using fused mixtures of KCl + LiCl of eutectic composition as the electrolyte. A table is given for the potentials of the maxima of the electrocapillary curves against the lead electrode for the metals studied. In a number of cases the p.d.s at the maxima of the electrocapillary curves for different metals coincide with the p.d. between these metals at their points of zero charge in aqueous solutions. Such agreement is not found for silver.

The Behaviour of Metals Under Alternating Stresses. E. Siebel (Metallwirtschaft, 1941, 20, (17), 409–414).—A review of recent work on fatigue and the phenomena associated with it, with particular reference to the effect of notches and corrosion on the fatigue behaviour of stressed parts, the effects of two types of stresses acting simultaneously, methods of determining fatigue damage, and means for improving the resistance of constructional materials to fatigue failure.—A. R. P.

Metals at High Temperatures. N. A. de Bruyne (Aircraft Eng., 1943, 15, (174), 223–226).—Published data on the strength of metals at high temperatures are examined in relation to expressions used by Andrade and by Dushman for flow and fracture at high temperatures. Where the strain energy becomes appreciable, a correcting term is necessary to allow for interaction between strain energy and activation energy. De B. examines the use of a relationship of the type suggested by Becker and previously used by himself in describing viscous flow, by application to results obtained by Martin (J. Inst. Metals, 1924, 31, 124) for the ultimate strength of aluminium at high temperatures. Results obtained by Dickinson (J. Iron Steel Inst., 1922, 106, 103) on a number of commercial steels at high temperatures are given, plotted in the form of the log of time to fracture at constant stress against the reciprocal of the absolute temperature; they show a linear relationship.—H. S.

\*A Note on the Thermoelectromotive Force. Karl F. Herzfeld (*Phys. Rev.*, 1943, [ii], **64**, (1/2), 37–38).—Theoretical. An analogy exists between the state of electrons in a temperature gradient and a gas at low pressure in a capillary in which a temperature gradient exists. Equations are derived and compared with the usual expressions.—W. H.-R.

The Scientific Significance of Ferromagnetism. Francis Bitter (J. Washington Acad. Sci., 1943, 33, (8), 235–238).—A review of the development of the scientific interpretation of ferromagnetism by means of theoretical and experimental investigations.—E. A.

Ferromagnetism and the Metallic State. Louis Néel (J. Phys. Radium, 1941, [viii], 1, 242-250; Chem. Zentr., 1942, 113, (I), 1603; C. Abs., 1943, 37, 3309).—The old Weiss hypothesis of the molecular field can be extended by slight additional assumptions to metals with incomplete intermediate shells (transition metals) to interpret many experimental phenomena. Furthermore, these phenomena can be readily classified for calculation. For the ferromagnetic phenomena the molecular field is positive. Certain difficulties, such as the existence of a Curie range, or a ferromagnetic and a paramagnetic Curie point, can be removed by assumptions based on possible fluctuations of the molecular field. For the anti-ferromagnetic metals, such as manganese or chromium, the molecular field is negative. By assuming that fluctuations of the molecular field are possible here also, one can calculate a susceptibilitytemperature curve which is horizontal over a wide range, and is, on the whole, in agreement with experimental results. Further, the molecular field should depend very markedly upon the mutual distances between the magnetic atoms. These deductions are supported experimentally, since ferromagnetism appears only for definite separations of the atoms. The case of manganese is especially interesting, because manganese lies close to the boundary of ferromagnetism, and only a slight enlarging of the lattice (e.g., by embedding nitrogen atoms) serves to make it ferromagnetic.

\*On the Thermomagnetic and Thermoelastic Phenomena in Ferromagnetic Metals. [Nickel and Iron.] D. I. Volkov (Zhur. Eksper. i Teoret. Fiziki (J. Exper. Theoret. Physics), 1939, 9, 444–450; Chem. Zentr., 1940, 111, (II), 3157).—[In Russian.] Cf. ibid., 1939, 9, 798; Met. Abs., 1943, 10, 341. V. investigated the Thomson-Nernst thermomagnetic fields. The experiments showed a rapid increase of the thermo-e.m.f. with a gradual transition to saturation, which occurs at the same value of H as the magnetic saturation. The change of the thermoelectric properties is thus limited in relation to the anisotropy by the orientating effect of the field in the region of spontaneous magnetization. The thermo-e.m.f. of nickel increases, and that of iron decreases, with the increase of tensile stress.

The Short- and Long-Term Order in Ferromagnetic Bodies. L. S. Stilbans (Zhur. Eksper. i Teoret. Fiziki (J. Exper. Theoret. Physics), 1939, 9, 432-437; Chem. Zentr., 1940, 111, (II), 3309).—[In Russian.] S. discusses the thermo-dynamic characteristics of ferromagnetic bodies. The usual methods of calculation, which do not take into consideration the short-term order, give incorrect results at temperatures above the critical. S. carried out calculations taking into account the short-term order, which are therefore also valid at temperatures in excess of the critical. Formulæ derived in calculations embracing the long-term order confirm the former ones.

On the Change of the Resistance of Metals in a Magnetic Field. A. Akhieser (Zhur. Eksper. i Teoret. Fiziki (J. Exper. Theoret. Physics), 1939, 9, 426-431; Chem. Zentr., 1940, 111, (II), 3156).-[In Russian.] The effect of the magnetic field on the resistance of metals at low temperatures was studied theoretically. A marked periodicity of the dependence of the resistance on the magnetic field was observed, similar to that shown experimentally, e.g., for bismuth.

Statistical Theory of Liquids.—II. G. Jaffé (Phys. Rev., 1943, [ii], 63, (7/8), 313-321).-Cf. Met. Abs., 1943, 10, 105.

#### **II.**—**PROPERTIES OF ALLOYS**

Recent Advances and Developments in the Field of Aluminium and Its

Alloys. (Linicus.) See p. l. \*Ageing in the Solid Solution of Silver in Aluminium. A. H. Geisler, C. S. Barrett, and R. F. Mehl (Metals Technology, 1943, 10, (2); A.I.M.M.E. Tech. Publ. No. 1557, 20 pp.; and Trans. Amer. Inst. Min. Met. Eng., 1943, 152, 182-200; discussion, 223-225).—The ageing of solid solutions of silver in aluminium has been studied for ageing temperatures up to 303° C., using alloys containing 10, 20, and 30% silver. Laue X-ray diffraction photographs show Guinier-Preston streaks, indicating that platelets form on the (111) planes of the aluminium solid-solution matrix. The initial precipitate has the  $\gamma'$  structure, which at a later stage begins to change to the equilibrium  $\gamma$ structure. The  $\gamma'$  and  $\gamma$  structures are both close-packed hexagonal, and are oriented alike; they differ only in interatomic distances. Microscopic examination shows that the  $\gamma'$  to  $\gamma$  transformation is accompanied by a discontinuous type of reaction nucleated at the grain boundaries, which probably involves the recrystallization of the strained matrix. Measurements of hardness and electrical resistivity were also made. Hardening is caused by the precipitation of  $\gamma'$  and the stresses in the matrix involved in keeping the  $\gamma$  phase in this strained  $\gamma'$  condition, and the electrical resistance is also regarded as affected by these stresses. The general problem of ageing is discussed .-- W. H.-R.

\*Mechanism of Precipitation from Solid Solutions of Zinc in Aluminium, Magnesium in Aluminium, and of Some Magnesium-Base Alloys. Lattice Spacings of Mg<sub>2</sub>Pb and Mg<sub>2</sub>Sn.] A. H. Geisler, C. S. Barrett, and R. F. Mehl (*Metals Technology*, 1943, 10, (2); *A.I.M.M.E. Tech. Publ.* No. 1558, 22 pp.; and Trans. Amer. Inst. Min. Met. Eng., 1943, 152, 201-223; discussion, 223-225) .-- X-ray, microscopic, and hardness-test methods were used to investigate the precipitation of zinc from aluminium-zinc alloys containing 12 and 25% zinc. Coherent platelets form parallel to octahedral matrix planes in the early stages of precipitation, but they break away from the matrix before they are thick enough to diffract as 3-dimensional gratings. Agehardening occurs during the formation and growth of the coherent platelets, but softening occurs when the non-coherent zinc structure appears. Similar

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investigations were made with aluminium-magnesium alloys containing 10 and 14% magnesium; coherent platelets form on (100) matrix planes, followed by growth to a well-defined Widmanstätten figure with plates on (100), and later on (120) matrix planes. Age-hardening takes place throughout the entire decomposition. The precipitation of Mg<sub>2</sub>Sn and Mg<sub>2</sub>Pb from magnesium-tin and magnesium-lead alloys was studied; coherent platelets may form, but if so they do not grow very large. The lattice spacings of the precipitated Mg<sub>2</sub>Sn and Mg<sub>2</sub>Pb were 6.744 A. and 6.836 A., respectively.

-W. H.-R.

\*Some Observations on the Age-Hardening of Aluminium Alloys Containing Zinc. W. Feldmann (Metallwirtschaft, 1941, 20, (20), 501-504).-Although it has long been known that aluminium alloys containing magnesium and zinc are capable of giving excellent mechanical properties when heat-treated, their commercial development has been hindered by their liability to stress-corrosion. It is now known that this liability can be removed by suitable heat-treatment. A study was therefore made of the age-hardening of an alloy containing zinc 4, magnesium 2, manganese 1% in sheet form. Samples were solution-treated for 2 hrs. at temperatures in the range 380°-500° C., quenched in cold water, and then aged for periods up to 81 days at room temperature and at temperatures in the range  $75^{\circ}$ -160° C. With ageing temperatures below 100° C., there was a general increase of hardness with time; with higher temperatures the hardness rose to a maximum and then decreased. Greatest hardness was obtained with a solution temperature of 500° C., Brinell numbers up to 120-130 being reached (9 days ageing at 140° C.). Proof-stress values up to 19 tons and ultimate stress up to 25 tons with 13% elongation were recorded. Ageing at room temperature followed by ageing at elevated temperatures resulted in maximum hardness being reached more quickly. After ageing at elevated temperatures, some ageing at room temperature occurred but was not pronounced. Lowering the solution temperature made the ageing slower, and lower hardness values resulted; for every quenching temperature there is an ageing temperature below which no hardening occurs. A study was also made of the hardening of a binary alloy of aluminium with 7% zinc at temperatures in the range  $-71^{\circ}$  C. to  $100^{\circ}$  C. Age-hardening was quite appreciable at  $0^{\circ}$  C. and was more rapid at lower temperatures.-H. W. L. P.

\*On the Conditions of Formation and the Habit of Segregates Formed on Ageing Aluminium Alloys Containing Zinc, Copper, and Magnesium. H. Röhrig and J. Roch (Metallwirtschaft, 1941, 20, (16), 383-386).-Studies were made of the early stages of precipitation in aluminium-base alloys containing copper 0.7, magnesium 0.5%, with zinc content varying between 0 and 15%. Cast samples were given a solution-treatment of 18 hrs. at 540° C. and were then hot-rolled; they were then re-treated for 24 hrs. at 540° C., quenched in cold water, and given precipitation-treatments for various periods of time at temperatures from 250° C. upwards. The resulting microstructures are described in detail, and several typical micrographs are reproduced. Precipitation commences at the grain boundaries and later appears in the body of the crystals; there is frequently a zone, comparatively free from precipitate, adjacent to the boundaries. Appreciable precipitate appears after 2 hrs. at  $250^{\circ}$  C., and the particles increase in size and number with time. They tend to appear as small needles oriented in specific directions, and tend to be smaller and more rounded with higher zinc contents. They are larger, the higher the temperature. The Brinell hardness increases with zinc content, more rapidly the higher the temperature. The ultimate tensile stress shows a well-defined minimum at  $250^{\circ}$  C.—H. W. L. P.

The System Aluminium-Zinc. O. Tiedemann (Z. physikal. Chem., 1942, [A], 191, 133-144; Brit. Chem. Abs., 1943, [A I], 59).—The work of Röhrig and Roch and of Feldmann (abstracts above) is discussed, and is shown to support the existence of a metastable region of aluminium-zinc alloys with up to 29% zinc.

\*On the Effect of Iron on the Age-Hardening of Wrought Aluminium-Copper-Magnesium Alloys. K. L. Dreyer and H. J. Seemann (*Metallwirtschaft*, 1941, 20, (25), 625–629).—A study was made of the age-hardening of a Duralumin-type alloy with additions of iron in the range 0.3-1.3%. Samples in the form of 2-mm. sheets were given a solution-treatment at various temperatures in the range  $480^\circ-540^\circ$  C., quenched in water, and tested after ageing at room temperature for periods up to 12 days. The results are given in graphical form, and show that the mechanical properties decrease with iron contents in excess of 0.5%. The rate of age-hardening decreases with increasing iron content; improvement resulting from increasing the solution temperature becomes less pronounced. Conductivity measurements taken at intervals during ageing show that specific resistance is lowered with increasing iron content—in other words, that the iron is removing copper from solid solution.—H. W. L. P.

\*The Prevention of Coarse Grain Growth in Aluminium [Alloy] Sheets for Deep Drawing. A. Schroeder and K. Matthaes (Metallwirtschaft, 1941, 20, (25), 631-636).—After preliminary experiments with tapered test-pieces, series of tests were made on the recrystallization of a clad Duralumin-type alloy during solution-treatment. In general, specimens were rolled or stretched by amounts varying between 0 and 30%, treated at 500° C., re-rolled or stretched, and re-treated at 500° C. Additional experiments were made on selected samples of very coarse- and very fine-grained material after the initial treatment. Special attention was paid to finding the critical lower limit of prior strain at which maximum grain growth took place and below which recrystallization did not occur. Final grain-size was found to depend primarily on the degree of prior deformation, initial grain-size and mode of deformation being relatively unimportant. The strain corresponding with the critical lower limit is greater, the larger the original grain, and the higher the critical limit, the coarser the corresponding grain. Curves are given showing final grain-size and critical limit as functions of the original grainsize ; their point of intersection gives the original grain-size for which no grain growth occurs on re-treatment. By selecting the initial treatment so as to give this grain-size, the problem of subsequent exaggerated grain-size is eliminated.—H. W. L. P.

\*Some Effects of Temperature on a High-Strength Aluminium Alloy. A. G. H. Damerell (*Metal Treatment*, 1943, 10, (35), 139–145).—The effects of ageing Hiduminium R.R. 59 (copper 2.2, magnesium 1.5, silicon 1.0, iron 1.0, nickel 1.0, titanium 0.5%, aluminium balance) at  $100^\circ$ ,  $150^\circ$ ,  $170^\circ$ ,  $200^\circ$ ,  $225^\circ$ , and  $250^\circ$  C. on the Brinell hardness, 0.1% proof stress, and ultimate stress are shown in a series of curves. The normal heat-treatment is for 15-20hrs. at  $170^\circ$  C. or 10 hrs. at  $200^\circ$  C., and produces the best combination of properties. After this treatment, the alloy is likely to be best able to retain its properties in service at high temperatures. Curves are given showing the effect on the Brinell hardness of heating fully aged and fully annealed specimens for 1-200 hrs. at temperatures are also recorded. Fully heat-treated material remains appreciably stronger than annealed material even after 200 hrs. at  $250^\circ$  C. ; but above  $300^\circ$  C. the effect of heat-treatment is largely transient.—J. C. C.

