METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

OCTOBER

Part 10

I.-PROPERTIES OF METALS

(Continued from pp. 529-531.)

The Increase of the Heat Radiation of Aluminium by Surface Treatment. G. Eckert (*Hauszeit. V.A.W. u.d. Erftwerk A.G. Aluminium*, 1932, 4, 31-32). —The radiation of heat from aluminium is considerably increased by electrolytic oxidation (Eloxal process) and thin coatings of water glass, slaked lime, suspensions of graphite or kieselguhr in water, powdered chalk, or sand.—M. H.

Research on Italian Aluminium. O. Scarpa (Alluminio, 1932, 1, 3-14, 73-79).—The average electrical conductivity of Italian hard-drawn aluminium wire has been determined with respect to the international standards proposed in 1928 in Paris. The variations in electrical conductivity caused by impuritics and by annealing are shown graphically. The temperature and the time of annealing, for minimum resistance, have been particularly investigated. Density and maximum strength measurements complete the research. The sp. resistance of hard-drawn aluminium is given as 2,850 and that of the annealed metal as 2,770 microhms/cm.³ at 20° C.—G. G. Measurements with the Aid of Liquid Helium. XV.—Resistance of Barium,

Measurements with the Aid of Liquid Helium. XV.—Resistance of Barium, Indium, Thallium, Graphite, and Titanium at Low Temperatures. W. Meissner, H. Franz, and H. Westerhoff (*Ann. Physik*, 1932, [v], 13, 555–563).—Researches on very pure materials.—v. G.

X-Ray Studies of the Thermal Expansion of Bismuth Single Crystals. Alexander Goetz and Rudolf C. Hergenrother (Phys. Rev., 1932, [ii], 41, 643-661) .- The spacings of the (111) plane in a single crystal of bismuth have been measured by X-ray methods at temperatures from - 182° to + 265° C. The coeff. of thermal expansion of the lattice were then calculated, and compared with those obtained by macroscopic measurements on single crystals. The coeff. of expansion of the crystal as a whole shows a slight but abrupt change at + 75° C., but otherwise varies little with temperature until about 40° C. below the melting point, when it begins to decrease. The lattice expansion shows no discontinuity at 75° C., and increases linearly with the temperature, the value of $d\alpha/dT$ being much greater than for the macroscopic coeff. When compared with the sp. heats, the lattice expansion shows a remarkable constancy of α/C_p in agreement with Grüneisen's relation, but this does not hold for the macroscopic coeff. (α is the coeff. of expansion, and C_p the sp. heat). The lattice expansion is given by :

$\alpha_{\rm m} = 14.4 \times 10^{-6} \left[1 + 1.76 \times 10^{-3} \left(T_{\rm abs.}\right) - 298^{\circ}\right].$

The results are discussed, and may be due to the existence of a mosaic structure as suggested by Zwicky. The paper contains numerous references to work on bismuth crystals.—W. H.-R.

The Hall Effect in Bismuth Single Crystals. H. Verleger (Z. Physik, 1932, 76, 760–765).—Voigt's formula for the Hall effect in a crystal, viz., $R\varphi = R_{\parallel} \cos^2 \phi + R_{\perp} \sin^2 \phi$, ϕ denoting the angle between the principal crystallographic axis and the length of the specimen, is confirmed in the case of a bismuth single crystal. The values of the constants are $R_{\parallel} = -1.33$; $R_{\perp} = -10.2$, in c.g.s. units.—J. S. G. T.

Some Thermo- and Galvano-Magnetic Properties of a Bismuth Crystal. H. E. Banta (*Phys. Rev.*, 1932, [ii], 41, 239-250).—A single crystal of bismuth was arranged so that a current could be passed through it in the presence of a magnetic field. The current through the crystal heats one junction, and

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cools the other by means of the Peltier effect, and the resulting temperature difference gives rise to a thermal e.m.f. in the crystal circuit. By measuring this e.m.f., the effect of the magnetic field on electrical and thermal conductivities and thermo-electric power can be obtained as functions of the relative directions of the field, the crystal axes, and the currents of heat and electricity in the crystal. The results are highly complex, and the details cannot be reconciled with existing theories, but suggest that the magnetic field may change the free electron density. The change in electrical conductivity is much more structure-sensitive than that of thermal conductivity, and there appears to be an essential difference between the two processes.

-W. H.-R.

Hall Effect in Beryllium. A. Ciccone (*Nature*, 1932, 130, 315).—A small, positive Hall effect has been observed in beryllium. The Hall coeff. is + 0.0024 + 0.0001.—E. S. H.

Magnetic Properties of Thin Cobalt Films, Electrolytically Deposited. E. P. T. Tyndall and W. W. Wertzbaugher (*Proc. Iowa Acad. Sci.*, 1929, 36, 297; *C. Abs.*, 1931, 25, 1139).—Initial magnetization curves and hysteresis loops of cobalt films from 40 to 100 millimicrons thick show the same general characteristics as iron films (*Phys. Rev.*, 1927, [ii], 30, 681-691) of the same range of thickness. The specific properties, however, depend largely on the acidity of the electrolyte. The linear relation between thickness and reciprocal of coercive force discovered for iron films is not in general true for cobalt, although it is approximated in some series of films.—S. G. The Degassing of Copper Castings by Lithium. A. Burkhardt and G. Sachs

The Degassing of Copper Castings by Lithium. A. Burkhardt and G. Sachs (*Metallwirtschaft*, 1932, 11, 239–242).—Addition of 0.003-0.01% of lithium to copper results in complete removal of gases, decomposition of cuprous oxide, and a non-porous casting. The electrical conductivity of the east metal is increased and the mechanical properties are improved. The conductivity of wire is increased to 59.8 m./ohm./mm.² by addition of 0.01% lithium and with further additions falls only slowly. (See also following abstract.)—v. G.

further additions falls only slowly. (See also following abstract.)—v. G.
Deoxidizers for Copper. Anon. (*Metallurgist (Suppt. to Engineer*), 1932, 8, 92–93).—The subject of the deoxidizing of copper is briefly discussed and reference made to recent published work, including a summary of a paper by A. Burkhardt and G. Sachs (see preceding abstract).—R. G.

Tensile Strength Tests on Whole and Soldered Gold and Silver Wires and Hardness Tests on Silver and Gold Plates. Joh. Aschan (*Finska Kemistsamfundets Medd.*, 1931, 40, 126-129; *C. Abs.*, 1932, 26, 2680).—As a result of the tests it is concluded that the tensile strength and hardness of 14-carat gold are almost equal to those of the softer forms of steel. Solders containing eadmium are very satisfactory.—S. G.