Refrigerating Aluminium Alloy Rivets and Parts. (Fletcher.) See p. 30. \*On the Creep Strength of Dural Sheet Rivets. E. Hottenrott (*Luftfahrt-forschung*, 1940, 17, 247–249; *Chem. Zentr.*, 1940, 111, (II), 3400).—H. reports investigations carried out on the creep strength of Dural-riveted joints of 6 different kinds. The determining factors for the explanation of differences in the creep strength values are recapitulated. The general importance of these preliminary experiments is briefly dealt with.

\*The Electrical Conductivity and Isothermal Hall Effect in Cuprous Oxide. William Feldman (*Phys. Rev.*, 1943, [ii], **64**, (3/4), 113–118).—The electrical conductivity and isothermal Hall effect in cuprous oxide were studied at temperatures up to 700° C. At the higher temperatures the conductivity may be represented by an equation of the type  $\sigma = Ae^{-\epsilon lkT}$ , where *T* is the absolute temperature, but this law is not obeyed below 300° C. There is no evidence that any intrinsic conductivity exists in cuprous oxide. The variation of the Hall coeff. with temperature suggests that *n*, the number of carriers, cannot be represented by a relation of the type  $n = n_0 \exp.(-\epsilon/kT)$ . There is no evidence for a change in sign of the Hall coeff. The general theory of semi-conductors is discussed; the simple theory requires considerable extension to explain the data.—W. H.-R.

\*The Hardness of Certain Primary Copper Solid Solutions. J. H. Frye, Jr., and J. W. Caum (Metals Technology, 1943, 10, (2); A.I.M.M.E. Tech. Publ. No. 1554, 8 pp.; and Trans. Amer. Inst. Min. Met. Eng., 1943, 152, 75–82).— The hardness of primary solid solutions of zinc, gallium, germanium, and arsenic in copper was studied for alloys containing up to 5·1 atomic-% of solute. Meyer analyses were made, and the values of the Meyer constants a and n are tabulated. The relation between lattice distortion and increase in hardness is discussed. If comparison is made between alloys containing equi-atomic percentages of solute, there is a roughly linear relation between the increase in the ultimate Meyer hardness number and the increase in lattice spacing, but no simple relation exists between lattice distortion and increase in hardness when alloys having different proportions of solute atoms are compared.—W. H.-R.

\*Stress-Relief Annealing of Cold-Worked, Hardenable Copper Alloys. J. Wortmann (Metallwirtschaft, 1941, 20, (21), 531-536).—Copper-base alloys containing (a) nickel 0.5, silicon 0.25%, (b) iron 0.8, silicon 0.4, aluminium 0.05%, or (c) tin 1, iron 0.15, manganese 0.2, phosphorus 0.1%, are usually hardened by annealing for 2 hrs. at  $860^\circ-900^\circ$  C., quenching, cold-working, and ageing at 400° C., whereby despite the removal of work-hardness, the strength and hardness remain practically unchanged owing to precipitation effects. Softening, however, occurs when the hardened alloys are kept at 400° C. for prolonged periods, e.g., the Brinell hardness, which is (a) 105, (b) 107, and (c) 135 immediately after ageing, falls to (a) 74, (b) 98 and (c) 70 after 120 hrs. at 400° C. This softening can be avoided by reducing the homogenizing temperature to 550°-700° C. and prolonging the time of homogenizing. For example, after heating for 24 hrs. at 700° C, quenching, cold-working to 50% reduction, and tempering at 400° C, the Brinell hardness of (a) rises to 121 in 24 hrs., and only slowly decreases after 264 hrs., reaching 102 after 1512 hrs.; the corresponding figures for (b) are 128 and 110, and for (c) 107 and 90. After 1512 hrs. at  $400^{\circ}$  C., the tensile strength of (a) is 35.7, of (b) 39.4, and of (c) 31.4 kg./mm.<sup>2</sup>, the corresponding elongations being 24, 18, and 38%. Very much lower values for tensile strength and hardness are obtained if the cold-working step is omitted.—A. R. P.

**Cartridge Brass : an Elementary Introduction.** L. E. Gibbs (*Metal Progress*, 1943, 43, (6), 897–900).—The physical properties of cartridge (70:30) brass, a single-phase  $\alpha$ -alloy, can be modified only by cold-working or annealing, the extent and effects of which are closely interrelated. The various "temper designations" of brass strip (quarter-hard, half-hard, &c.) are tabulated with the corresponding nominal reduction in the B. and S. system, and with the approximate percentage reduction for (a) sheet and strip and (b) rod and round shapes. The gauge system is explained. Annealed material is classified

according to grain-size; comparison charts at a standard magnification have been made available by the American Society for Testing Materials. A chart correlating tensile strength, elongation, grain-size, and copper content shows that the optimum relationship between ductility and tensile strength is attained in the 70:30 region; the specification limits are usually 68.5-71.5%copper. The effects of cold-working and annealing on the hardness, tensile strength, elongation, and apparent elastic limit of cartridge brass are shown graphically .-- P. R.

\*Effect of Antimony on Some Properties of 70:30 Brass. Daniel R. Hull, H. F. Silliman, and Earl W. Palmer (Metals Technology, 1943, 10, (2); A.I.M.M.E. Tech. Publ. No. 1552, 11 pp.; and Trans. Amer. Inst. Min. Met. Eng., 1943, 152, 127-137; discussion, 137-143).-Tests on the effect of antimony on the rolling properties of 70:30 brass were made on a laboratory scale, and then under full-scale commercial conditions. Both hot- and coldrolling properties were examined, and impact tests were also carried out. Antimony affects the impact strength of 70:30 brass, and under some conditions this is shown by lengthwise splitting of cold-rolling bars, by edge cracking, and by a brittle shear fracture. Impairment of impact strength in cast brass is measurable at 0.01% antimony; at about this concentration the effect is apparent in rolling, and 70:30 brass cannot be cold-rolled with 0.10% antimony. The presence of lead in amounts appreciably less than 0.10% greatly accentuates the effect of antimony. Fired small-arms cartridge cases, when melted, may yield castings containing about 0.007% antimony and 0.07% lead, and the difficulties of using this kind of scrap are discussed; cold work followed by annealing improves the impact strength of such material. The paper is followed by a lengthy and interesting discussion.

-W. H.-R. Max Petersen \*X-Ray Line Broadening by Cold-Working Alpha Brass. and C. W. Tucker (Phys. Rev., 1943, [ii], 63, (9/10), 385).-According to Niemann and Stephenson (Phys. Rev., 1942, 62, 330) the broadening of X-ray diffraction lines from cold-worked alpha brass is enhanced by speed of working, although the internal friction introduced by cold-working is not. Experiments were made by P. and T. with annealed cartridge brass extended at different rates, including slow stretching, and extension by a falling weight at a speed of 30 ft./second. The X-ray back-reflection photographs showed no significant differences in line broadening, and the supposed disparity between internal friction and line-broadening is not confirmed.-W. H.-R.

\*Investigations of Ferromagnetic Impurities. II.-[In Copper, Brass, and Silver.] (Constant, Faires, and Lenander.) See p. 1.

Special Brasses. H. E. Arblaster (Australasian Eng., 1943, 43, (324), 16-16b, 45-48).-A survey of the compositions and physical and mechanical properties of special brasses, prepared by the addition-separately or in various combinations-of iron, silver, phosphorus, tin, manganese, aluminium, nickel, silicon, and lead to copper-zinc alloy " parent brasses." The effect of the different additions is discussed. Silver solders are included in the survey. -E. A.

Leaded Brasses. Robert S. Burpo, Jr. (Metals and Alloys, 1943, 17, (6), 1215).—A tabular digest of U.S.A. specifications.—J. C. C.

\*Experiments on the Substitution of Nickel for Tin in Tin Bronzes and Red Brass. A. H. Hesse and J. L. Basil (Amer. Foundryman, 1943, 5, (8), 2-4).-H. and B. report that the substitution of nickel for tin in alloy G (copper 88, tin 9, zinc 3%) results in a decrease in the amount of intercrystalline shrinkage. In the cases of alloy M (copper 88, tin 6.5, zinc 4, lead 1.5%) and red brass (copper 85, tin 5, zinc 5, lead 5%), the intercrystalline shrinkage is little affected by nickel substitution. Physical properties are not materially changed by replacements of less than 7.5% tin by nickel. Corrosion tests conducted in still river water showed no variation in the corrosion rate of

conducted in still river water showed no variation in the corrosion rate of modified G and M alloys, although a slight increase was noted in the corrosion rate of red brass in which 2.5% tin had been replaced by nickel. With moving river water, fairly rapid corrosion rates were noted in all three alloys when modified by addition of nickel.—J. E. G.

\*Magnetic Properties of Solid Solutions. III.—The Paramagnetic Alloys of Copper and Nickel. A. R. Kaufmann and C. Starr (*Phys. Rev.*, 1943, [ii], 63, (11/12), 445–450).—Cf. *ibid.*, 1941, 60, 134; *Met. Abs.*, 1942, 9, 40. The susceptibilities of copper-nickel alloys containing 0–50% nickel by weight have been measured at temperatures between 14° and 1300° K. An equation of the Curie–Weiss type does not represent the results, and an empirical equation of the type  $\chi = aT + b + (c/T)$  is found to be satisfactory. The variations of the constants in this equation for the different alloys are discussed from the viewpoint of modern theory. Alloys in the range 30–38% nickel show a considerable field dependence of the susceptibility at low temperatures. —W. H.-R.

\*An X-Ray Study of the Dissociation of an Alloy of Copper, Iron, and Nickel. Vera Daniel and H. Lipson (*Proc. Roy. Soc.*, 1943, [A], **181**, (987), 368–378).— The alloy  $Cu_4FeNi_3$  is single phase (face-centred cubic) above about 800° C., and at lower temperatures its equilibrium condition consists of two phases of similar structure. A specimen was heat-treated at 650° C. for 1 hr., and an X-ray powder photograph then showed sharp diffraction lines, each surrounded by two slightly diffuse, but quite strong, side bands. These are interpreted as indicating that there is a modulation in the structure, which is parallel to the cube planes, the period of the modulation being about 50 unit cells. The modulation is presumably due to the segregation of the different kinds of atoms, and the periodic structure may be the first step in the dissociation into two phases. The theory of periodic variations in a lattice is examined, but does not yet account completely for all the experimental data. —W. H.-R.

\*On Binary Systems with Germanium. II.—Germanium-Arsenic, Germanium-Antimony, Germanium-Bismuth. Herbert Stöhr and Wilhelm Klemm (Z. anorg. Chem., 1940, 244, 205-223; Chem. Zentr., 1940, 111, (II), 3602).-Cf. ibid., 1939, 241, 305; Met. Abs., 1939, 6, 354.-The systems germaniumarsenic, germanium-antimony, and germanium-bismuth have been investigated. (1) In the system germanium-arsenic two compounds, GeAs and GeAs<sub>2</sub>, appear with wide ranges of homogeneity. Both the melting-point maxima, at 732° and 737° C, are very flat. The solubility of the germanium in arsenic at 685° C. is  $16 \pm 1$  atomic-%; the limit of solubility of arsenic in germanium is ~3%. The  $\alpha$ -solid-solution field is followed by a heterogeneous region extending up to about 23 atomic-% germanium. This is followed, up to 59%, by the homogeneous fields of the phases GeAs<sub>2</sub> and GeAs, without a detectable two-phase region. Next comes a heterogeneous region up to 97% germanium. There is a further small region of solubility on the germanium side. While the hexagonal lattice constants of arsenic are : a = 3.754and c = 10.52 A., the constants of the saturated  $\alpha$  solid solution were found to be : a = 3.701 and c = 10.71 A. Hence the expansion of the lattice takes place in the direction of the c-axis. Arsenic is practically without effect on the lattice constants of germanium. Magnetic measurements show that the diamagnetism of both metals is considerably increased by the presence of the other. (2) The systems germanium-antimony and germanium-bismuth are quite simple, being both eutectic systems with low solubility in the solid state. X-ray investigations show that the solubility of germanium in antimony lies between 2.2 and 4.6 atomic-%, and that of antimony in germanium between 2.5 and 3.9 atomic-%. The lattice constants of antimony are :

a = 4.296 and c = 11.24 A., and those of the solid solution saturated with germanium are: a = 4.266 and c = 11.30 A. The lattice constants of the solid solution of antimony in germanium remain unchanged within the limits of error, although the density is increased markedly. Magnetic measurements show that the magnetism of germanium is only slightly changed by the presence of the antimony. On the other hand, the magnetism of antimony is strongly affected by the solution of germanium. The antimony exhibits an abnormally great diamagnetism; the saturated solid solution is, however, slightly paramagnetic. (3) In the system germanium-bismuth, the eutectic temperature is  $271^{\circ}$  C., and the eutectic composition practically at 100% bismuth. The solubility regions are small on both sides. The solubilities, determined by X-ray analysis, are : germanium in bismuth  $\leq 1.5$  atomic-%, and bismuth in germanium  $\leq 2$  atomic-%.

\*A Magnetic Study of the Two-Phase Iron-Nickel Alloys.—II. K. Hoselitz and W. Sucksmith (*Proc. Roy. Soc.*, 1943, [A], **181**, (986), 303–313).—Cf. Sucksmith, *Proc. Roy. Soc.*, 1939, [A], **170**, 551; *Met Abs.*, 1940, **7**, 365. The method of using measurements of magnetic saturation intensity to determine equilibrium phase boundaries is extended, and is used to determine the  $\alpha/\alpha + \gamma$ and  $\alpha + \gamma/\gamma$  boundaries in iron-nickel alloys containing up to 34 atomic-% nickel. The method is suitable for the study of phase segregation, and the results show that when  $\gamma$  crystallizes from  $\alpha$ ,  $\gamma$  of equilibrium composition is formed, whilst the  $\alpha$  continuously changes composition until equilibrium is finally reached. The speed of approach to equilibrium is assumed to be proportional to the difference between the composition of the uniformly changing  $\alpha$  phase from its equilibrium composition, as in radio-active decay. The heat of activation is of the order of 34,000 cal./mol. At 325° and 300° C. the " halfvalue" times would be about 10 years and 40 years, respectively, so that there is a lower practical limit of temperature in the study of these alloys.

-W. H.-R.

\*Diffusion Rates of Carbon in Iron-Molybdenum and Iron-Tungsten Alloys. R. Smoluchowski (*Phys. Rev.*, 1943, [ii], **63**, (11/12), 438-440).—Experiments on the diffusion of carbon in iron-tungsten and iron-molybdenum alloys at 1000° C. are described. Both elements retard the diffusion of carbon, the effect of tungsten being about twice that of molybdenum at equivalent atomic percentages. This is in contrast to the behaviour of cobalt, which accelerates the diffusion of carbon in iron (*Phys. Rev.*, 1942, **62**, 539; *Met. Abs.*, 1943, **10**, 106).—W. H.-R.

\*The Diffusion of Air Through Monel Metal. H. S. Coleman and H. L. Yeagley (J. Chem. Physics, 1943, 11, (3), 135–139).—The diffusion of the gases of the atmosphere through the walls of a Monel metal tube (nickel 69·70, copper 28·00, iron 2·57, and carbon 0·1%) was measured. The rate of diffusion shows a marked discontinuity at about 900° C., and dilatometric observations confirm the existence of some physical change at that temperature. This physical change may be associated with the formation of a solid solution, NiO–Ni, or the occurrence of an order-disorder transformation. The gases diffuse in the atomic form and leave the inside surface of the tube as diatomic molecules.—S. J. K.