Indium Available in Commercial Quantities. William S. Murray (Indust. and Eng. Chem., 1932, 24, 686).—M. describes physical and chemical properties of indium, and reviews the work done on the electrodeposition of this metal. When co-deposited with other metals, the hardness and surface stability of the deposits are increased. Uses for the metal, which has a tensile strength of 7.99 tons/in.² (99.71% pure) and considerable ductility, are found in the automobile, electrical, jewellery, and dental trades. It is now available in larger quantities than hitherto.—F. J.

Researches with the Aid of Liquid Helium. XVII.—Resistance of Lead in a Magnetic Field at Temperatures Below the Superconducting Point. W. Meissner (Ann. Physik, 1932, [v], 13, 641–648).—v. G.

Measurement of the Height of a Large Drop of Mercury [Surface Tension of Mercury]. Marie Kernaghan (*Phys. Rev.*, 1932, [ii], 40, 1020–1021).—A note. Burdon (*Nature*, 1931, 128, 456) criticized K.'s determination (see this J., 1931, 47, 370) of the surface tension of mercury on the grounds that the true summit of the mercury drop was not measured. Further experiments show that this criticism is unjustified.—W. H.-R. Heat Conductivity, Wiedemann-Franz-Lorenz Value, and Thermoelectric Power of Mercury Single Crystals. Hermann Reddemann (Ann. Physik, 1932, [v], 14, 139-163).—Single crystals of mercury were prepared by Sckell's method (this J., 1931, 47, 66) and their thermo-electric power was measured in different directions; the values for the couple, crystal perpendicular to the principal axis/crystal parallel to this axis are at — 76° C., $\pm 23 \times 10^{-7}$ and at $- 187^{\circ}$ C., $\pm 27.5 \times 10^{-7}$ v./° C. The heat conductivity (measured by Lees' method) is 0.264 watt/cm./° C. at — 77° C. and 0.290 watt/cm./° C. at $- 187^{\circ}$ C. perpendicular to the principal axis; parallel to this axis the corresponding figures are 0.341 and 0.399 watt/cm./° C.—v. G.

Further Data on the Thermal Diffusivity of Nickel. Richard H. Frazier (*Phys. Rev.*, 1932, [ii], 40, 592-595).—The thermal diffusivity (*i.e.* the ratios of the thermal conductivity to the product of specific heat and density) of two grades of nickel of 99.25% and 91.56% purity, respectively, has been measured by the method previously described (Frazier, J., this volume, p. 292). For the purer metal the result is in good agreement with that obtained in the previous investigation for nickel of 99.23% purity, but a lower value is obtained for the impure metal, in which manganese was the chief impurity.—W. H.-R.

Magnetization of Electrolytic Nickel Films. E. P. T. Tyndall and H. E. Malmstrom (*Proc. Iowa Acad. Sci.*, 1930, 37, 312–313; *C. Abs.*, 1931, 25, 4452).—The magnetic properties of nickel films deposited electrolytically on brass tubes are determined by the method previously described for iron and cobalt films (see this J., 1930, 43, 399; abstract above, p. 594; and *Phys. Rev.*, 1927, [ii], 30, 681–691). Films about 130 $\mu\mu$ thick attain a magnetization of about 380 e.g.s. units in a field of 200 gauss, a value about equal to that for bulk nickel. As in iron and cobalt, the coercive force is high, but the remanence is somewhat less than was found for iron and cobalt.—S. G.

Does Nickel Show a Positive Elongation in the Joule Magnetostrictive Effect ? S. R. Williams (*Phys. Rev.*, 1932, [ii], 41, 251-253).—Recent statements that a positive elongation is to be expected for the Joule magnetostrictive effect in nickel may be misleading. A positive elongation in nickel occurs only when there is remanent magnetism present in the specimen, or an extraneous field is imposed, and then only when the magnetizing field is opposed in direction to the remanent magnetization or the extraneous field. Curves showing the changes in length of nickel under various conditions of magnetization are reproduced.—W. H.-R.

Magnetic Properties of Iron, Nickel, Cobalt, and Some Alloys at High Temperatures. H. Kühlewein (*Wiss. Veröff. Siemens-Konzern*, 1932, 11, (1), 124– 140).—Forrer's observation that some metals have two magnetic transformation points has been confirmed by measurements by the ballistic ring method. Thus nickel containing 1% manganese loses its ferromagnetism at 378° C. and its paramagnetism at 436° C. on heating; the reverse changes occur at 340° C. and 394° C., respectively, on cooling. The magnetic transformation point of cobalt--iron alloys with 20–70% cobalt is identical with the A₃ transformation point, and the paramagnetic change occurs at a higher temperature than the ferromagnetic change, as is the case with all face-centred iron, cobalt, and nickel alloys. The transformation temperatures of certain cobalt alloys from a hexagonal to a face-centred cubic lattice and vice versa are affected by the presence of external magnetic fields, probably owing to the development of larger internal stresses by magnetostriction in the hexagonal lattice than in the γ -lattice. The magnetization curves of Invar above 500° C. resemble those of single crystals.—A. R. P.

The Shift of the Transmission Band of Silver by Cold-Working. Henry Margenau (*Phys. Rev.*, 1932, [ii], **40**, 800–801).—Application of the theory of Kronig (*Proc. Roy. Soc.*, 1929, [A], **124**, 409) suggests that change of lattice constant may be responsible for the shift in the ultra-violet minimum of reflecting power of silver when the surface is cold-worked. Existing data on the change of density after cold-work are of the order of magnitude required by this explanation.—W. H.-R.

The Specific Resistance of Thin Metallic Films, Especially of Silver and Tungsten. L. Hamburger and W. Reinders (Rec. trav. chim., 1931, 50, 441-474: C. Abs., 1931, 25, 4161).-Thin films of silver were formed by sublimation and condensation on glass walls. The thickness of the film was calculated from the weight of the film and the density of the metal by assuming this to be the normal density of the compact metal. The average thickness of the silver film formed at room temperature was 16 atoms, of the tungsten film 1 atom. At - 185° C, each metal film was 2 atoms thick. From measurements made at room temperature and at the temperature of liquid air, it is concluded that the sp. resistance of thin metal films depends on the metal employed, the thickness of the film, the type of formation, the temperature and changes in temperature, the foundations on which the metal is deposited, and other influences. The sp. resistance of thin films is greater than that of the massive metal, the deviation being the greater the more refractory the metal and the lower the temperature at which condensation takes place. Tungsten films $2 \mu\mu$ thick formed at - 185° C. have a negative temperature coeff. Thin films of both silver and tungsten are attacked by moist oxygen, but not to any great extent by the dry gas.-S. G.