The Effect of Low Temperatures on the Mechanical Properties of Monel Metal. N. G. Neuweiler (Schweiz. techn. Z., 1940, 479–483; Chem. Zentr., 1940, 111, (II), 3400).—N. discusses the effect of low temperatures on the mechanical properties of industrially important alloys of the Monel-metal type, with reference to the experimental results of various investigators. Evidence is presented that the most important mechanical properties of Monel metal remain practically unchanged or even improve at temperatures down to the temperature of liquid air. Contribution to the Evaluation of Bearing Metals on the Basis of the Results of Tests and Their Constructive Interpretation. O. Hummel (Metallwirtschaft, 1941, 20, (22), 559-563).—In lubricated bearings the frictional resistance can be calculated by the expression  $W = z \cdot fv/d$ , where z is the absolute viscosity of the lubricant, f is the area of the lubricated surface, v is the speed of the moving part, and d is the thickness of the lubricant film. Since the determination of z under practical bearing conditions presents considerable difficulties, it is suggested that the behaviour of bearing metals can be better represented from a practical point of view by a v-p-t (speed–load–temperature) characteristic which can be represented diagrammatically. Methods of determining and evaluating these diagrams are discussed at some length.

-A. R. P.

On the Volume Changes of Alloys in the Heterogeneous Liquid-Solid Range. —I. F. Sauerwald (*Metallwirtschaft*, 1941, 20, (17), 405–408).—The volume changes which occur while an alloy is cooling through the temperature range between the liquidus and solidus depend on the volumes of the liquid and solid phases and the changes that take place in these due to temperature and concentration variations which may be deduced from the volume isotherms and the equilibrium diagram. This is illustrated by examples taken from the iron-carbon, copper-zinc, copper-tin, and copper-aluminium systems.

-A. R. P.

Lattice Constants, Atomic Radii, and Valency Electron Concentrations. H. Perlitz (*Metallwirtschaft*, 1941, 20, (22), 555–557).—A lecture on the Hume-Rothery rule and its implications.—A. R. P.

[Contribution] to the Theory of Solid Solutions. I.—Correlation in Solid Solutions. II.—X-Ray Scattering by Solid Solutions. I. Livshits (Zhur. Eksper. i Teoret. Fiziki (J. Exper. Theoret. Physics), 1939, 9, 481–499, 500– 511; Chem. Zentr., 1940, 111, (II), 3307).—[In Russian.] [I.—] The correlation between the arrangement of the various atoms in the lattice of a solid solution may be defined by a "correlation parameter" which can either be calculated from the free energy of the solid solution, or else determined on the basis of abstract considerations of probability. In the case of a three-dimensional lattice, only an approx. determination is possible, which is, however, equivalent to Kirkwood's approximation in the calculation of the free energy. The resulting expression for the free energy of solid solutions may be used for the determination of the curve of Curie points in the c, T diagram, the decomposition curve of the solid solution, the changes in specific heat, &c. [II.—] On the basis of the results of [I], the intensity of the scattered lines for the linear case has been calculated first without and then with reference to lattice distortion. The calculations were then extended to the three-dimensional lattice. Equations were derived for the maximum and the width of the Bragg lines.

[Contribution] to the Theory of the Decomposition of Binary Alloys. B. N. Finkelstein (Zhur. Eksper. i Teoret. Fiziki (J. Exper. Theoret. Physics), 1940, 10, 341-345; Chem. Zentr., 1940, 111, (II), 3307).—[In Russian.] In continuation of recent investigations of Becker (Ann. Physik, 1938, 32, 128; Met. Abs., 1938, 5, 539), and Livshits (cf. abstracts above) equations were derived for the change of the free energy  $\Delta F$ , the linear dimensions  $L_0$  of the nuclei present in equilibrium, and their work of formation A.

\*The Propagation of Order in Crystal Lattices. J. Ashkin and W. E. Lamb, Jr. (*Phys. Rev.*, 1943, [ii], **64**, (5/6), 159–178).—Theoretical. Part I gives an outline of the general matrix theory in three dimensions applied to the problem of the propagation of order in a binary crystal alloy, and shows that states of long-range order are not possible over a range of temperatures unless the maximum characteristic value of the associated matrix is degenerate over this same range. Part II discusses the propagation problem in two-dimensional crystals. The approximation of Zernike (*Physica*, 1940, 7, 565; *Met. Abs.*, 1941, 8, 226) is better for a two- than for a three-dimensional crystal.

-W. H.-R.

\*Statistics of Two-Dimensional Lattices with Four Components. J. Ashkin and E. Teller (*Phys. Rev.*, 1943, [ii], 64, (5/6), 178–184).—Theoretical. Statistical methods are used to investigate a two-dimensional square lattice consisting of four kinds of atoms, subject to the simplifying assumptions that only nearest neighbours interact, and that there are only two distinct potential energies of interaction, one between like, and the other between unlike atoms. The partition functions are obtained in two forms, and predictions can be made regarding the nature of the transition point from order to disorder.

-W. H.-R.

\*Some Remarks on the Statistics of Binary Systems. Gregory H. Wannier (*Proc. Roy. Soc.*, 1943, [A], **181**, (987), 409–411).—A discussion of results obtained by Fuchs (*Proc. Roy. Soc.*, 1942, [A], **179**, 340; *Met. Abs.*, 1942, **9**, 244).—The method used should and does partly cover both the two-phase system and the case of superstructure. The quantitative results must be accepted with caution, as the method contains important errors of both type and magnitude.—W. H.-R.

On the Statistics of Binary Systems. Klaus Fuchs (*Proc. Roy. Soc.*, 1943, [A], 181, (987), 411–415).—A reply to the criticisms of Wannier (abstract above).—W. H.-R.

## III.—STRUCTURE

#### (Metallography; Macrography; Crystal Structure.)

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

Hints for Polishing and Etching, with Special Reference to Soft Metals. [Solubility of Sodium in Lead.] E. Schulz (*Metallwirtschaft*, 1941, 20, (17), 418-424).—Methods of polishing and etching aluminium, lead, and their alloys to reveal the macro- and micro-structure are briefly described, and characteristic micrographs of annealed and aged structures are reproduced. Micrographic examination of sodium-lead alloys shows that the limiting solid solubility of sodium in lead at room temperature does not exceed 0.2%, whereas resistance measurements indicate a limit of over 0.4%.—A. R. P.

\*Electrolytic Polishing of Copper. W. Engelhardt (*Metallwirtschaft*, 1941, 20, (15), 349–356).—Recent work on the electrolytic polishing of copper is critically reviewed on the basis of the results obtained by E. in a repetition of the work of Jacquet, Elmore, and Benedicks and Ljunggren; an explanation is also offered of the phenomena observed in Jacquet's process. The effects ascribed by B. and L. (*Korrosion u. Metallschutz*, 1940, 16, 17; *Met. Abs.*, 1940, 7, 291) to the presence of oxide inclusions are shown to occur also with deoxidized copper under certain conditions; E. considers them to be due to disturbances set up by adherent gas bubbles. Some commercial uses for electrolytic polishing of copper are suggested.—A. R. P.

Surface Replicas Containing Dye for Use in the Light Microscope. Vincent J. Schaefer (*Metal Progress*, 1943, 44, (1), 72–73; also (abridged) *Met. Ind.*, 1943, 63, (20), 312–313).—References are given to accounts of the early use of transparent replicas in the microscopic study of surfaces. The method has recently been developed for use in conjunction with both the electron microscope and the ordinary microscope : a transparent synthetic resin is allowed to flow on to the prepared surface, and later removed by transparent adhesive tape, which is closely pressed into the resin during solidification.

By dissolving a dye in the resin before use, the variations in the thickness of the resin film, and hence in the depth of attack by the etching reagent, are automatically reproduced in a photograph taken by transmitted light. The technique adopted is described, and examples are illustrated.—P. R.

The Significance of the Etch Figures on the Crystal Faces of Aluminium. I. N. Stranski (*Ber. deut. chem. Ges.*, 1942, [A], 75, 105–113; *C. Abs.*, 1943, 37, 3314).—A lecture. Cf. Mahl and Stranski, *Z. physikal. Chem.*, 1942, [B], 51, 319; *Met. Abs.*, 1943, 10, 141.

\*The Structure of Electrodeposited Chromium. William Hume-Rothery and Malcolm R. J. Wyllie (Proc. Roy. Soc., 1943, [A], 181, (987), 331-344).-The visual appearance and crystal orientation of electrodeposited chromium were studied for deposits prepared at current densities from 50 to 3000 amp./ft.<sup>2</sup>, and temperatures from 12° to 85° C., using a standard chromic acid bath containing 250 grm.  $CrO_3$  per litre, and a ratio of  $CrO_3$  to sulphate ion of 100:1. Some measurements were also made at 95° C. The brightest deposits have a (111) preferred orientation, and are confined to a definite range of temperature and current density. With increasing variation of the conditions of deposition (temperature or current density) from those characteristic of the brightest deposits, two effects are produced : (a) an increasing proportion of particles of random orientation are present, and (b) the perfection of alignment of the particles of preferred orientation becomes less. The hardness of electrodeposited chromium has been measured for deposits prepared over the range  $25^{\circ}$ –90° C. at current densities of 500, 1000, 1750 amp./ft.<sup>2</sup>. The brightest deposits have the greatest hardness, and this maximum hardness is the same for all three current densities, although the temperatures of deposition at which the maximum occurs is different. The residual stress present in electrodeposited chromium has been measured by the method of Stoney (Proc. Roy. Soc., 1909, [A], 82, 172), and is as high as 27 tons/in.<sup>2</sup> for some of the deposits, but is almost zero for the bright deposits. [Note by Abstractor: The equation of Stoney for the residual stress used by H.-R. and W. appears to be in error by a factor of 4, and the ordinates in Fig. 5 of their paper should be divided by 4; this has been done in giving the value 27 tons/in.<sup>2</sup> above.] -W. H.-R.

\*X-Ray Studies of Electrodeposits of Copper. (Maitak.) See p. 19.

\*Preliminary Spectrographic and Metallographic Study of Native Gold. Welton J. Crook (Metals Technology, 1943, 10, (2); and Trans. Amer. Inst. Min. Met. Eng., 1943, 152, 255–268).—Specimens of native gold from different sources were analysed spectrographically, and etched sections were examined microscopically. All the specimens contained copper, silver, and iron. The copper and silver are probably present as a definite alloy with the gold, whilst the iron is thought to be present in the form of iron sulphide or as oxide inclusions. There is some evidence that placer nuggets from "new" deposits show strain lines, whilst those from "old" deposits do not, thus suggesting. that recrystallization occurs over long periods of time.—W. H.-R.

\*The Structure of Liquid Mercury. J. A. Campbell and J. H. Hildebrand (J. Chem. Physics, 1943, 11, (7), 330–333).—The structure of liquid mercury at  $-38^{\circ}$ ,  $0^{\circ}$ ,  $50^{\circ}$ ,  $100^{\circ}$ ,  $150^{\circ}$ , and  $200^{\circ}$  C. was examined by means of the diffraction of monochromatic molybdenum  $K_a$  X-radiation. The first and second main peaks, at  $3 \cdot 0$  and  $5 \cdot 7$  A., respectively, remain constant in position, but become lower and broader as the temperature is raised, whilst small peaks in the neighbourhood of 4 and 7 A. not only broaden but shift rapidly and finally disappear. The number of atoms in the first co-ordination layer varies between 6.0 and 5.3.—S. J. K.

\*The Reflection of X-Rays from the "Anti-Phase Nuclei" of AuCu<sub>3</sub>. A. J. C. Wilson (*Proc. Roy. Soc.*, 1943, [A], **181**, (987), 360–368).—Jones and Sykes (*Proc. Roy. Soc.*, 1938, [A], **166**, 376; *Met. Abs.*, 1938, **5**, 485) have

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shown that the superlattice lines in X-ray photographs of  $AuCu_3$  are not always as sharp as the main lines, and that the broadening depends on the indices of the line. This is the result of the existence of "anti-phase nuclei," in which the superlattice is organized in different ways. The theory of the subject is developed, and detailed calculations are made of the broadening to be expected from five different ways in which the nuclei can "change step." None of the models assumed explains all the facts, but the best agreement is obtained by assuming that the changing step occurs so that gold atoms avoid each other.—W. H.-R.

**Crystallography for Routine Analysis.** C. H. Walker (*Metropolitan-Vickers Gaz.*, 1943, 20, (340), 167–173).—The principles and method of obtaining X-ray diffraction patterns, and some of the applications of crystal analysis in routine testing, are discussed. The production of X-rays and of X-ray patterns with the powder camera and the universal camera, is described and illustrated.—E. A.

## V.—POWDER METALLURGY

On the Historical Development of Sintered Hard Metals. F. Skaupy (Metallwirtschaft, 1943, 20, (21), 537–538).—A review of the patent literature. —A. R. P.

\*The Micro-Hardness Tester—a New Tool in Powder Metallurgy. (Steinitz.) See p. 25.

\*Ĉopper-Lead Bearings by Powder Metallurgy. W. D. Jones (Metallurgia, 1943, 28, (168), 255-260).—Three powder compositions, containing 16-5, 25-5, and 36-5% of lead and having extremely good cold-pressing properties, were examined. Percentage solidities in excess of 80% were obtainable without the addition of lubricants, with compacting pressures as low as 5 tons/in.<sup>2</sup>. Practically non-porous bearing metals were obtained, using these powders, by employing pressures of the order of 5 tons/in.<sup>2</sup>, sintering temperatures over the range  $650^{\circ}$ - $850^{\circ}$  C., and coining pressures of 10 tons/in.<sup>2</sup>. The treatments desirable in order to obtain porous alloys which could be oil-impregnated if desired, were also investigated; and similar results were obtained with copper-tin-lead alloy powders. No difficulties were experienced in bonding the alloys by conventional methods to a steel backing.—J. W. D.

## VI.—CORROSION AND RELATED PHENOMENA

\*The Behaviour of Compound Parts Made from Cast Iron and Silumin in Artificial Sea-Water and in Salt Solution. G. Schikorr and K. Alex (*MetaW-wirtschaft*, 1940, **19**, 777–779; *Chem. Zentr.*, 1940, **111**, (II), 3261).—Experimental evidence is provided which shows that: (1) Silumin is "nobler" than cast iron in sea-water and less noble in 3% salt solution; (2) in compound pieces the less-noble metal is accordingly more attacked, and—at its expense—the "nobler" more protected; (3) consequently corrosion tests of aluminium alloys carried out in salt solution instead of in artificial sea-water may give results exactly opposite to those obtained in sea-water in practice.

\*On the Action of Ozone on Powdered Metals. [Gold and Lead.] Heinz Schütza and Irmgard Schütza (Z. anorg. Chem., 1940, 245, (1), 59-66; Chem. Zentr., 1940, 111, (II), 3165).—Compact gold and lead were atomized by H.-F. sparks in oxygen containing ozone. Gold yielded a brown-black oxidation product which gave up ozone on heating to  $160^{\circ}-200^{\circ}$  C. The analysis of the product, stored in a desiccator over sulphuric acid, showed the following composition : metallic gold 58.9,  $Au_2O_3$  (determined by conversion with oxalic acid) 36.1, ozone 2.2, and water 2.5%. Thus, the ozone must be either absorbed exceptionally strongly, or evolved by decomposition of a higher oxide. No light could be thrown on this question by either radiographic or magnetic investigations. Lead yields a brown oxidation product, consisting mainly of PbO<sub>2</sub> and of some lower oxides, and giving up 4% ozone on heating. Care has to be taken regarding the purity of the oxygen used, which must be especially free of nitrogen, as the nitrogen oxides formed would accumulate in the atomized products. The pure oxides  $Au_2O_3$  and PbO<sub>2</sub> yield on heating oxygen only and no ozone, and do not precipitate iodine from a KI solution. Previous contradictory statements (by Brunk) are attributable to traces of nitrogen compounds difficult to remove.

\*Rate of Solution of Magnesium in Acids. T. H. James (J. Amer. Chem. Soc., 1943, 65, (1), 39–41).—The rate of dissolution of magnesium in sulphuric, hydrochloric, formic, acetic, valeric, and glycolic acids was determined at  $20^{\circ}$  C. by shaking an excess of the metal in the form of shavings with a standard volume of acid; the measured rates are apparently those of the chemical reaction. The undissociated organic acids react at a smaller rate than  $H_3O^+$ , but the rates of all those tested are of the same order of magnitude and are not affected by addition of sodium chloride to the acid.

-A. R. P.

Thermodynamic Considerations in the Corrosion of Metals. J. C. Warner (Electrochem. Soc. Preprint No. 5, 1943, (Apr.), 67–80; (abridged) Metallurgia, 1943, 28, (164), 61–66).—From a review of available thermodynamic data, the spontaneity of corrosion reactions for most of the common metals in deoxygenated water and in water saturated with carbon-dioxide-free air is calculated, and the results are tabulated and briefly discussed. A thermodynamic discussion of the mechanism of the corrosion of zinc in moist air containing carbon dioxide, and of the tarnishing of silver in air containing sulphur vapour, hydrogen sulphide, or sulphur dioxide, is also offered. The condition for the steady state or limiting corrosion rate is defined by a method analogous to the application of Bernoulli's theorem to fluid flow problems.

-A. R. P.

Laws Governing the Growth of Films on Metals. U. R. Evans (Electrochem. Soc. Preprint No. 10, 1943, (Apr.), 129–136; also (abridged) Metallurgia, 1943, 28, (165), 133–135).—From a review of recent work on the growth of films on metals, the three laws expressing the rates of growth are derived and discussed. The linear law,  $y = k_1 t$ , occurs with porous films on light metals which allow oxygen to leak towards the metal surface. The parabolic law,  $y^2 = k_2 t + k_3$ , occurs with non-porous films having ionic and electronic conductivity, and is governed by outward ionic migration under a potential gradient. The logarithmic law,  $y = k_4 \log (k_5 t + k_6)$  occurs when the conditions needed for parabolic thickening are absent, and is due to the outward passage of interstitial matter through flaw-paths or zones of loose structure.—A. R. P.

#### VII.—PROTECTION

(Other than by Electrodeposition.)

<sup>†</sup>Protective Chemical and Surface Finishes for Scientific Instruments and Apparatus. H. Sutton (J. Sci. Instruments, 1943, 20, (6), 86–92).—The general problem of the protection of metal surfaces against atmospheric attack is discussed, special attention being paid to "immersion treatments," and the preparation of metal surfaces which are to be painted. The paper deals with the treatment of steel surfaces, zinc-base alloys, cadmium, aluminium and its alloys, magnesium-rich alloys, and electrodeposited coatings. Possible sources of corrosion in instruments are electrochemical action between

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different metals, and a table of electrode potentials with respect to a saturated calomel electrode of different metals immersed in sea-water is given. Unsuitable packing materials are also sometimes a source of corrosion.—W. H.-R.

Surface Protection of Aluminium and Aluminium Alloys. W. Linicus (Werkstatt u. Betrieb, 1940, 73, 146–151; Chem. Zentr., 1940, 111, (II), 3260).— A review of the known methods for protection of aluminium and its alloys by metallic and non-metallic coatings, and of the application of aluminium to the surface protection of steel.

Behaviour of Various Magnesium Alloys During Anodic Oxidation. Max Bräuer (Z. Metall- u. Schmuckwaren-Fabrik. Verchrom., 1941, 22, 392– 393; Chem. Zentr., 1942, 113, (I), 2062; C. Abs., 1943, 37, 3352).—The properties of anodic oxide coatings on magnesium alloys are, to a great extent, dependent on the constituents of the alloys. In general, the coatings are bright, but they are darkened by a high percentage of aluminium. Lightyellow or light-grey coatings are produced on alloys which are rich in manganese. Zinc in amounts exceeding the aluminium content produces coatings unpleasant in appearance. A coating 15 microns thick on alloy AZM has a dielectric strength of 290 v. Additions of zine and aluminium have a considerable effect on the hardness of the coatings. Magnesium-manganese alloys approach Duralumin in their wear-resistance.

\*Determination of Tin Coating Weights. (Bendix, Stammer, and Carle.) See p. 23.

**Protection Against Rust by Hot-Galvanizing.** Heinz Bablik (Oberflächentechnik, 1940, 17, 95–96, 101–103, 109–111, 117–119; Chem. Zentr., 1940, 111, (II), 3260).—A comprehensive description of the importance of zinc coatings for the protection of iron, and of the chemical and metallurgical conditions in hot-galvanizing.

Metal Spraying. — (Aircraft Production, 1943, 5, (59), 445–447).— Applications in America are described for the protection of foundry patterns and core boxes and air-cooled engine cylinders. Reference is made to sprayed bearing bushes and liners, and to reclamation of worn parts by spraying.—H. S.

Metal Spraying. C. K. Wilson (Steel, 1943, 112, (19), 98–100).—The application of metal spraying to flat and irregular surfaces is described. The importance of the proper preparation of the surface to be sprayed is stressed. Readily accessible, machinable surfaces of hardness <58 Rockwell C may be prepared by grit-blasting and special machining. But the new electrical method of "fuse-bonding" is suitable for preparation of inaccessible surfaces of any hardness. In this latter process a special electrode alloy (composition not given) is fused to the surface by electric resistance heating in such a way as to form a metal froth on solidifying which provides remarkably good bonding for the sprayed metal on the base material.—E. A.

Sprayed Metal Reduces Maintenance Costs. B. Granowski (Australasian Eng., 1943, 43, (225), 16–17, 48, 50–51).—The applications and advantages of metal spraying in plant maintenance are discussed, and the spraying process is compared with welding. Tests were carried out in the laboratory and on crankshafts, and the wear resistance, hardness, machinability, bond strength, and microstructure of various sprayed metal deposits, were determined. Wet-grinding proved to be the most suitable method for finishing the sprayed surfaces. G. recommends the use of dissolved acetylene as the fuel gas, in conjunction with an inert gas or deoxidized air as the impending medium in the spraying process, and a suitable heat-treatment after spraying. —E. A.

Metallizing for Profit. Clyde B. Clason (Weld. Eng., 1943, 28, (6), 34-37).—Metal spraying is stated to be used to build up worn parts, undersized components, and defective castings; to increase resistance to corrosion and C scaling; bond metals to non-metallic materials; and to provide decorative or reflective finishes. Among the metals used are : aluminium, lead, tin, zinc, copper, bronzes and bearing metals, nickel, nickel alloys, and stainless steels. Data are included on grit-blasting and other pre-metallizing treatments, spraying speeds, and finishing operations.—E. G. W.

#### VIII.—ELECTRODEPOSITION

Surface Protection by Electrodeposited Coatings. Richard Springer (Werkstatt u. Betrieb, 1940, 73, 123–126; Chem. Zentr., 1940, 111, (II), 3259).—A survey of the electrodeposition of zinc, copper, brass, and hard chromium.

\*The Structure of Electrodeposited Chromium. (Hume-Rothery and Wylie.) See p. 14.

**Chrome-Plated Parts.** H. G. Conway (*Aircraft Production*, 1943, 5, (53), 109).—The plater is often not allowed enough latitude. Working limits for the unplated part, the plated part, and the finished part are indicated in relation to flash chroming and heavy-deposit chroming.—H. S.

The Hard-Chromium Plating Process. G. Elssner (Feinmechanik u. Präzision, 1940, 48, 199–204; Chem. Zentr., 1940, 111, (II), 3402).—A review.

Hard-Chromium Plating. Harry M. Dean (Australasian Eng., 1943, 43, (320), 13–14).—After a brief description of the history of chromium and of the properties of chromium deposits, the methods for hard chromium plating—as applied in Australian plants—are described, with special reference to precautions to be observed, and to economics of the processes.—E. A.

\*Electrolyte for Chromium Plating. G. M. Kuperman and L. D. Melikadze (Trudy Tbilis. Khim. Inst., 1940, 2, 207–216; Khim. Referat. Zhur., 1941, 4, (2), 78; C. Abs., 1943, 37, 3351).-[In Russian.] The object of the experiments was to devise a method for obtaining chromium electrolyte from available raw materials. The following technical scheme was used : proavailable faw matching. The following exclusion of the form affect with a section of  $CaCr_0_4$  from fused  $Na_2Cr_2O_7$  and the separation of  $CrO_3$  from it by decomposition with  $H_2SO_4$ . The optimum concentration of the initial  $Na_2Cr_2O_7$  is 10%. Increasing the concentration of  $Na_2Cr_2O_7$  increases the amount of NaOH formed from the reaction:  $Na_2Cr_2O_7 + 2Ca(OH)_2 =$  $2CaCrO_4 + 2NaOH + H_2O$ ; this increases the solubility of  $CaCrO_4.2H_2O$ . The process must be carried out at 90° C., at which temperature a higher yield of the fine-grained CaCrO4 precipitate is obtained, and the CaCrO4 is less soluble than at lower temperatures. The excess CaO required for a complete precipitation is 15–20%. The precipitate formed contains  $CaCrO_4.2\dot{H}_2O$  81% and CaO 19%. The CaCrO<sub>4</sub> is filtered, washed, dried, and transformed into CrO<sub>3</sub> with H<sub>2</sub>SO<sub>4</sub> (400 grm./litre) by mixing and heating. The gypsum is separated by settling or filtering, the solution containing 60-70 grm. of  $CrO_4$ /litre is evaporated, the excess  $H_2SO_4$  neutralized with  $CaCrO_4$ , and the gypsum formed is separated, to leave a solution containing CrO<sub>3</sub> 300, H<sub>2</sub>SO<sub>4</sub> up to 2.5, and CaO up to 5 grm./litre. The solution is suitable for chromium plating. The relative amounts of the substances used per unit of CrO<sub>3</sub> are : Na2Cr2O7.2H2O 2:127, H2SO4 (monohydrate) 1.858, and CaO 1.270. The adaptation of the method to plant conditions is described in detail.

Possible Applications of Heavy Copper Plating in the Production of Coatings on Parts of Machine and Apparatus. H. M. Forstner (*Metallwirtschaft*, 1940, **19**, 803–809; *Chem. Zentr.*, 1940, **111**, (II), 3259).—F. defines heavy copper plating as an electrodeposited, non-porous copper coating of <0.10 mm. thickness, 24-28 kg./mm.<sup>2</sup> strength, 40-60% elongation (on 100 mm.), and 65-85 Brinell hardness. Its possible applications are surveyed.

Production of Copper Patterns by Electroforming. (Laukel.) See p. 28.

\*X-Ray Studies of Electrodeposits of Copper. G. P. Maitak (Zapiski Inst. Khim. Akad. Nauk U.R.S.R. (Mem. Chem. Inst. Acad. Sci. U.S.S.R.), 1941, 7, 527-536; Chem. Zentr., 1942, 113, (I), 3176; C. Abs., 1943, 37, 3350).— [In Russian.] The copper electrodeposits were obtained at various c.ds. from N-CuSO<sub>4</sub> solution and from N-CuSO<sub>4</sub> + N-H<sub>2</sub>SO<sub>4</sub> solution. At c.d. 0.05 amp./cm.<sup>2</sup> the lattice parameter was 3.610 A., which agrees with the value obtained electrochemically. At 0.05 to 0.025 amp./cm.<sup>2</sup> deposits from either solution gave the highest overvoltage. At c.d. higher than 0.05 amp./cm.<sup>2</sup> spongy deposits were obtained which had larger lattice parameters. At 0.6 amp./cm.<sup>2</sup> the parameter reached a maximum. At the very start of copper-sponge deposition the same parameter was obtained at 0.6 amp./cm.<sup>2</sup> (and the same overvoltage) as at 0.05 amp./cm.<sup>2</sup>. In some of the spongy deposits X-rays revealed the presence of Cu<sub>2</sub>O. The size of the primary particle was 200 A., no matter whether the deposit was solid or spongy.

\*Hydrogen Overvoltage of Various Electrolytic Copper Deposits. G. P. Maitak (Zapiski Inst. Khim. Akad. Nauk U.R.S.R. (Mem. Inst. Chem. Acad. Sci. U.S.S.R.), 1941, 7, 537-550; Chem. Zentr., 1942, 113, (1), 3176; C. Abs., 1943, 37, 3351).—[In Russian.] The electrolyte used was N-CuSO<sub>4</sub> in N-H<sub>2</sub>SO<sub>4</sub>. The c.d. varied from 0.001 to 1.0 amp./cm.<sup>2</sup>. At 0.1 amp./cm.<sup>2</sup> the overvoltage was 0.64-0.66 v. The lowest overvoltage obtained was for spongy deposits at 0.6 amp./cm.<sup>2</sup>.

Electro-Tinning and Detinning of Steel Sheet. Josef Teindl (Hornický Věstník, 1941, 23, 95–97; Chem. Zentr., 1942, 113, (I), 2192; C. Abs., 1943, 37, 3350).—Clean and smooth steel sheet is necessary to produce bright tin coatings. Commercial methods for hot and electrolytic tinning are described. Electro-tinning causes no loss of tin by oxidation, is more economical, and can produce a sheet having 30 grm. of tin/m.<sup>2</sup> on one side and 5 grm./m.<sup>2</sup> on the other, whereas 40 grm./m.<sup>2</sup> on each side is given by hot tinning. Sheet having approx. 3 grm./m.<sup>2</sup> of tin is satisfactory for lacquering. Porosity in tin coatings cannot be eliminated by either method. Sheet for use in food cans should have  $\geq 3-5$  pores/cm.<sup>2</sup>, although up to 17 have been allowed.

The Electrodeposition of Zinc. E. Werner (*Metallwirtschaft*, 1940, 19, 655–656; *Chem. Zentr.*, 1940, 111, (II), 3259).—Comprehensive description of the present state of the technique.

\*Êlectroplating with Three Electrodes. Application to Bright Deposits of Zine and Cadmium. J. Guzmán and L. Quintero (Anales. Soc. españ. Fis. Quim., 1936–1939, [v], 35, (1), 24–40; Chem. Zentr., 1940, 111, (11), 3402).— In G.'s indicator potential method the metal deposits are precipitated electrolytically by a current of ions; this current is maintained constant by a potential which is controlled in a definite way by three electrodes. The method was applied to electrodeposition, where control of the c.d. is unnecessary. Bright zinc and cadmium deposits have been prepared by this method from cyanide solutions containing colloids and some nickel. In order to obtain a bright zinc deposit, an indicator potential of 410 mv. has to be applied, with a soluble anode and without agitation of the electrolyte. To produce a bright cadmium deposit, the same indicator potential of 520 mv. has to be applied and under similar conditions to those used for an ordinary cadmium deposit.