Notes on the Evaporation of Ag, Be, Cr, and Si. C. Hawley Cartwright (*Rev. Sci. Instruments*, 1932, 3, 298-304).—The technique and apparatus required for evaporating silver, beryllium, chromium, and silicon in order to obtain good films by deposition are discussed.—J. S. G. T.

Sodium and Potassium Metals. Paul M. Tyler (U.S. Bur. Mines Information Circ. No. 6579, 1932, 1-7).—General.—S. G.

Constitution of Tantalum and Niobium. F. W. Aston (*Nature*, 1932, 130, 130).—Analysis of the mass spectra of tantalum and niobium pentafluorides gives the following values for the atomic weights : tantalum = 180.89 ± 0.07 , niobium = 92.90 ± 0.05 . These values are considered to be more trustworthy than those determined by chemical methods and recommended by the International Committee.—E. S. H.

The Hall Effect [in Tellurium] with Audio-Frequency Currents. Lawrence A. Wood (*Phys. Rev.*, 1932, [ii], **41**, 231–238).—The Hall e.m.f. in tellurium has been studied with currents of frequencies up to 25,000 cycles/second, both null and comparison methods being used. Both methods indicate that the Hall coeff. is constant to within about 2% for frequencies up to 10,000 cycles/second, and to within 7% for the complete range studied. The frequency, wave form, and phase of the Hall e.m.f. are the same as those of the longitudinal currents producing it, and the results are in general agreement with expectation. The Hall coeff. $R_{\rm H}$ was determined as 481.—W. H.-R.

On the Transformation of White Tin into Grey Tin ("Tin-Pest"). G. Tammann (Z. Metallkunde, 1932, 24, 154–156).—See abstracts from papers by Tammann and Dreyer (this J., 1931, 47, 644–645) and Tammann and Kohlhaas (J., this volume, p. 467).—M. H.

Conduction of Heat and Electricity in Zinc and Cadmium Crystals. E. Goens and E. Grüneisen (Ann. Physik, 1932, [v], 14, 164–180).—The heat conductivity of single crystals of zinc and cadmium of different orientations have been determined at various temperatures. The following table gives the

Temperature (°O.)	Zine .	Zinc 1.	Cadmium .	Cadmium L.
$+ 20 \\ - 190 \\ - 252$	$1.24 \\ 1.32 \\ 7.1$	$1.24 \\ 1.37 \\ 5.7$	0.83 0.90 1.80	1.04 1.13 2.00

extrapolated values for ideally pure, undeformed crystals parallel to (\parallel) and perpendicular (1) to the principal axis in watts/cm./° C.—v. G.

Poisoning and Activation of Zinc. K. Jablezynski and J. Kulesza (Z. anorg. Chem., 1932, 207, 157-160).—The rate of dissolution of "Kahlbaum" zinc in 0.5N-hydrochloric acid at room temperature measured by the volume of hydrogen evolved from 1 cm.² of the surface per second, is decreased by potassium cyanide (0.005N) by about 32-45% (according to the activity of the zinc) and considerably increased by potassium thiocyanate, but with 0.000002N-thiocyanic acid the action ceases. Carbon disulphide increases the activity by about 50%, even at 0.0002M. Sulphur dioxide as concentrated as 0.073M and thiouric acid have no influence on the reaction velocity.—M. H.

The Metal Crystal. (Sir) Harold Carpenter (Proc. Roy. Inst. Great Britain, 1930, 26, 267-285).—See this J., 1930, 44, 466.—S. G.

The Mechanism of Plasticity. N. Seljakow (Z. Physik, 1932, 76, 535–536). —Plastic deformation of rock-salt crystals is shown, by X-ray analysis, to result in the deformation of the original cubic crystal into a series of parallel layers having cubic symmetry with superposed layers possessing monoclinic crystal symmetry characterized by different angles of inclination between the diagonals of the crystal faces in their original and displaced positions. The maximum value of this angle was found to be 1°, corresponding with an internal stress of 30 kg./mm.².—J. S. G. T.

Corrigendum to the Paper "On the Problem of Fatigue in Metals." W. Kuntze (Metallwirtschaft, 1932, 11, 225).—Cf. J., this volume, 149.—v. G.

Recovery from Cold-Work, Estimated According to the Change in Hardness and Rate of Dissolution. G. Tammann and F. Neubert (Z. anorg. Chem., 1932, 207, 87-92).—The hardness and rate of dissolution in dilute hydrochloric acid of cold-worked magnesium, aluminium, cerium, and zine have been determined after annealing for 1 hr. at different temperatures; both decrease on recovery from cold-work within the same temperature interval (which is characteristic for each metal) and finally reach the values for the soft state. With electrolytic iron the rate of dissolution in 3N-sulphuric acid follows the tensile strength and not the hardness.—M. H.

Rockwell Hardness Unchanged by Magnetic Treatment. R. H. Harrington (*Metal Progress*, 1932, 221, (6), 40–41).—Rockwell hardness tests, performed on two samples of material hardneed and magnetically treated in the manner described by E. G. Herbert (*J. Iron Steel Inst.*, 1929, 120, 239), showed that magnetic treatment did not appreciably affect the Rockwell "A" hardness in either case. H. therefore considers any attempt at a theoretical explanation of Herbert's results in terms of lattice structure to be premature.—P. M. C. R.

Magnetic Analysis of Internal Stresses. M. Kersten (Z. Physik, 1932, 76, 505-512).—A method of deriving the mean internal stress in plastic rolled nickel wire from the reversible energy of magnetization is discussed. The values of the stresses derived agree with those already obtained by K. from a consideration of initial magnetic permeability (this J., 1931, 47, 642). Suggestions are made as to the effect of internal stresses on the energy of magnetization of single crystals.—J. S. G. T.