Flexibility of the Cuprous-Oxide Rectifier for Automatic Control Equipment in Electroplating. G. E. Huenerfauth (*Electrochem. Soc. Preprint* No. 7, 1943, (Apr.), 97-104; also (abridged) *Met. Ind.*, 1943, **63**, (2), 26-28).—The cuprous-oxide rectifiers now on the market are much more flexible sources of current for plating than are motor generators, and may readily be provided with automatic control mechanisms for plating and anodizing. Various types of timers and relays coupled with control of the low-wattage 110-v., single-phase current on the magnetic contactor coil built into the c 2 of parallel and series operation allow ease in

rectifier unit, and the use of parallel and series operation allow ease in working out automatic control not previously obtainable; several examples are quoted with reference to wiring diagrams.—A. R. P.

Grinding and Polishing in Electrodeposition. Hugo Krause (Schleif- u. Polietechn., 1940, 17, 131–135; Chem. Zentr., 1940, 111, (II), 3259).—A comprehensive survey.

# IX.—ELECTROMETALLURGY AND ELECTROCHEMISTRY (Other than Electrodeposition.)

The Cerium Amalgam Electrode and the Thermodynamics of Aqueous Cerium (III) Sulphate Solutions. [Solubility of Cerium in Mercury.] George C. Walters and Thomas De Vries (J. Amer. Chem. Soc., 1943, 65, (1), 119–122).—A semi-solid amalgam containing  $2\cdot7\%$  of cerium was obtained by electrolysis of a saturated solution of CeCl<sub>3</sub>.H<sub>2</sub>O crystals in absolute alcohol. The potential of the cell Ce-Hg (two-phase) | M-Ce<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> | Hg<sub>2</sub>SO<sub>4</sub>, Hg was found to be 1·4275, 1·4373, and 1·4473 v. at 15°, 25°, and 35° C., respectively, from which it appears that the potential of metallic cerium in a solution containing cerous ions is 1·6824 v. at 25° C. Measurements of the potentials of cells with various cerium contents of the amalgam indicate that the solubility of cerium in mercury is 0·312% at 25° C.—A. R. P.

\*On the Electromotive Behaviour of Nickel in the Presence of Hydrogen.-III. Bruno Foresti (Gazz. chim. ital., 1940, 70, 349-359; Chem. Zentr., 1940, 111. (II), 3451).-The electromotive behaviour of massive nickel electrodes (98.8-99.55% nickel) in the presence of hydrogen was investigated within the  $p_{\rm H}$  range 5.8–12.27. Electrodes annealed in a nitrogen atmosphere for 12 hrs. remained more "noble" than the latter. On the other hand, electrodes polished with  $Al_2O_3$  became activated and reached the potential of the hydrogen electrode. Eckell found the same result in a similar experiment with cold-worked nickel electrodes. The polishing effects lattice deformation on the metal surface, and at the same time imparts catalytic activity, as a result of which a direct relation is set up between the formation of "active centres" and the lattice distortion. This not only yields zones of atoms topochemically suitably ordered for the activation adsorption, but at the same time also puts these atoms into an excited state in connection with the deformation. It may be assumed that the "active centres" consist of groups of excited atoms of definite order, which would explain the heterogeneous structure of catalytically active surfaces.

\*Studies on Overvoltage. XV.—A Study of Decomposition Potentials. Cathodic and Anodic Polarization of a Platinized Platinum Cathode Near the Reversible Value in Hydrogen-Saturated Acid Solutions. A. L. Ferguson and Myron B. Towns (*Electrochem. Soc. Preprint* No. 8, 1943, (Apr.), 105–117).— Further evidence is put forward in support of the proposition that the electrode phenomena at, and on either side of, the reversible value are all the same, and that the electrode potential is determined by the activities of the hydrogen atoms and ions at the electrode-solution interface, and can be calculated by the Nernst equation if these activities are known. From this it follows that hydrogen ions may be discharged at potentials more positive than the reversible value, and that the potential depends largely on the material and physical condition of the electrode.—A. R. P.

\*Studies on Overvoltage. XVI.—Cathodic and Anodic Polarization of a Platinized Platinum Cathode Near the Reversible Value in Nitrogen-Saturated Acid Solutions. A. L. Ferguson and Myron B. Towns (*Electrochem. Soc. Preprint* No. 9, 1943, (Apr.), 119–128).—Anodic and cathodic polarization curves obtained in nitrogen-stirred acid solutions under various conditions support the theory proposed in previous papers for the mechanism of electrode potential and overvoltage.—A. R. P.

## X.—REFINING

The Possibilities of Improving Commercial Lead. Willy George (Metall u. Erz, 1940, 37, (7), 253-256; Chem. Zentr., 1940, 111, (II), 3257).—The preparation of the purest possible lead can be carried out by decreasing the bismuth content in the refined lead, either by suitable choice of the melting charge, or by the use of known metallurgical working methods, the application of which must be adapted to each individual case. The other impurities (copper and antimony) can be reduced by extracting first the copper with sulphur by the Colcor method, and then removing the antimony by refining in the reverberatory furnace. For the removal of zinc from lead, the most suitable method is a pre-treatment used in conjunction with Parkes' process, consisting of treating the lead with NaOH and at the same time poling with water vapour or with NaOH and water, in cast-steel kettles at 800° C. The poling with NaOH not only removes all the zinc except a few units in the fourth place of decimals, but also effects an after-refinement in which (except for copper and bismuth) all other impurities are removed down to the same order of magnitude as the zinc content.

## XI.—ANALYSIS

<sup>†</sup>A Review of Spectrographic Analysis of Some Metals and Alloys.—II. Jacob Sherman and J. W. Jenkins (*J. Amer. Soc. Naval Eng.*, 1943, 55, (3), 404–469).—Cf. *Met. Abs.*, 1943, 10, 329. The calibration of photographic plates and the preparation and purification of graphite electrodes are described, and the spectrographic analysis of Al alloys, steels, steel solution, Zn spelter, Zn-base die-casting alloys, ingot Cu, pig Pb, Pb and Pb battery materials, is discussed in detail, with special reference to the method used, the elements to be determined, the spectrograph used, the photographic plate, the excitation or source, the preparation of the specimen and standards, the electrodes (upper and lower) used, the reference lines for the elements in Angstrom units, the densitometer used, if any, and the analytical procedure.—J. W. D.

densitometer used, if any, and the analytical procedure.—J. W. D.
Sampling for Spectrographic Analysis. H. H. Simmons (*Metals and Alloys*, 1943, 17, (6), 1221).—Molten metal is drawn by a syringe bulb into a glass tube. The glass cracks away, leaving a clean rod which is readily formed to the correct shape for electrodes.—J. C. C.

\*Estimation of Aluminium as Phosphate. Herbert Blumenthal (Metall u. Erz. 1940, 37, (8), 315–316; Chem. Zentr., 1940, 111, (II), 3230).—Neutralize the Al solution (50 mg. Al), containing HCl or  $H_2SO_4$ , with NH<sub>3</sub> so as just to produce a slight precipitation of Al(OH)<sub>3</sub>. Dissolve this in as little HCl as possible, add 25 c.c. of a cold saturated SO<sub>2</sub> solution, 20 c.c. of 10% (NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub> solution, and 15 c.c. acetic acid (1:3). The SO<sub>2</sub> solution must be sufficient to prevent the precipitation of AlPO<sub>4</sub>. Make up to 400 c.c., boil for 20 minutes with some filter paper, and filter through a S. & S.-Weissbandfilter. Wash the precipitate until free of Cl', dry, and calcine at 1250° C. to a constant weight. In the case of a Zn alloy containing Al, dissolve 10 grm. of sample in (1:1) HCl with addition of KClO<sub>3</sub> and make up to 1 litre. Transfer 100 c.c. of this solution to a 500-c.c. measuring flask, and add NH<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> until the solution is just acid to methyl orange. Then make up to 400 c.c. and pass in H<sub>2</sub>S. Except for negligible traces, all the Zn will be thus precipitated, and also any Cu present. Make up to 500 c.c., filter 250 c.c. of it boil off the H<sub>2</sub>S, and treat the solution as above.

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Quantitative Determination of Antimony, Bismuth, and Gold in Red Copper by the Logarithmic Method. A. L. Ostashevskaya (Zavod. Lab. (Works' Lab.), 1938, 7, 958–963; Chem. Zentr., 1940, 111, (II), 3231).—[In Russian.] O. examined the accuracy of the log. method, and found the magnitude of errors to be similar to those in microphotometry. Although the minimum concentrations determinable of Sb, Bi, Au, and Cu are somewhat higher than in microphotometry, they can be reduced by the use of high-sensitivity plates.

\*Method for the Quantitative Spectrographic Analysis of Solutions. IV.— Estimation of Cadmium and Zinc. A. K. Rusanov and V. M. Alexeeva (Zavod. Lab. (Works' Lab.), 1938, 7, 963–967; Chem. Zentr., 1940, 111, (II), 3231).—[In Russian.] The Cd and Zn in solutions are estimated by visual comparison of the intensity of the lines : Cd 4799·91 A. and Mn 4823·50 A.; Zn 4722·16 A. and Mn 4783·43 A.; Zn 4810·53 A. and Mn 4823·50 A. The determination may be carried out in 10 minutes with an accuracy of  $\pm 4.5\%$ for Cd in the concentration range of 0·03–1%, and  $\pm 2.7\%$  for Zn in the concentration range of 0·01–1%.

\*Polarographic Analysis of Copper and Zinc in Brass Plate. A Rapid Control Method. Willard P. Tyler and Walter E. Brown (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1943, 15, (8), 520–523).—The plate is removed from Fe or steel by means of ammoniacal  $(NH_4)_2S_2O_8$ , the solution is added to a supporting solution containing  $NH_4OH$ ,  $NH_4CI$ ,  $Na_2SO_3$ , and gelatin, and, after the  $Na_2SO_3$  has reduced the excess of  $(NH_4)_2S_2O_8$ , polarographed in the usual way. By measuring only the ratio of the diffusion currents of Zn and Cu, exact temperature control, extreme accuracy in measuring the volume of the solutions, and a standard capillary tube, are unnecessary. An analysis takes only 20 minutes, half of which time is occupied in allowing the reducing action of the sulphite to go to completion. The original must be consulted for full manipulative details and the method of calculating the results.

-A. R. P.

\*Preliminary Spectrographic and Metallographic Study of Native Gold. (Crook.) See p. 14.

\*Rapid Method for the Determination of Magnesium, Calcium, and Barium Ions. N. K. Senyuta (Zavod. Lab. (Works' Lab.), 1939, 8, 721–723; Chem. Zentr., 1940, 111, (II), 3370).—[In Russian.] Precipitate the Ba with an excess of standard  $Na_2CO_3$  solution, the Mg with an excess of standard alkali solution, and the Ca with a standard Na oxalate solution. Separate the precipitates from the precipitating solutions by means of an inert layer (CCl<sub>4</sub>) heavier than the precipitating solution, and titrate back the excesses, in the case of Ba and Mg with acid, and in the case of Ca with acid KMnO<sub>4</sub> solution. The results are not quite as accurate as those obtained by means of gravimetric analysis; each estimation takes, however, only 20–30 minutes.

\*Investigation of the Solubility of Nickel Dimethylglyoxime in Alcoholic Solutions in the Determination of Nickel by the Dimethylglyoxime Method. F. Nussbaumer (*Metallwirtschaft*, 1941, 20, (24), 599-600).—Ni dimethylglyoxime is slightly soluble in dilute  $C_2H_5OH$ , so that only a slight excess of the usual 1% alcoholic solution of the reagent should be used; 70%  $C_2H_5OH$ instead of the usual 95% is preferred as the solvent for the reagent. Not more than 0.08 grm. of Ni should be present in the solution to be precipitated, and a volume of 500 c.c. is recommended; if Fe<sup>···</sup> is present, 10 grm. of tartaric acid should be added before making the solution just alkaline with NH<sub>4</sub>OH. The reagent should be added at 70° C. and the precipitate collected in a porous glass filter after 1–2 hrs.—A. R. P.

\*Methods for the Quantitative Spectrographic Analysis of Solutions. III.— Estimation of Thallium and Indium. A. K. Rusanov and B. I. Bodunkov (Zavod. Lab. (Works' Lab.), 1938, 7, 573–579; Chem. Zentr., 1939, 110, (II), 691). —[In Russian.] It is shown that the spark discharge is applicable not only in the visual quantitative spectrography of metals, but also for solutions. An analytical method has been developed, which is suitable for the quantitative estimation of Tl and In in solutions, based on the comparison of the intensities of the following lines : Tl 5350·47 A. with Fe 5270·361/5269·54 A., and In 4511·31 A. with Cs 4555·3 A. Fe and Cs are added to the solution as comparison elements. The estimation is carried out in 10 minutes with an accuracy of  $\pm 5.5\%$  for Tl (concentrations 0·006–0·1%) and of  $\pm 7.0\%$  for In (concentrations 0·006–0·2%).

\*Volumetric Method for the Estimation of Tin and Antimony in the Presence of One Another. G. A. Pevtsov (*Zavod. Lab.* (*Works' Lab.*), 1938, 7, 916–917; *Chem. Zentr.*, 1940, 111, (II), 3231).—[In Russian.] The estimation of Sn<sup>\*\*</sup> and Sb<sup>\*\*\*</sup> is based on titration with bromate in the presence of indigo carmine as the indicator. The method may also be applied for estimation of Sb alone.

\*Determination of Tin-Coating Weights. G. H. Bendix, W. C. Stammer, and A. H. Carle (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1943, **15**, (8), 501– 504).—A square sample  $(2 \times 2 \text{ in.})$  of the tinplate is suspended vertically in a 400-c.c. beaker by means of a magnet so as not to mask any of the tinned surface; on either side of the sample is placed a porous cylinder containing a carbon cathode immersed in 1 : 4 HCl. Into the beaker are poured 200 c.c. of 1 : 7 HCl and 20 c.c. of a standard KI-KIO<sub>3</sub> solution (50 grm. of KIO<sub>3</sub>, 280 grm. of KI, and 0·1 grm. of NaOH in 18 litres) and a current of 3 amp. is passed between the electrodes for 2–5 minutes; the I remaining in the solution is then titrated with thiosulphate.—A. R. P.

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

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

Interference Fringes for the Measurement of Surface Micro-Topography. J. F. Kayser (*Metal Treatment*, 1943, **10**, (35), 153–156, 172).—The quality of highly-finished surfaces which are smooth enough to be reflecting may be evaluated by observing the interference fringes produced when a glass cover slip is fastened to the surface and illuminated with monochromatic light by means of the optical train of a metallurgical microscope. The interference fringes may be regarded as contour lines spaced at intervals of half the wavelength of the light. A source of monochromatic light from sodium or mercury vapour lamps gives the most clearly defined fringes, but filtered light from a Pointolite lamp gives brighter and more critical illumination. Photographs of some glass rods and lapped steel surfaces are reproduced.—J. C. C.

Roughness of Metallic Surfaces, with Special Reference to Castings. Hugh O'Neill and R. T. Insley (*Metal Treatment*, 1943, **10**, (35), 181–187).—Methods of measuring surface roughness are briefly reviewed. The preparation and use of a set of five specimens of cast bronze (the L.M.S. Roughness Comparascope) as a reference standard is described, and the effect of particle size of moulding sand on the surface finish of castings is discussed.—J. C. C.