Inter-Diffusion of Metals. E. A. Owen and L. Pickup (Nature, 1932, 130, 201-202).—The inter-diffusion of mixtures of copper and zinc particles heated together in a vacuum has been studied by high-precision X-ray analysis. Photographs taken at various time intervals show that the diffusion of copper and zinc is controlled entirely by the thermal equilibrium diagram, the rate of diffusion of the various phases being different. The rate of diffusion at a given temperature is independent of particle size. The system studied is somewhat complicated, but the following expression is put forward tentatively as the fundamental law of inter-diffusion: $c_0 - c = \Sigma K e^{-mt}$, where c is the composition at time t, c_0 the final composition, and K and m are constants

depending on the temperature at which inter-diffusion occurs, each phase having a different set of constants.—E. S. H. New Photoelectric Phenomenon. Q. Majorana (Nature, 1932, 130, 241).—

When a metal film carrying an electric current is exposed to intermittent light. a thermionic amplifier allows a sound of the same frequency to be heard in a telephone. This effect is observed with silver, gold, and platinum, but not in wires of aluminium or zine. The experiments show that the metals examined increase in electrical resistance when illuminated, the increase being of the order of 1/10,000 to 1/100,000. For silver the maximum effect is produced by light in the ultra-violet region .- E. S. H.

A New Method of Measuring Contact Potential Differences in Metals. W. A. Zisman (Rev. Sci. Instruments, 1932, 3, 367-370) .- A method of measuring contact p.d. between metals, using a three-stage audio-frequency amplifier and head-telephones in which the audible signal disappears when the p.d. applied to a condenser balances the contact p.d., is described. Measurements to 0.001 v. can be made in a few seconds. Forms of apparatus, suitable for studying metals in air and in high vacua, respectively, are described .-- J. T.

Constant Ratio between Thermal and Electrical Conductivities of Metals. A. Grebel (Chaleur et Ind., 1929, 10, 569-571; Ceram. Abs., 1930, 9, 364) .---A constant ratio between electrical conductivity and thermal conductivity has been shown to exist for silver, copper, gold, aluminium, nickel, iron, platinum, lead, and mercury in the temperature range 0°-100° C. This ratio is equal to approximately 16 cm.² ohm seconds. The ratio between the two conduc-tivities may be expressed as follows: $\gamma = 3.3 \left(\frac{R}{N \times \epsilon}\right) T$, where R = the gas

constant, N = Avogadro's number, e = the charge on the electron, and T is the absolute temperature. R must be expressed in ergs and e in electromagnetic units.-S. G.

The Problem of the Electrical Conductivity of Metals. C. D. Niven (Canad. J. Research, 1931, 5, 79-86).-It is pointed out that mathematicians in their attempts to form theories of electrical conduction, do not lay emphasis on the fact that at low temperatures resistance, as a rule, does not vanish. In those cases in which it does, it vanishes suddenly. In view of this, the question arises as to whether the right model for conductivity in a metal is visualized. It is suggested that fundamentally a metallic atom is one in which the electron configuration is incomplete. Ordinary conduction consists of a process whereby an electron jumps from one atom to another and remains with the atom it jumps to until it is in a sort of equilibrium with the motions of the electrons already in that atom. In the super-conducting state the electronic orbits of different atoms become synchronized, so that when an electron leaves one atom another electron automatically comes on the atom to take its place. A study of the resistance-temperature curves as well as other points emphasizes the importance of structure in conductivity .--- S. G.

"Matthiessen's Constant," or the Relation between Electrical Resistivity and Temperature Coefficients of Metals. J. T. MacGregor Morris and R. P. Hunt (Phil. Mag., 1932, [vii], 14, 372-383).-Matthiessen, in 1862, concluded that " the absolute difference in the resistance of an alloy between 0° and 100° C. is equal to the absolute difference between the means of the resistance of the component metals between 0° and 100° C." The authors restate the "law," which is known to be invalid in some cases, in the form : " For the alloys of any particular metal with another, the rate of increase of resistivity with temperature is independent of the concentration." It follows that the value of $R_0 \times$ temperature coeff. is a constant for a series of alloys, and the name "Matthiessen's constant" is suggested for it. Experimental work relating to the subject is reviewed, and it is concluded that the constant has decided practical value in enabling one to predict rapidly the resistivity of a sample of commercially pure metal by measurements of its resistance temperature coeff. No knowledge of the dimensions of the specimen is necessary. Although the application of the "constant" is limited, e.g. in the case of cutectic mixtures, the examples given show the law to be of wide application, each metallic element having associated with it a definite constant.—J. S. G. T. Dispersion Theory Applied to Metallic Conduction. Y. Fujioka (Z. Physik,

Dispersion Theory Applied to Metallic Conduction. Y. Fujioka (Z. Physik, 1932, 76, 537).—The effect of an external alternating electric field on the motion of electrons in a metallic conductor is discussed mathematically. Satisfactory agreement is obtained between theoretical deductions and experimental results.—J. S. G. T.

Superconductivity with High-Frequency Currents. J. C. McLennan, A. C. Burton, J. O. Wilhelm, and A. Pitt (*Nature*, 1932, 130, 201).—Cf. J., this volume, p. 217. Observations have been made on the electrical resistance of tin when both a.e. (frequency $12 \times 10^{\circ}$) and d.e. are flowing simultaneously. Under these conditions there is a common critical point on the temperature scale, the position of which is determined by the ratio of the magnitude of the d.e. to that of the a.e. The experiments establish the depression of the critical point for the d.e. resistance by the application of high-frequency currents, and the raising of the critical point for the high-frequency resistance in the presence of d.e.—E. S. H.

Contribution to the Theory of Electrical Resistance and the Superconductivity of Metals. Erich Kretschmann (Ann. Physik, 1932, [v], 13, 564–598).--v. G.

The Structure Sensitiveness of Magnetism in Metals. F. W. Constant and F. E. Lowance (J. Elisha Mitchell Sci. Soc., 1932, 47, 24-25; C. Abs., 1932, 26, 2679).—The changes in magnetic susceptibilities of copper, silver, bismuth, and platinum when subjected to various degrees of cold-work, were determined by the Gouy method. Diamagnetism decreased in diamagnetic metals, and paramagnetism increased in the platinum. The changes are caused by an increase of the paramagnetic component due to accumulation of free electrons during the twisting, stretching, and pounding of the metal.—S. G.