The Problem of the Heavy-Current X-Ray Tube and Its Solution by Means of a Multi-Dimensionally Rotated Spherical Anode.—II. H. Stintzing and H. Meub (*Metallwirtschaft*, 1941, 20, (19), 469–474).—Cf. *ibid.*, p. 45; *Met. Abs.*, 1943, 10, 360. Details are given of the behaviour of the tube under heavy loads. It is possible to give exposures of 12 seconds at 500 milliamp. without undue heating. The speed of revolution of the spherical copper anode about the two axes must be so adjusted that the surface is adequately scanned. Methods of outgassing the tube are described fully, and reference is made to the choice of copper as a target material on account of its thermal properties, cost, and workability. Brief reference is made to the steps necessary to avoid scattered radiation.—H. W. L. P. Simplified Electron Microscopy. C. H. Bachman (*Electronics*, 1943, 16, (2), 78-81).—A brief survey of the history of the development of electron microscopes is given, followed by a description of a modern instrument with horizontal electron path and electrostatic lenses.—E. V. W.

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

A Rotating Cantilever Machine for 200-Kg. Tensile-Compressive Stresses. E. Erlinger (*Metallwirtschaft*, 1941, 20, (17), 414-416).—The machine is designed to apply a permanent tensile or compressive load of 100 kg. and an alternating load of 100 kg. to give a maximum loading in each cycle of 200 kg., and is so constructed that the amplitude of the vibrations can be varied to suit the elasticity of the metal tested. Both loads are applied by means of springs, and tests can be made up to  $50 \times 10^3$  reversals. Diagrams and a full description of the construction of the machine are given.—A. R. P.

The Useful Data to be Derived from Fatigue Tests. J. O. Almen (Metal Progress, 1943, 44, (2), 254-261).-Fatigue data obtained by laboratory tests on specimens of high finish prepared under carefully standardized conditions have only limited application to problems of mechanical design. The relatively rough finish of machine parts permits local concentrations of stress which are largely eliminated in laboratory specimens. Stress calculations must be reviewed in the light of individual conditions; direct measurements by photoelastic or extensometer methods give the statistical average of the stress over the region involved, whilst fatigue tests relate to the weakest element present. Operating loads cannot be accurately known and are rarely constant. Fatigue curves on a number of materials are reviewed with a view to correlating "laboratory" tests with tests on actual machine parts: the curves differ in direction rather than in form, and some degree of correlation is shown to be possible, given a sufficient number of observations. The most industrially interesting portion of the fatigue curve lies beyond the fatigue endurance limit, i.e., in the region representing a finite life period. A series of graphs illustrates the influence of the form of specimen both on fatigue strength and on the degree of scatter among the results. Such graphs, representing different types of finish, are found when plotted on log-log paper to converge towards a point corresponding with the ultimate tensile strength of the material at a considerable number of stress cycles, and it is shown that log-log curves of this type may be used in the evaluation of effective stress.

-P. R.

Hardness of Aluminium Sheet (Tests and Conversion Charts). Richard L. Templin (Metal Progress, 1943, 44, (1), 86–88; also (abridged) Met. Ind., 1943, 63, (23), 357).—The essential procedure in the Brinell, Vickers, Rockwell, Barcol, Webster, and Shore hardness tests is briefly summarized. Satisfactory and comparable results depend on a close standardization of test conditions; results are influenced by the thickness of the specimen, the type of support, and sometimes by surface preparation. Hardness conversion tables can apply only within a limited range, *i.e.*, between two types of test and on a single material in standardized condition. In attempts to use the hardness test (Brinell) to estimate tensile strength in light-alloy sheet, it has been found that the ratio hardness/tensile strength varies widely for different alloys, whilst no simple ratio can be said to exist between hardness and fatigue strength. Hardness forms, however, a satisfactory check on heat-treatment provided that the type of alloy is known.

-P. R.

# 1944 XIII.—Physical and Mechanical Testing, &c. 25

Hardness Tests. Robert S. Burpo, Jr. (Metals and Alloys, 1943, 17, (6), 1217, 1219).—Characteristics of the common hardness-testing instruments are tabulated.—J. C. C.

\*The Micro-Hardness Tester—A New Tool in Powder Metallurgy. Robert Steinitz (Metals and Alloys, 1943, 17, (6), 1183–1187).—A square-ground diamond penetrator is substituted for a microscope objective, after the specimen has been adjusted so that a selected spot is seen at the junction of the crosshairs in the eye-piece. The diamond is then lowered into contact with the specimen by the microscope focusing screws, pressures of 25–300 grm. being applied through a calibrated spring. The use of the instrument for measuring the hardness of metal powders mounted in Bakelite and of the grains in compacts is illustrated.—J. C. C.

Testing the Hardness and Softness [of Metals] with a Pre-Loading Machine. K. Frank (*Metallwirtschaft*, 1941, 20, (17), 416–417).—Modifications of the usual hardness-testing machines (Brinell, Rockwell, Vickers) are described to allow of their being used for testing the hardness of awkwardly shaped objects, such as shell-cases, by measuring the difference in depths of impression made by 10- and 150-kg. loads.—A. R. P.

Hardness Testing with the Barcol Impressor. J. H. Hrucka (*Iron Age*, 1943, 152, (16), 84–87).—The Barcol tester is a hand-size portable impressor in which a hardened truncated cone penetrator is held down by a spring-headed plunger. Experiences in using this impressor for testing the hardness of aluminium and its alloys, brass, copper, steel, and certain plastics, are described. The instrument is almost fool-proof, but a certain manual dexterity is required for testing the hardness of plastics. For copper and aluminium alloys constantly reproducible values are obtained.—J. H. W.

Hardness Determinations According to Rockwell, Brinell, and Vickers with a Single Apparatus. J. H. Kimman (*Polytech. Weekblad*, 1941, 35, 321-323; *Chem. Zentr.*, 1942, **113**, (I), 412; *C. Abs.*, 1943, **37**, 3378).—The development of hardness determinations and the procedures for determining the Rockwell, Brinell, and Vickers hardness values are reviewed, and the universal instrument of Frank is described.

Progress in Micro-Testing. D. W. Rudorff (*Metallurgia*, 1943, 28, (168), 273-277).—A new method for investigating thermoelasticity devised by Chevenard is described, and the type of thermoelastic curve obtained and its applications are discussed. Consideration is also given to micro-testing technique, and apparatus for micro-tensile testing, micro-shear testing, microstatic-torsional testing, micro-torsional-fatigue testing, and micro-hightemperature-creep testing, are described.—J. W. D.

**Â** New Method of Non-Destructive Testing. Rudolf Berthold (Metallwirtschaft, 1941, 20, (17), 425–426).—A series of substances which undergo colour changes on heating has recently been placed on the market in Germany. Some of these may be used for detecting flaws in finished articles, e.g., lack of adhesion between bearing metal and shell, laps and elongated blow-holes parallel to the surface of a metal article, and the presence of inclusions. The article is painted on one side with a film of the substance, and heat is applied to the other side; in the absence of flaws, &c., the colour change takes place uniformly on the unheated side, but if flaws exist, their presence is revealed by a retardation in the colour change in the neighbourhood of the flaws due to the much smaller rate of heat transmission through gases than through metals.—A. R. P.

Electrical Measurement of Stresses. A. Theis (Aircraft Eng., 1943, 15, (170), 106–109).—Translated from Z. techn. Physik, 1941, 22, (11), 273–280. The technique of strain gauging with the use of strip and ring-shaped gauges, is described.—H. S.

Rapid and Accurate Inspection of Spot Welds [in Aluminium Sheet]. L. L. Anderson (*Metal Progress*, 1943, 44, (3), 433–434, 462).—An illustrated description is given of a hand-operated tensile-testing apparatus for use on welded aluminium sheet. The U.S. Navy requirements, which include maximum as well as minimum values, are summarized in respect of shear tests on overlapping joints and tensile tests on spot welds. The machine is adaptable for both types of test; its design permits the use of exceptionally long specimens, and the considerable space within the frame allows the machine to be used in testing a large variety of finished pieces.—P. R.

Quality Inspection of Beryllium Copper. Wayne Martin (Metals and Alloys, 1943, 17, (6), 1203–1207).—The suitability of beryllium-copper wire for spring making may be predicted from tests of electrical conductivity and tensile strength; the best heat-treating temperature should be determined for each batch. For strip, inspection is best carried out by tests of elastic modulus and hardness. The grain-size is an indication of the temperature at which solution heat-treatment was carried out; stringers of  $\beta$  phase indicate segregation in the ingot and cause difficulties in spring fabrication; and grainboundary precipitates of  $\gamma$  phase, which are said to be caused by slow heating during batch-annealing, reduce the amount of beryllium available for hardening, and give rise to distortion in hardening. For best physical properties a short-time heat-treatment at a higher temperature than normal is recommended.

-J. C. C.

#### RADIOLOGY

**X-Ray Inspection of Castings (Army Air Forces' Requirements).** Robert Katz (*Metal Progress*, 1943, 44, (1), 89–94; and (abridged) *Found. Trade J.*, 1943, 71, (1423), 249–250).—A description is given of the procedure adopted by the U.S. Army Air Forces in the X-ray examination of structural castings in which the ultimate design load produces stresses between 20 and 100% of the permissible stress. The presence of certain defects leads to immediate rejection; in other cases the test castings are subjected to a static loading test, the frequency of tests on subsequent batches depending on the results obtained in the first test batch. Radiographs of aluminium alloys are reproduced to show various types of defect, the nomenclature, cause, and characteristic appearance of which are given.—P. R.

X-Rays in Industry. J. K. Allen (Siemens Mag. (Eng. Suppt.), 1943, (211), 1-4; (212), 1-4).—An historical survey of the discovery and application of X-rays is given, followed by some modern uses of the X-ray shadowgraph. —E. V. W.

## XIV.—TEMPERATURE MEASUREMENT AND CONTROL

Temperature Regulation of All Kinds of Metallurgical Furnaces. C. Sieber (*Metallwirtschaft*, 1941, 20, (24), 603–610).—Various modern types of automatic temperature controllers for numerous types of melting and annealing furnaces are described with reference to wiring diagrams, and the principles underlying their construction are outlined.—A. R. P.

Temperature Measurement and Control with Solid Photoelectric Cells. Marlin E. Fogle (*Electrochem. Soc. Preprint*, No. 14, 1943, (Apr.), 183–191; also (abridged) *Metallurgia*, 1943, 28, (166), 162; and *Met. Ind.*, 1943, 63, (5), 82).—Various types of photo-electric pyrometers using solid cells are described and compared with optical and total-radiation pyrometers for measuring and controlling high-temperatures in steel furnaces and ceramic kilns.—A. R. P.

## **XV.**—FOUNDRY PRACTICE AND APPLIANCES

The Melting and Pouring of Alloys. S. Simpson (Australasian Eng., 1943, 43, (322), 16–17, 37, 38–39).—S. deals with the classification and selection of the various furnace types for a given job, composition of the charge and its effect on melting, furnace atmosphere control, function and composition of fluxes, and precautions to be observed in pouring.—E. A.

Metallurgical Factors of Importance to the Practical Aluminium Founder. S. A. E. Wells (Found. Trade J., 1943, 71, (1420), 179–184; discussion, (1421), 207–210; (1422), 225–228; also Met. Ind., 1943, 63, (8), 114–117; (9), 139– 140).—A paper read before the London and Lancashire Branches of the Institute of British Foundrymen. An outline is given of precautions to be adopted in melting aluminium-base alloys. The technique of grain refinement using titanium or niobium is described. The effect of dissolved gases giving rise to "pinholes" is described, and suggestions are made for the elimination of this defect. W. reports that a serious loss of magnesium can occur from a repetition of the flux degasification treatment on Ceralumin "B," resulting in a softening of the alloy. Repeated melting of this alloy in the absence of flux does not lead to any loss of magnesium. In the case of "Alpax Gamma," repeated flux treatment leads to substantial magnesium loss, with corresponding decreases in Brinell hardness and proof stress.—J. E. G.

Melting, Alloying, Heating Aluminium and Alloy Ingot. R. R. LaPelle (*Metal Progress*, 1943, 44, (2), 276–282).—This short description of the equipment and methods employed in the production of high-strength aluminium alloys includes an illustrated account of an oil-fired reverberatory furnace for remelting ingots and scrap. Factors influencing the choice of fuel are reviewed. The procedure of alloying and of casting different types of ingot is described, and a brief account is given of "homogenizing" treatment and of cladding operations.—P. R.

Aluminium Cylinder Heads for Aircraft Engines. G. Eldridge Stedman (*Steel*, 1943, **112**, (15), 102–105; (16), 114–116).—The foundry practice at an American aluminium foundry is reviewed, in the casting of cylinder heads with a remarkably low value of scrap.—E. A.

\*The Casting of Aluminium-Alloy Power Gears. N. I. Mirusev (Liteynoe Delo (Foundry Practice), 1941, 12, (3), 29; Chem. Zentr., 1942, 113, (I), 2817; C. Abs., 1943, 37, 3378).—[In Russian.] Experiments with the aluminium alloy "ASWP," containing copper 9–12, silicon 1·2, zinc 0·5, magnesium 0·5, and nickel + manganese 1%, showed that cracking difficulties could be reduced 80% by modifying the composition to copper 7·5, iron 0·55, and silicon 1·62%. Welding repairs must be checked by X-rays, and the strength by rotation at 8000–9000 r.p.m. for 5 minutes and 80 hrs. at 6500 r.p.m.

Some Causes of Gas Unsoundness [in Copper Alloys] and How to Eliminate Them. H. L. Smith (*Trans. Amer. Found. Assoc.*, 1942, 50, (2), 490–497; discussion, 497–498).—S. points out that faulty melting practice is one of the most important factors causing porosity and other casting defects in copperbase alloys. It is submitted that in fuel-fired furnaces the water vapour formed reacts with carbon contained either in the fuel, the crucible, or the charcoal covering, to give carbon monoxide and hydrogen, the latter dissolving readily in the melt. On pouring, the exposed metal surfaces are oxidized, and the dissolved hydrogen rapidly reduces this oxide, forming water vapour which, being entrapped in the metal, leads as it cools to the production of gas holes. In the crucible melting of copper and copper-base alloys, carbon may be absorbed from the crucible which, during pouring, forms carbon monoxide and carbon dioxide. In electric-arc-furnace melting it is suggested that the cumulative effect of carbon gas porosity is due (a) to the reaction of carbon monoxide with the metal to form carbon and metallic oxide, (b) to the reaction of the metallic oxide with more carbon monoxide to form minimum amounts of carbon dioxide, and (c) to the reduction of these minute amounts of carbon dioxide in the arc, thus permitting the reaction to proceed from the start.

-J. E. G.

Producing Bomber Castings. J. A. Oates (Aircraft Production, 1943, 5, (56), 292-296; (57), 307-312).—A mechanized foundry is described, and details are shown in numerous illustrations of the equipment and of the moulding technique for the Stirling undercarriage gear-box.—H. S.

Roughness of Metallic Surfaces, with Special Reference to Castings. (O'Neill and Insley). See p. 23.

Gravity Die-Casting.—I. —— (Aircraft Production, 1943, 5, (59), 434–442).—The organization and casting methods used in the production of aluminium alloy parts of the Rolls-Royce Merlin engine as gravity die-castings, are described. These include gear-case cover, coolant pump body, boost-control casing, cylinder skirt, &c.—H. S.