Magnetic Properties of Thin Metal Films. W. Elenbaas and W. F. van Peype (Z. Physik, 1932, 76, 829-849).—The magnetic properties of thin films of iron and nickel, of thickness $0.2-20 \mu$, electrolytically deposited, have been investigated. The coercive force of iron increases with decreasing thickness of film; the remanence likewise increases, but differently in the case of films deposited at different current densities. This is apparently attributable to the development of a fibrous texturo with increasing current density. The longitudinal stress in the film, calculated by the aid of Becker's theory, ranges from 20 to 100 kg./mm.², dependent on the current density employed and the thickness of the film. Annealing in vacuo for about } hr. at 600° C. causes the coercive force to be reduced to about one-half its original value; the remanence is, in similar circumstances, considerably reduced only in the case of the very thickest films. The magnetic properties of the thinnest films both of iron and nickel are dependent not only on the stress, but also on the film thickness. Nickel films have a permeability of 6-12. Hysteresis and virginal magnetization curves are rectilinear. The magnetic properties of the thickest films of nickel agree with results found by Kersten in the case of nickel under tension. Annealing in vacuo for about 3 hr. at 450° C. causes the coercive force to be reduced to about 1 its initial value; the remanence of thick films increases considerably in similar circumstances, whilst the increase is much less in the case of thin films. Extrapolation to zero thickness of film indicates no increase of remanence due to annealing. Annealing causes no change in the fibrous texture of iron films; [111] remains the axis of the fibrous structure. In the case of nickel films, however, prior to annealing the axis of the fibrous structure is [110]; subsequent to annealing, however, the axis [100] is oriented normal to the plane of the film .-- J. S. G. T.

II.-PROPERTIES OF ALLOYS

(Continued from pp. 534-543.)

Contribution to the Study of Aluminium-Iron-Chromium Alloys. C. Taillandier (*Rev. Mét.*, 1932, 29, 315-325).—Aluminium-rich alloys containing up to $2 \cdot 29\%$ chromium and $4 \cdot 18\%$ iron were investigated by thermal analysis, dilatation curves, microscopic examination, and mechanical tests.—H. S.

Modern Structural Materials. V.—Eutectic, Hypoeutectic, and Hypereutectic Aluminium-Silicon Alloys. Gillis Em. Huss (*Teknillinen Aikakauslehti*, 1931, 21, 307-315; C. Abs., 1932, 26, 2951).—The diagram for the thermal equilibrium of the aluminium-silicon system, based on investigations of normal alloys, shows that in the range 1.5-10.5% silicon the alloys consist of a matrix containing 1.5% silicon in solid solution in aluminium plus eutectic, and between 10.5% and 100% silicon, of silicon plus eutectic. In the microstructure of the normal aluminium-silicon alloy (10.5% silicon) the eutectic occurs in large plates, but when modified it is present as fine dispersed particles. The production of the alloy called Silium is based on the Pacz method, further modified by Czochralski. The eutectie of the modified alloy contains approximately 15% silicon. Alusil and Supra are typical hypocutectic aluminiumsilicon piston alloys. The microstructure of these alloys shows large plates of graphitoidal silicon. This structure is characteristic of white bearing metals, and has good sliding properties. Alusil contains copper 1, silicon 21-23, iron 0.3-1, and aluminium 75-77.7%. Supra contains copper 4-5, silicon 20-22, manganese 1.5-2, iron 0.3-1, and aluminium $70-74\cdot 2\%$.—S. G.

Modern Structural Materials. VI.—Heat-Treatable Aluminium Alloys. Gillis Em. Huss (*Teknillinen Aikakauslehti*, 1931, 21, 380-388; *C. Abs.*, 1932, 26, 2951).—A review of the properties of heat-treatable aluminium alloys and their behaviour on ageing or supercooling.—S. G.

Investigations of the Hot Strength of Light Metals by Static and Alternating Deformation. W. Schwinning and E. Strobel (Z. Metallkunde, 1932, 24, 132–137, 151–153).—Complete tension-elongation diagrams have been constructed and the vibration strength (rotating bending) has been determined for wires (5 mm. diam.) of hard-drawn and soft commercial aluminum (99, 33%) and of age-hardened Lautal at 7 different temperatures between 20° and 300° C. Annealing at 100° C. (100 hr.) has only a slight influence on the static and dynamic properties of normally age-hardened Lautal; annealing at 200° C. (2 hrs.) and higher temperatures results in a considerable deterioration of all mechanical properties.—M. H.

Dynamic Strength Properties of Some Light Alloys. K. Matthaes (Z. Metallkunde, 1932, 24, 176-180).-(1) The mechanical properties of Duralumin "681B," "681ZB," Lautal, and Elektron "AZM" in the extruded state, Duralumin "681ZB" and Aeron in the rolled state, and sand-cast 92:8 aluminium-copper alloy and Elektron "AZF" as determined in the tensile. compression, shear, torsion, and bending tests are tabulated. (2) The notchbar impact strengths of the extruded and rolled materials have been determined at temperatures between $+100^{\circ}$ and -180° C. The impact strength of Duralumin, Lautal, and Aeron increases with fall in temperature, the values for Duralumin and Lautal reaching a maximum between -100° and -150° C. and then decreasing. On the other hand, the impact strength of Elektron "AZM" uniformly decreases from 0.95 m.kg./cm.² at +80° C. to 0.3 at -180° C. (3) Results of determinations of the endurance bending strength and torsion vibration strength of all alloys, for which the original paper must be consulted, are tabulated and diagrammatically shown. (4) The bending strength of Duralumin "681ZB" after 10 million reversals in the corrosion fatigue test with tap water is about 8.2 kg./mm.² against 11 kg./mm.² for the same alloy protected by anodic oxidation .--- M. H.

Aluminium Alloys for Forging and Rolling. H. d'Auvigny (Aluminium Broadcast, 1931, 3, (6), 5-8).—A translation of a paper read before the Sécurité Aérienne. Attention is directed to the confusion arising from the recent large influx of new alloys. The mechanical properties of the principal alloys are tabulated, the following classification being adopted: (1) non heat-treated alloys; (2) alloys owing heat-treatability to (a) Mg₂Si (Silmalec type, ageing at room temperature), (b) CuAl₂ (Lautal type, ageing at 100°-200° C.), (c) both Mg₂Si and CuAl₂ (Duralumin type, ageing at room temperature after quenching, but remaining soft after slow cooling).—J. C. C.

K. S. Seewasser—The Most Corrosion-Resistant Light Metal. Anon. (Aluminium Broadcast, 1931, 3, (8), 8-10).—A translation of extracts from a booklet issued by Vereinigte Leichtmetallwerke, dealing with properties, uses, and commercial forms of the alloy K. S. Seewasser.—J. C. C. Steel versus Aluminium Alloy ["R.R. 56"]. Anon. (Aluminium Broad-

Steel versus Aluminium Alloy ["R.R. 56"]. Anon. (Aluminium Broadcast, 1931, 3, (10), 17).—A reprint of Data Sheet No. 12 issued by High-Duty Alloys, Ltd.—J. C. C.

Diagram of Solidification of Calcium-Sodium Alloys. E. Rinck (Compt. rend., 1931, 192, 1378-1381; C. Abs., 1931, 25, 4505).—At 850° C. the equilibrium Ca + 2NaCl $\equiv 2Na$ + CaCl₂ is bivariant for weak concentrations of calcium or sodium in the metallic phase. If the concentration of one metal exceeds its solubility in the other, a second metallic phase appears and the system becomes monovariant. Isotherms at -710° C. (the temperature of solidification of the alloy), 850°, 975°, and 1100° C. show the concentrations at which the metallic phase separates into two layers. At 710° C., the composition of one layer is 7% sodium in calcium and the other 14% calcium in sodium. The curve of reciprocal solubilities of calcium and sodium as a function of the temperature shows a cutectic point at 0.025° below the melting point of sodium. By extrapolation, it is shown that calcium and sodium are miscible in all proportions at temperatures above 1185° C. Two varieties of calcium are shown in the phase diagram. This is a general method for studying systems of partly miscible metals when the concentration of the saline phase of the monovariant system varies with the temperature.—S. G.

The Cobalt-Tungsten System. W. P. Sykes (Amer. Soc. Steel Treat. Preprint, 1932, Oct., 1-37) .- The tentative constitutional diagram of the binary system has been constructed from data furnished by microstructures, diffraction patterns, thermal analyses, and electrical resistance measurements. Cobalt dissolves some 35% of tungsten at 1465° C., the temperature of the cutectic. The solid solubility decreases to about 3% tungsten at 550° C. The complete cutectic occurs at a composition near to 46% tungsten and consists of the cobalt-rich solid solution (β) + an intermediate phase (δ) represented by the formula WCo (75.7% tungsten). This latter phase is formed on cooling by a peritectic reaction between the tungsten-rich solid solution (dissolving 0.2 and 0.3% cobalt) and the cobalt-rich liquid. A second intermediate phase (ϵ) forms at 1100° C. as the result of a peritectoid reaction between (δ) and the cobalt-rich solid solution (β) . It approximates in composition to the formula Co, W2 (47.1% tungsten). The cobalt-rich solid solutions are subject to age-hardening at temperatures above 500° C. A maximum hardness of Rockwell C65 (Brinell 770) has been observed as the result of ageing at 600° C. for 200 hrs. a rolled alloy containing 35% tungsten. The hardness developed by ageing is unusually persistent at temperatures as high as 700°-750° C.-S. G.

Cast "Aluminium-Bronzes." V.—Mechanical-Technological Properties. W. Claus and F. Goederitz (*Giesserei*, 1931, 18, 340-346; *C. Abs.*, 1931, 25, 4831). —The tensile properties (tensile strength, elongation) and Brinell hardness of the east binary "aluminium-bronzes" of the previous papers (this J., 1930, 43, 456; 1931, 47, 408; and this volume, p. 13) are determined. Binary "aluminium-bronzes" when cast in sand moulds always have poor tensile properties, whilst chill-castings of these alloys possess good tensile properties. In general, the Brinell hardness of sand- and chill-castings of binary alloys is higher at the bottom than at the top of the casting. The hardness of tinaluminium-bronze chill-castings is higher than that of all binary "aluminiumbronzes." No advantage is offered by the special "aluminium-bronzes" investigated, over the tin-bronzes cast under the same conditions.—S. G.

Applications of "Aluminium-Bronze" and Notes on its Resistance to Wear. M. G. H. Meigh (*Rev. Mêt.*, 1932, 29, 209-214).—Casting difficulties, influence of design on properties of castings, polishing and frictional properties, corrosion-resistance and electrolytic corrosion, resistance to oxidation and structural breakdown at elevated temperatures are discussed.—H. S.

Researches on the Copper-Beryllium System. Heinz Borchers (Metallwirtschaft, 1932, 11, 317-321, 329-330).—Very pure alloys containing up to 33% beryllium have been prepared by melting the metals in magnesia erucibles under hydrogen and their properties investigated by thermal, dilatometric, micrographic, and electrical methods. The diagram obtained agrees in its main features with that proposed by Ocsterheld and by Masing and Dahl, but certain modifications are made in the phase boundaries, particularly the liquidus and solidus lines of the β -phase and the β -($\beta + \gamma$) boundary.—v. G.

Copper-Phosphorus Alloys with a High Content of Phosphorus. A. Burkhardt, W. Linicus, and G. Saehs (*Metallwirtschaft*, 1932, 11, 331-333).—Alloys with phosphorus contents nearly up to Cu_3P can be rolled and pressed at $300^{\circ}-600^{\circ}$ C. The tensile strength of the alloy with 9% phosphorus is 52 kg./mm.² and the Brinell hardness is 220 kg./mm.². The hardness of alloys with a high phosphorus content does not decrease on annealing, so that the compound Cu_3P is apparently of a hard nature and cannot further be hardened. The alloys which are very brittle at room temperature develop a considerable elongation and reduction in area at high temperatures, whilst the tensile strength decreases. The alloys are resistant to corrosion.—v. G.

A Study of the Influence of Metallic and Non-Metallic Impurities in Bronzes. M. Ameline (Bull. Assoc. Tech. Fonderie, 1931, 5, 293-306; C. Abs., 1932, 26, 2159).—The impurities were classified as metallic impurities comprising such elements as antimony, lead, zinc, arsenic, iron, aluminium, manganese, and nickel and non-metallic impurities comprising sulphur, oxygen, and in rare instances SiO₂. Impurities were added singly to a bronze of 99% copper and 10% tin. Precautions were taken to eliminate such secondary influences as changes in pouring temperature and rate of cooling. The results of tests with zinc, lead, antimony, arsenic, oxygen, and sulphur additions are shown in curves. The trends in the tensile strength, elastic limit, and elongation are plotted against percentage of impurity added. Many articles relating to work by other investigators are cited.—S. G.