The Venting of Die-Casting Dies. H. K. Barton (*Machinery (Lond.*), 1943, 63, (1616), 386–388).—Methods of designing die-casting dies to ensure adequate venting are described. In dies with simple parting lines, it is often sufficient to finish the die faces with rather coarse shaper cuts, the direction of the cut on one die surface being at right angles to that on the other. Recesses may be vented by undercut plugs. When deep cavities are cut on one side only of the die, a modified gate should be used to slow down the incoming metal stream and allow more time for air to escape.—J. C. C.

**Continuous Casting.** Leslie H. Day (*Metal Treatment*, 1943, **10**, (35), 173–180).—Descriptive. In continuous casting machines the metal is poured either through a stationary mould or between rolls. In the Junghaus and Williams machines, water-cooled moulds of good thermal conductivity are used, the heat being withdrawn laterally. In the Edred and Poland–Lindner machines the moulds are of relatively poor conductivity. If metal is cast on a rotating roll, as in an early machine designed by Bessemer and the Hazelett A machine, folding occurs, and low-melting constituents are segregated. This difficulty is overcome in the Hazelett B continuous casting-rolling mill by the use of a cooling member on which the metal solidifies before passing between the rolls. Reference is made to the Merle machine.

-J. C. C.

Use of Ultrasonics in Metallurgy [for Producing Homogeneous Alloys]. W. Becker (Novosti Tekhniki (Tech. News), 1941, 10, (4), 25–26; Chem. Zentr., 1942, 113, (1), 2579; C. Abs., 1943, 37, 3376).—[In Russian.] The addition of lead to alloys, for instance to aluminium and zine alloys, for the purpose of improving workability, is often difficult because of irregularity in distribution. High-frequency sound-waves, applied by a method similar to the one used in the production of stable emulsions such as mercury-water and water-oil emulsions, were utilized in the production of aluminium and zine alloys containing 10% and 7%, respectively, of lead. These alloys were so stable that even repeated remelting did not cause segregation. The apparatus used is described. The process is also adapted for the introduction of constituents which have low solubility or high melting point and for the removal of gas inclusions from castings.

**Production of Copper Patterns by Electroforming.** A. K. Laukel (*Trans. Amer. Found. Assoc.*, 1942, **50**, (2), 394-401; discussion, 402-404).—L. stresses the importance of choosing suitable pairs of metals for plate and pattern if corrosion is to be avoided. The production of copper patterns using moulds made in plaster of Paris is described in detail. The limitations and advantages of this process are outlined.—J. E. G.

Correlated Abstract of Literature on Flowability and Deformation of Sands. P. E. Kyle and F. R. Evans (Amer. Foundryman, 1943, 5, (1), 4-8).—A critical survey is submitted of methods of measuring flowability, with particular reference to a test, devised by K. and E., dependent upon the hardness gradient of a mould. On the basis of data available it is submitted that flowability and deformation are interdependent within any one mould, that flowability should be related to the preparation of the mould, and that deformation should be related to the ability of a mould to withstand loads imposed upon it either by handling or by molten metal during pouring.

-J. E. G.

A Study of the Flowability of Foundry Sands. Erik O. Lissell and Eugene J. Ash (*Trans. Amer. Found. Assoc.*, 1942, 50, (2), 637–653; discussion, 653–656).—L. and A. suggest that a distinction should be made between (1) autoflowability or flow under conditions of freedom from any external force other than gravitation, and (2) the flowability which is exhibited when sand is subjected to an applied force. In this second type of flowability it is possible to distinguish between (a) compression flow due to the movement of the binder between the sand grains, and the general movement of the sand grains principally in the direction of the applied force, and (b) true flowability, that is, the flow of the sand grains in a direction other than that of the applied force. L. and A. consider that by means of the Dietert method a satisfactory measurement of compression flow may be made.—J. E. G.

\*Progress Report—Comparison Data on the Durability of Naturally-Bonded and Synthetic Moulding Sands by the Repeated-Pour Test. Jack CoVan (*Trans. Amer. Found. Assoc.*, 1942, **50**, (2), 539–561; discussion, 561–567).— It is considered that the most satisfactory durability test for moulding sands is the Nevin repeated-pour test. The durability of three synthetic sands and two naturally-bonded sands were examined. C. reports that in the case of the naturally-bonded sands the amount of natural clay bond required to maintain a green compression strength of 6 lb./in.<sup>2</sup> throughout the series was at least twice as much as that required to maintain this strength in the synthetic sands. It is therefore concluded that, in the case of the sands examined, the synthetic sands are more durable than the natural sands.

-J. E. G.

\*A Foundry Investigation of Bond Clay Properties. A. S. Nichols, F. W. Hintze, and F. L. Overstreet (*Trans. Amer. Found. Assoc.*, 1943, 50, (4), 1257–1290; discussion, 1291–1300).—An investigation into the effect of bonding clays upon the durability of moulding sands, and the relation of casting defects to sand properties.—J. E. G.

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

Similar British and American Secondary Aluminium Alloys are Compared. —— (Amer. Foundryman, 1943, 5, (9), 19–20).—A comparison of alloy D.T.D. 424 with an American counterpart. Points mentioned include foundry technique, composition limits, and mechanical properties.—J. E. G.

Mechanical Ingoting of Aluminium and Magnesium Turnings. Max Stern (*Iron Age*, 1943, 152, (7), 90–92; also (abridged) *Met. Ind.*, 1943, 63, (20), 313).—A description is given of a method, nearing the production stage, of recovering aluminium and magnesium turnings and grindings by briquetting them into nearly solid blocks. Complete evaporation of water and oil and precise temperature control eliminate oxidation and contamination risks. The ingots can be used for melting, for deoxidizing and alloying, or for direct extrusion and forging.—J. H. W.

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

\*Melting and Refining of Zinc in the Electric Furnace. H. Bille (*Elektrowarme*, 1941, 11, 198–200; *Chem. Zentr.*, 1942, 113, (I), 1551; *C. Abs.*, 1943, 37, 3349).—Experiments were carried out on zinc alloys containing copper, aluminium, and magnesium in an 80-kw. resistor furnace and in a 120-kw. low-frequency induction furnace. Results in the resistor furnace were satisfactory, except that power consumption was high. Difficulties were encountered in the induction furnace owing to short life of the lining, but these difficulties were overcome by proper selection of refractory and mode of application. The main advantage over fuel-fired furnaces is constancy of composition of the alloy made, owing to low zinc losses.

 **New Type of Low-Frequency Induction Furnace for Light Metals.** H. Capitaine (*Metallwirtschaft*, 1941, 20, (24), 610–611).—Cf. *Aluminium*, 1942, 24, 69; *Met. Abs.*, 1943, 10, 188. A new type of low-frequency induction furnace for melting aluminium and its alloys consists of a broad rectangular charging chamber connected by three narrow channels to a smaller rectangular chamber provided with a pouring spout; the primary coil is embedded in refractories between the channels, which therefore act as the secondary. In melting scrap the dross collects in the charging chamber and the clean metal flows into the casting chamber. The furnace will melt 10 charges of 2 tons per 24 hrs., and when melting charges consisting of 40% of briquetted lathe turnings the channels require cleaning out every 4–5 days by means of a special steel plunger, an operation which takes only 15 minutes. A photograph and plan and elevation diagrams of the furnace, are included.—A. R. P.

## XVIII.-HEAT-TREATMENT

**Refrigerating Aluminium Alloy Rivets and Parts.** B. J. Fletcher (*Metals and Alloys*, 1943, 17, (6), 1178–1182).—Ageing of aluminium alloys 17S (copper 4, manganese 0.5, magnesium 0.5%) and 24S (copper 4.5, magnesium 1.5, manganese 0.6%) does not commence until the lapse of 16 hrs. at  $32^{\circ}$  F. (0° C.) and requires 2 weeks for completion. At 0° F. (- 16° C.) no ageing takes place for one week. Equipment for refrigerating aluminium alloy rivets, after quenching in order to retard ageing, is illustrated. The rivets are rinsed in alcohol after quenching to remove moisture which would freeze the parts together.—J. C. C.

\*Stress-Relief Annealing of Cold-Worked, Hardenable Copper Alloys. (Wortmann.) See p. 8.

#### XIX.-WORKING

Cartridge Brass (Cold Working and Annealing). L. E. Gibbs (Metal Progress, 1943, 44, (2), 243–248, 292).—A series of charts shows the influence of "ready-to-finish" grain-size on the tensile properties of 70: 30 brass (a) after varying amounts of cold rolling, and (b) after a stated amount of cold rolling followed by annealing at various temperatures; similar results are then summarized graphically for 70: 30 rod. The grain-sizes resulting from the final annealing are shown in both cases. The relations between hardness, cold work, and grain-size are illustrated by photomicrographs showing brass in various stages of cold working and recrystallization, and the influence of these factors on the result of the final annealing is reviewed in detail in its application to industrial processes.—P. R.

Drop-Stamping, Using the Cecostamp to Speed-Up Production of Sheet-Metal Parts. — (Aircraft Production, 1943, 5, (51), 6-9).—The production of compound-curvature parts in sheet metals is described. Zinc alloys are used for the lower die and hardened lead for the purch. The dies are cast in sand moulds, with the use of a pattern made in wood or plaster.—H. S.

**Drop-Hammer Technique.** — (Aircraft Production, 1943, 5, (52), 57–60).—Some notes on the production by an aircraft company of compound curvatures in sheet metal.—N. B. V.

Rubber Dies for Small Presses. A. Bernard (Aircraft Production, 1943, 5, (59), 415–417).—A description of bench-type fly-press practice in blanking and forming operations with the rubber pad, is given.—H. S.

**Plastic Punches.** —— (Aircraft Production, 1943, 5, (54), 166–169).—The plastic punch is moulded directly upon the die. The metal die and plastic punch are used in a drop-hammer or hydraulic press for forming parts in light alloy sheet. The plastic may be worked with hand wood-working tools and is capable of being re-used.—H. S.

Aircraft Sheet-Metal Work. Wilfred E. Goff (Aircraft Production, 1943, 5, (55), 219–229).—Methods of production of sheet-metal equipment for Bristol engines, especially manifolds and cowlings, are described. Nickel plating and subsequent heat-treatment of exhaust rings are described.—H. S.

Sheet-Metal Working. W. S. Neville (Aircraft Production, 1943, 5, (53), 129–133).—Processes evolved for the production of aircraft components are described. These include rubber die practice, flanging, bending, stretching, and drilling.—H. S.

Elastic Theory in Sheet-Forming Problems. F. R. Shanley (Aircraft Eng., 1942, 14, (164), 293–299; (165), 325–328).—[I.—] The term elastic theory is used here to cover all theories relating to change of shape resulting from the application of stress. S. discusses maximum elongation in relation to gauge length, and also permanent strain, combined stresses, triple tension, shear stresses, pure shear, intermediate conditions, Poisson's ratio, and matters related to forming properties of metal sheets. He then deals with forming processes, giving special attention to bending, spring-back, curved " cut-outs," ' stretching, and double curvature. [II.-] Applications flanges, of the double-acting press are discussed. The method of gripping the sheet is important in relation to the range of forming that can be done. Drawing of hollow parts from sheet and the use of a draw ring to prevent wrinkling, permissible strains, dimensional relationships of blank to cup, and other features are mentioned with examples. The use of the wedge-draw test at Lockheed is described. Material properties which are of importance to formability are given for a number of aluminium alloy sheets .- H. S.

Machinability of Metals. A. M. Portevin (*Metal Progress*, 1943, 44, (1), 107–108).—Factors influencing machinability include the following : (1) hardness of the material in relation to the tool; (2) hardness attainable by the material as a result of cold work; (3) force exerted by the tool; (4) working temperature at the point of the tool; (5) presence of non-abrasive or of very hard inclusions; (6) homogeneity or otherwise of the structure of the material; (7) nature of the machined surface. Each factor is discussed in some detail.—P. R.

\*Method of Determining the Machinability of Metals. I. A. Oding and P. R. Virrilep (Zavod. Lab. (Works' Lab.), 1940, 9, 1025–1029; Chem. Zentr., 1942, 113, (I), 261; C. Abs., 1943, 37, 3379).—[In Russian.] A device for testing the machinability of iron, steel, and non-ferrous metals is described. The instrument is easy to operate, and the effect of structural inhomogeneities is eliminated by the use of small specimens. The machining mechanism, and the effects of structure and tool dimensions, can be studied. The instrument permits the determination of cutting indexes at room and elevated temperatures, and the measurement of the tool temperature. The cutting indexes at a speed of 0.4 m./minute have been determined for cast iron, steel, alloy steels, brass, and bronze.

## XX.—CLEANING AND FINISHING

Metal Degreasing. — (Aircraft Eng., 1942, 14, (165), 329–330).—The properties of trichlorethylene and other solvents used in vapour-bath degreasing plant are compared, with special reference to fire hazard, danger to health of operators, latent heat of vaporization, and corrosive action on various metals. Brief mention is made of acidity of the solvent and its removal, and to the use of inhibitors.—H. S.

[Technical and Economic Aspects of Metal Cleaning and Finishing.—60.] Metal Cleaning Before Processing. Kenneth D. Kahn (*Iron Age*, 1943, 152, (11), 62–65).—In an article summarizing research and development since 1917, the advantages and disadvantages, and the equipment and functions, of the principal metal-cleaning methods are described, and the solvent vapour degreasing process is discussed.—J. H. W.

The Seophoto Process. N. Budiloff and K. Hahn (Metallwirtschaft, 1941, 20, (16), 387-392).-In this process, the anodic film on aluminium is impregnated with some material sensitive to light, and the product is exposed. developed, fixed, &c., as usual. Aluminium or aluminium-magnesium alloys of high purity are used : alloys containing copper are unsuitable. For anodizing, the sulphuric, oxalic, or chromic acid process is used, depending on the colour and finish required; chemical dips, such as the M.B.V., are unsuitable. Special precautions have to be taken in processing to avoid superficial imperfections, and thorough cleanliness is essential. Impregnation is done by dipping or rolling, a double process being needed where the lightsensitive substance is insoluble (e.g., silver halides). Ferrogallic or Prussian blue processes may be used. The sensitive material is deposited in the pores of the film; no medium such as albumen or collodion is used, and the product consequently possesses the corrosion- and heat-resistant properties of the anodic film. Impregnation, exposure, and development do not affect the absorptive capacity of the film : the process may therefore be repeated or the picture dyed if required. The process may be used for notices, placards, instrument scales, map reproductions, half-tone work, &c.-H. W. L. P.

#### XXI.—JOINING

**Bonding Plastic and Metal.** — (Aircraft Production, 1943, 5, (52), 55–56).—The Plastel process is described briefly, with reference to the properties of the joints and possible applications of the process in aircraft work.—H. S.

Silver Alloy Brazing with High-Speed Localized Gas Heating. J. I. Butzner (*Iron Age*, 1943, 152, (13), 38–44).—The technique and equipment for gas-air brazing, which has the advantages of fast localized heating and exceptional flexibility, are described with many examples.—J. H. W.

\*The Metallurgy of Fillet Wiped Soldered Joints. E. E. Schumacher, G. M. Bouton, and G. S. Phipps (Metals Technology, 1943, 10, (2); A.I.M.M.E. Tech. Publ., No. 1566, 6 pp.; and Trans. Amer. Inst. Min. Met. Eng., 1943, 152, 291–296; discussion, 296–297).—The causes of porosity in wiped soldered joints are discussed, and the solidification process of a solder is described. In joining lead pipes to cable sheaths by wiped soldered joints, a saving of more than 60% of solder can be made, if, instead of the customary full-sized wiped joint, only a wipe of fillet proportions is formed. This method also eliminates many causes of porosity. The possible saving of tin by the use of new solder alloys is briefly mentioned, and is referred to in the discussion on the paper.—W. H.-R.