The Properties and Applications of Nickel-Bronzes. J. McNeill (Mech. World, 1932, 91, 562-565).—The compositions are given of 5 commercial bronzes to which varying proportions of nickel were added. In every case improvement in clastic limit, in tension and compression and in yield-point were obtained. There is usually an optimum nickel content corresponding with increased strength and toughness, without loss of ductility. The increase in melting-point is approx. 6.6° C. per 1% nickel when replacing copper and 18° C. when replacing tim. Increased fluidity is also claimed, although it is suggested that the action of nickel in preventing lead segregation (lead-sweat) in high-lead bronzes is partly due to greater rapidity of setting when the metal enters the mould and partly to increasing the solubility of lead in molten copper. The superior density of nickel-bronzes is attributed to the action of nickel in minimizing the presence of incipient shrinkage cracks. With 1.5% nickel, a reduction of 50% in grain-size can be obtained. Applications of nickel-bronzes are illustrated and described, all showing improvement in properties as compared with nickel-free bronzes. Such examples are centrifugally-cast bronze wormwheels in automobile worm-gear transmission, sand-cast gear rim blanks, and leaded-bronze bearings. It is shown that nickel improves the mechanical properties of bronze at elevated temperatures as compared with Admiralty gun-metal. High-nickel bronzes are advantageous for the bearing faces of sluice-valves in hydraulic engineering (nickel 30, tin 8%) and for valve parts for controlling superheated steam (nickel 40-70%). The properties of such a bronze (nickel 50, tin 10%) at temperatures up to 590° C, are tabulated.—F. J.

The Copper-Tin Bronzes and the Effect of Phosphorus on Them. Gustav Krebs (Z. ges. Giesserei-Praxis: Das Metall, 1932, 53, 281-282).—Tin has a hardening effect on copper, pure copper having a Brinell hardness of 55, a 90:10 bronze 71, and a 86:14 bronze 91. Higher tin content has a still greater hardening effect up to 28% tin, when the hardness is maximum and over 227. Above this, the hardness falls until a 10:90 copper-tin alloy is no harder than pure zine. Copper has a fibrous and tin a crystalline structure, and to attain the highest strength and hardness with the alloys, a strong deoxidizing agent is required, and for this purpose phosphorus is used. The phosphorus is added in such quantity that 0.2% remains in the alloy after melting. It has the additional advantage of causing crystallization of the copper and stronger crystallization of the tin and of removing the injurious cuprous oxide. It also lowers the melting point of the alloys, but not to any practical extent. The strength and tenacity of phosphor-bronze are about double those of ordinary bronzes.—J. H. W.

[Influence of Tin in Phosphor-Bronze.] Anon. (Machinery (N.Y.), 1930, 36, 397).—Brief note of the increase of strength of phosphor-bronze obtainable by increasing the tin content from, for example, 5-7%.—H. F. G.

On Lead-Tin Bronzes, their Constitution, and their Suitability and Application as Bearing Metals for Severe Service. B. Blumenthal (Metallwirtschaft, 1932, 11, 360-362, 374-375).—A review of the literature with special reference to the work of French, Rosenberg, Harbaugh, and Cross (this J., 1928, 40, 511). —v. G.

Herculoy [Silicon-Bronze]. Anon. (Met. Ind. (Lond.), 1932, 41, 37).—A short note, giving the properties and advantages of Herculoy, a new patent alloy which is a silicon-bronze containing tin, with a special facility for fabrication.—J. H. W.

Holding Power and Tightness of [Brass] Heat-Exchanger Tubes. C. O. Sandstrom (Chem. and Met. Eng., 1932, 39, 323-325) .--- Tests made to determine the holding power of 18-gauge Admiralty brass tubes in heat-exchangers are described. The tubes were rolled into H-in. diam. holes, some plain-drilled, some threaded in 3-in. plates, the latter simulating the tube-plates. The conclusion is reached that in a practical application of such tubes in heatexchanger practice, a sufficient pressure would cause the tube to break or collapse, before pulling out of a drilled hole. A reamed hole, whilst being less susceptible to leakage, would offer less resistance to pulling out than the rougher-surfaced drill hole. In compression tests, the tubes buckled, the metal tending to fill the hole and increase the resistance to movement, thus obviating pushing-out. Flaring the ends of the tubes, whilst favouring more the flow of fluid, offered no resistance to slip or withdrawal. In a heat-exchanger by using 40% of the strength of the tube at the average yield load for the safe working load, the allowable working pressure is calculated to be 2,725 lb./in.². It is therefore evident that rolled tubes of the size used in heat exchangers will stay the tube-plates against any practical working pressure. Further tests were made to determine the extent of leakage between rolled tubes and their scats in the tube-plates and to ascertain the comparative effectiveness of different kinds of joints. The results of the tests emphasized the importance of reaming

the holes to obtain tightness. The different types of joint and the test-heat exchanger are illustrated and described. The conclusion is reached that a tube rolled or expanded into a reamed hole makes a satisfactory joint against fluid pressure, such leakage of one fluid as may occur being so slight as not harmfully to contaminate the other, except in cases demanding extreme purity of product. Auxiliary welding is not necessarily an improvement, except where the form of counterbore permits good penetration of the weld metal, the shrinkage of which enhances tightness of the joint.—F. J.

Investigations on Metal Transfer in [Electrical] Contacts and Suitable Gold Alloys for such Contacts. C. Benedicks and J. Härdén (Z. tech. Physik, 1932, 13, 71-76, 111-117, 166-171).—Contact points for potential regulations with a relatively high current loading have been tested for change in weight during use and the magnitude and direction of the metal transfer between the two points determined with a view to find suitable substitutes for gold for this purpose. The best behaviour in the tests was shown by an alloy of gold with 7% of platinum. In general, alloys behaved better as contacts than pure metals (gold, silver, platinum). Of considerable importance is the removal of heat by suitable cooling devices. At low current strengths metal is transported from anode to cathode, the quantity of metal transferred rising with increasing current to a maximum and then falling to zero; with still greater currents transfer takes place in the reverse direction. A theoretical explanation is given of this behaviour and other phenomena.—J. W.

On the Effect of Additions of the Readily Fusible Heavy Metals to Lead Bearing Alloys. K. L. Ackermann (*Metallwirtschaft*, 1932, 11, 292-293).— The properties of lead-base bearing alloys are not improved by additions of mercury, bismuth, thallium, or cadmium.—v. G.