\*Safe Substitute Solder for Food Cans. H. W. Gillett, E. J. Cameron, and Robert F. Griggs (Metal Progress, 1943, 44, (3), 420, 421, 454; also Met. Ind., 1943, 63, (24), 373-374).-A report to the U.S. War Production Board. Tests carried out in the U.S.A. between 1938 and 1942 showed that in respect of mechanical properties and suitability for automatic soldering a lead-silver solder containing 2.5% silver was satisfactory. Possible dangers to health lay in absorption of lead by the food and in the presence in the latter of spattered droplets of solder. Cadmium and bismuth solders are unsuited for food containers, as cadmium has some toxic action and supplies would in any case be insufficient, whilst the bismuth solders have a long freezing range and hence do not form sound seams unless the latter are held under pressure. Experiments on lead absorption were carried out on a variety of foods at 98° F. (36.7° C.) with 3 alloys, the 22% silver solder and 2 lead-tin-silver solders. Determinations of lead absorption at 3-month intervals showed a negligible increase in lead content over the period, the absorption immediately after canning being above the safe maximum in one case only : experiments at room temperature showed only negligible lead content after 4 months. It increased in the presence of large numbers of solder pellets, but not to a serious extent.-P. R.

\*Spot-Weld Joint Efficiency for Aluminium Alloys. C. W. Steward (*Weld. J. (J. Amer. Weld. Soc.*), 1943, 22, (10), 5285-5328).—The factors governing joint efficiency and production economy were studied for Alclad 24ST, 0.040 in. thick, and the results are summarized. Spots parallel to the joint at distances  $\frac{1}{4} - \frac{1}{2}$  in. showed that a spacing less than  $\frac{1}{2}$  in. resulted in low strength, and a similar result was obtained with varying distances  $(\frac{1}{4} - \frac{3}{4}$  in.) between spots in the direction of the load. Efficiency tests on specimens of varying sizes showed that a maximum joint efficiency of 100% could be produced with an average of 93%. The maximum stress on a standard specimen obtained was 61,800 lb./in.<sup>2</sup>, with an average of 59,800 lb./in.<sup>2</sup>. The best spot pattern was  $\frac{1}{2}$  in in each direction, and a.c. welds were found to be better than d.c. welds, probably owing to the slight annealing effect.

-E. G. W.

**Spot Welding** [of Light Alloys]. T. M. Roberts (*Aircraft Production*, 1943, 5, (57), 338–343).—Spot-welding developments with condenser-type equipment for the resistance welding of light alloys are described. The merits of the high-voltage and medium-voltage condenser discharge types of welding machine are discussed, the latter being preferred by R. for welding the lighter gauges. The high-lift head, electrode design, refrigeration, surface preparation, and weld strength are interesting features to which special attention is given.—H. S.

**Spot Welding Light Alloys.** — (Aircraft Production, 1943, 5, (51), 3-5).—Modern types of machine, methods of preparation of the work, electrodes, and manipulation are discussed briefly.—H. S.

Observations on the Repair of Cast Light Metals by Welding. K. F. Zimmermann (*Metallwirtschaft*, 1941, 20, (15), 361-365).—Light metal castings are easily repaired by oxy-acetylene welding, if the parts are first throughly cleaned, a suitable flux is used and the residue completely removed after welding, and the alloy used for building-up the worn or broken parts has a similar composition to that of the parts. Several examples are given with illustrations.—A. R. P.

Rapid and Accurate Inspection of Spot Welds [in Aluminium Sheet]. (Anderson.) See p. 26.

Modern Welding Methods for Copper and Copper Alloys. J. J. Vreeland (Weld. J. (J. Amer. Weld. Soc.), 1943, 22, (10), 784–792).—This long survey includes procedure data for the gas and arc welding of copper and copper alloys, together with test results and microstructures. Tough-pitch copper

 $\frac{1}{16}-\frac{3}{8}$  in. thick can be carbon-arc welded, using phosphor-bronze filler rod, but above  $\frac{3}{8}$  in. thickness this is not possible, as multiple-bead welds tend to crack. Deoxidized copper may be oxy-acetylene welded with phosphorusdeoxidized (with or without silver) copper rod or silicon-copper filler. It is also possible to carbon-arc weld deoxidized copper with silicon-copper rod or phosphor-bronze filler of a suitable grade. High copper brasses (to 15% zinc) are preferably welded with silicon-copper (1.5% silicon) by the oxyacetylene process or with 3% silicon-copper rod and suitable flux by the carbon-arc method. Brasses containing 58-80% copper are preferably carbon-arc welded with 3% silicon-copper, although oxy-acetylene welding or carbon arc welding with brass rods may be used. Bronzes are welded satisfactorily with phosphor-bronze or silicon-copper rods by the carbon-arc and also by the metallic-arc process, the latter method being advisable for aluminium-bronze and beryllium-bronze. The carbon arc can be used for aluminium-bronze and beryllium-bronze with high silicon-copper rods. Some examples are illustrated.—E. G. W.

The Welding of Copper by Direct Electric Heating, Using Phosphor-Copper Deoxidizers and Fluxes. A. N. Alimov and S. A. Gorbunov (Avtog. Delo (Autogenous Ind.), 1940, 11, (3), 6–10; Chem. Zentr., 1940, 111, (11), 3400).— [In Russian.] A welding method for copper wire or strip is described by which the copper parts to be joined are heated to welding temperature by the direct passage of current between carbon electrodes, and the welding is carried out with the application of a quick-acting deoxidizer and flux consisting of phosphor-copper with  $7\cdot5-8\%$  phosphorus. The mechanical properties of these copper welds were superior to those made without the phosphor-copper flux.

Repair of Copper Vessels and Boiler Parts by Welding. H. Schnedler (*Metallwirtschaft*, 1941, 20, (15), 357–360).—The value of oxy-acetylene welding for repairing copper boilers, electrical apparatus, locomotive fire-boxes, and similar large articles is illustrated by several examples. A neutral flame and a good coating of a borax flux are essential for obtaining sound welds.

-A. R. P.

Locomotive Parts Fabrication and Welding of Bronze Bearing Surfaces. J. W. Kenefic (*Weld. J. (J. Amer. Weld. Soc.*), 1943, 22, (10), 799–805).— Among a number of typical applications of welding to repair and fabrication, are included illustrated examples of building-up bearing surfaces with leadbronze electrodes or the carbon arc, the bronze welding of cast-iron parts, and the facing of fabricated driving boxes with bearing brass.—E. G. W.

\*The Flash Welding of Nickel and High-Nickel Alloy Rod. Wendell F. Hess and Albert Muller (Weld. J. (J. Amer. Weld. Soc.), 1943, 22, (10), 532s-544s).-Satisfactory flash-welding conditions were established for  $\frac{1}{4}$ - and  $\frac{3}{8}$ -in. diameter rods of "A" nickel, Monel, "K" Monel, and Inconel. Effects of welding variables investigated-cam shape, flashing time, upset, current during forging, and energy input—are described, and the fundamental considerations are discussed. During the work a method of measuring energy input and distribution was developed, using a high-speed recording wattmeter. Welds of optimum strength were obtained at short-circuit power levels just sufficient to maintain uniform fine flashing at the butted surfaces. Lower power resulted in erratic welds of low strength and higher power resulted in reduced weld strength owing to entrapped oxide. Current must be maintained during the initial stages of upset to facilitate forging. Satisfactory microstructures are illustrated, and the three major defects in flash-welded high-nickel alloys are listed as: (i) oxide at the interface, (ii) trapped dendritic material at the interface, (iii) partial fusion in the weld region. Alteration of the clamping dies is required in cases where current conduction from one side only of the clamp is provided in order to avoid "die burns." Other machine data are included.-E. G. W.

On the Present Position of Welding Technique for Hard-Metal Alloys. R. Kottisch (*Metallwirtschaft*, 1941, 20, (15), 365–368).—Methods of welding hard-metal (cobalt alloys and sintered carbides) inserts and tips to steel articles are briefly described, and some new uses are mentioned.—A. R. P.

Welding in the Construction of Aircraft. James W. Cowie (Australasian Eng., 1943, 43, (325), 20–22).—After a brief description of the development of welding in aircraft, C. discusses the distortion in welded parts due to: (1) residual stresses in the metal released by heat; (2) contraction of metal in the heated zone; and (3) contraction of the weld deposit. The methods to overcome or reduce distortion, used singly or in combination, are given as: (1) contra heating; (2) weld procedure; (3) pre-stretching; and (4) uniform heating.—E. A.

Electric Welding of Wire. V. N. Voskresenski (*Tochn. Ind.* (*Precision Ind.*), 1940, **11**, (4), 17–19; *Chem. Zentr.*, 1940, **111**, (II), 3259).—[In Russian.] A comprehensive survey of the various methods, circuit layouts, and apparatus for electric welding of ferrous and non-ferrous wires for contacts, &c., with examples of satisfactory and defective welding. Scale-proof chromium-nickel, chromium-aluminium-iron, and chromium-cobalt-aluminium-iron alloys are best welded by means of electric discharges, and not by a.c. or d.c. arc. Wires or wire + strip are welded with the best results in two stages : (1) by first thickening the ends to be welded by strong discharges, and (2) then carrying out the welding operation proper. The strength of the discharges in these operations has to be adjusted according to the diameter of the wire in order to maintain the voltage <30. The above method is unsuitable for welding of aluminium wire, which has to be done by the usual lap-welding method.

Welding of Metals with Bronze. — (Commonwealth Eng., 1943, 30, (10), 231–236).—Fusion and non-fusion welding with coated aluminiumbronze electrodes are discussed, as applied to metals and alloys having a higher melting point than that of the welding rod, such as wrought, cast, and malleable iron, carbon and alloy steels, copper-zinc alloys in general, manganese bronzes, &c. Composition and properties of the various aluminium-bronze welding rods are tabulated, and the process of welding and some of its special applications are described in detail.—E. A.

Atomic Hydrogen Welding. L. G. Pickhaver (*Weld. Eng.*, 1943, 28, (6), 42–45).—This general account of the atomic hydrogen welding process includes a reference to multi-arc welders.—E. G. W.

\*Establishment of Cooling Curves of Welds by Means of Electrical Analogy. V. Paschkis (*Weld. J. (J. Amer. Weld. Soc.*), 1943, 22, (10), 462s-483s).—This paper applies a method developed earlier, in which it was shown that certain electrical circuits follow exactly the same mathematical laws as apply to transient heat flow. The heat and mass analyzer was used to study the mechanism of heat transfer from a metallic arc to a plate, and two general curves were obtained, one for each of the two components of energy transfer radiation and heat in the metal melted from the electrode. The possibilities of the method were established, but further work is required to obtain more curves and to correlate the data with direct thermal measurements. Full details of the curves and the experimental work must be obtained from the paper.—E. G. W.

Why the Weld Recorder? J. R. Fletcher and J. Van Den Beemt (Weld. J. (J. Amer. Weld. Soc.), 1943, 22, (10), 815–818).—The weld recorder (or ampere-squared-second recorder) provides the most accurate method of checking the value of  $I^{2}t$  in the formula : Heat  $\propto I^{2}Rt$ . The apparatus and circuit are briefly described, and its application to a stainless steel spot weld is summarized. It is stressed that weld recorders must be used only with timers giving perfect synchronous control, and must be employed with proper

weld procedure and test weld examination. The variables which affect weld strength but not the recorder are noted, as well as those which affect both weld strength and the recorder.-E. G. W.

Shrinking Galvanized Steel. C. R. Goetjen (Weld. Eng., 1943, 28, (5), 40). -In shipbuilding it is sometimes necessary to flame-shrink galvanized steel plates after welding in order to overcome distortion, and a special technique has been worked out to reduce the removal of the zinc coating. A highly oxidizing flame, with a central cone  $\frac{5}{2}$  in. long, is used, in conjunction with a quench spray. The flame is withdrawn from the metal when the first sign of

colour (dull red) appears.—E. G. W. Reclamation by Hard Facing. F. G. Jones (Weld. J. (J. Amer. Weld. Soc.), 1943, 22, (10), 797-798) .- In a general review of hard-facing methods, the non-ferrous alloys-chromium-boron-nickel and chromium-tungsten-cobaltare mentioned as being of particular value for resistance to wear and corrosion, and also to erosion at high temperatures. Typical applications are noted briefly.-E. G. W.

Health Aspects of Welding. A. G. Cranch and B. L. Vosburgh (Metal Progress, 1943, 44, (2), 253, 290; also Canad. Metals, 1943, 6, (10), 35-37, 44).-From a pamphlet issued by the National Safety Council. The principal hazards to health in welding operations are those arising from (a) radiation (intense light and, in some cases, ultra-violet radiation), and (b) toxic gases and fumes. Radiation hazards can be combated by protective gear (goggles, screens, &c.) and the use of non-reflecting paint. Poisonous gases, mainly oxides of nitrogen, can be eliminated by proper ventilation. Protection from lead or cadmium fumes should be afforded by air-supplied masks : zinc fumes do not constitute a permanent hazard, but cause acute poisoning ("zinc fever") over short periods. Ventilation of welding shops should ensure good visibility at the point of operation and permit a comfortable working temperature; in confined spaces exhaust ventilation is usually desirable.-P. R.

## XXV.-BOOK REVIEW

Reports of the Progress of Applied Chemistry. Volume XXVII, 1942. Demy 8vo. Pp. 545. 1943. London: The Society of Chemical Industry, 56 Victoria St., S.W.1. (Members, 11s. 6d.; non-members, £1.)

This volume covers, in 26 reports, progress in the whole field of applied chemistry, mainly as recorded in *British Chemical Abstracts* during the year 1942. An analysis of the papers referred to in the course of the two chapters which are of especial interest to the members of this Institute, reveals clearly the difficulty of attempting to give a balanced survey of progress in metallurgy in the third year of the war. Thus, of 106 papers mentioned in the report on "Non-Ferrous Metals" (by Dr. E. S. Hedges), 21 are British, 45 American, 19 German, 6 Russian, and 15 from other countries; in that on "Electrochemical and Electrometallurgical Industries" (by Dr. J. W. Cuthbertson), the predominance of American papers is much greater, viz., 65 per cent. of the total. The figures are : British 23, American 52, German 1, Russian 1, Indian 3. This disproportion reflects two facts : first, the difficulty that has existed of obtaining, since May 1940, the literature of enemy countries and, since 1941, the Russian literature; and second, that in the period under survey the United States had only just begun a reduction in the number of scientific papers published. The other reports have not been examined in detail, but the same tendency appears to prevail in them too.

This analysis is not to be interpreted as serious criticism of the reports or of the two authors specifically mentioned; it is given only to show that really comprehensive surveys must wait upon access being gained to literature that is not at present available and upon the publication of much matter at present suppressed. As interim reports—the best, no doubt, it is possible to make at this date—the two reports, and indeed the volume as a whole, are admirable, and they deserve to be widely read, particularly by those who find little time nowadays for keeping their technical reading up to date.

The volume is provided with name and subject indexes, and the standard of production of former years is well maintained.

POLITECHNIKI