Measurements with the Aid of Liquid Helium. XIX.—Researches on Alloys of the Lead-Thallium and Lead-Bismuth Series with Respect to Superconductivity. W. Meissner, H. Franz, and H. Westerhoff (Ann. Physik, 1932, [v], 13, 967-984).—Superconductivity in the lead-thallium and lead-bismuth series is in accordance with the equilibrium diagram.—v. G.

Binary Alloys of Magnesium. A. Dumas and F. Rockaert (*Rev. Aluminium*, 1932, 9, 1717–1728).—The addition of metals to magnesium increases the ductility and influences the hardness and resistance to corrosion more or less according to whether they enter into solid solution with the magnesium or not. All the alloys have a density of about 1.8, and the resultant properties are characteristic of the hexagonal crystallization of magnesium, nearly all other metals crystallizing in the cubic system. The following binary alloys with magnesium have been studied with respect to the equilibrium diagram, composition of compounds, and the principal alloys, physical and chemical properties, and heat-treatment: aluminium, zinc, silicon, copper, cerium, cadmium, manganese, and calcium. The alloys with aluminium and zinc present the most interesting characteristics, but otherwise complex alloys give the best results. Although the effects of alloying other metals with magnesium are not always additive, excellent results can be obtained by selecting suitable combinations of metals.—J. H. W.

Magnesium Takes its Place as a Structural Material. John A. Gann (*Iron Age*, 1932, 129, 872–873).—Cf. J., this volume, p. 419. Abstract of an address to the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. Outlines the principal applications of magnesium as a deoxidizer and for alloying, and predicts its future for use in structural work.—J. H. W.

Magnesium Alloys. Anon. (Machinery (N.Y.), 1931, 38, 280A).—Data sheets giving the compositions and properties of the "Dowmetal" alloys F, E, A, T, M, G. —J. C. C.

The Use of Light-Weight Magnesium Alloys. John A. Gann (Machinery (N.Y.), 1932, 38, 568-569).—A general account of the properties and uses of the "Dowmetal" alloys A, E, F, T, M, and G.—J. C. C.

Magnetic Properties of Manganese and Chromium in Solid Solution. L. Néel (J. Phys. Radium, 1932, [vii], 3, 160-171).—Dilute (below 3%) solid solutions of manganese in copper or silver and of chromium in gold are paramagnetic and obey Weiss's law. The Curie constants vary in proportion to the concentrations. Under these conditions the magnetic moment of chromium is 23.47 magnetons. A theoretical discussion follows.—E. S. H.

Electrode Potentials of Iron-Manganese Alloys. Cyril Wells and J. C. Warner (*Electrochem. Soc. Preprint*, 1932, Sept., 233-236).—Electrode potentials of iron-manganese alloys, over the whole range of composition, have been determined. The electrode potentials of all of the alloys fall on a smooth potential-composition curve. The absence of any abrupt changes in the direction of the potential-composition curve indicates the presence of γ -solid solution, which in both single and 2-phase ranges determines the electropotential of the alloy. This is in agreement with the results of the X-ray, microscopic, thermal, and dilatometric investigations.—P. M. C. R.

NCT 3—A Recent Addition to the Heat-Resisting Alloys. John L. Everhart (*Power*, 1932, 75, 174; *C. Abs.*, 1932, 26, 2155).—NCT 3 analyses (maximum): carbon 0·20, manganese 0·70, sulphur 0·03, phosphorus 0·03, silicon 2·00, chromium 23·0–27·0, and nickel 17·0–21·0%. The physical properties, in the hot-finished and quenched conditions, are, respectively: Rockwell hardness, B–95, B–85; yield-point, 55,000 lb./in.², 35,000 lb./in.²; tensile strength, 95,000 lb./in.², 85,000 lb./in.²; elongation, 35%, 55%; reduction of area, 55%, 70%. The alloy cannot be hardened by heat-treatment. Mechanical working causes a stiffening of the material with a rise in tensile strength and a decrease in ductility. The alloy is restored to its softest and most ductile form by heating to a high temperature and either quenching in water or cooling rapidly in air.—S. G.

Testing Nickel-Iron Alloy by Means of the A.C. Potentiometer. D. C. Gall (J. Sci. Instruments, 1932, 9, 219-222).—In transformer design the core loss current and the magnetizing current can be found from the power loss and the energy stored in the iron. A method of measuring these by means of the a.c. potentiometer is described, and curves are given for the nickel-iron alloys Stalloy, Rhometal, Radiometal, and Mumetal.—W. H.-R.

Precipitation Hardening of Silicon-Nickel Alloys. O. Dahl and N. Schwartz (*Metallwirtschaft*, 1932, 11, 277-279).—The hardness of silicon-nickel alloys can be doubled by heat-treatment, e.g. a hardness of 417 kg./mm.² is obtained with the 8.6% silicon alloy. The electrical resistance rises slightly at the beginning of precipitation-hardening, then falls; the hardening process is very slow. Alloys with up to about 7% silicon can be readily worked. The magnetic transformation of nickel is reduced by addition of silicon to 140° C. with 4.6% silicon.—v. G.

Magnetic Materials in the Year 1931. T. D. Yensen (Year-Book Amer. Iron Steel Inst., 1931, 452-485; C. Abs., 1932, 26, 2151).—The rather technical subject of ferromagnetism and ferromagnetic materials is presented in simple language. The influences of various foreign elements, grain boundaries, and strains due to rapid cooling or to mechanical deformation, as affecting the ferromagnetic properties of materials, are treated at some length. Materials of high magnetic permeability are now being prepared from iron-nickel and iron-nickel-coolat alloys and from pure iron.—S. G.

Hipernik and Other Magnetic Alloys; Great Improvements Due to Heat-Treatment. T. D. Yensen (*Metal Progress*, 1932, 21, (6), 28-34, and 70).— An extended series of observations on nickel-iron alloys such as Hipernik (50% nickel) showed that low permeability and high hysteresis loss were the result of distortion of the space-lattice by the presence of widely-diffused colloidal particles of oxide. Annealing in hydrogen has proved an effective remedy. The different magnetic properties of alloys in the nickel-iron series are correlated with the respective crystal structures; improved methods of treatment are suggested and the importance of homogeneity is emphasized.—P. M. C. R.

Electric Resistance Alloys for High-Temperature Service. Anon. (Metallurgia, 1932, 6, 125–127).—Alloys of the nickel-chromium and of nickelchromium-iron series for high-temperature service such as metallic resistors used for temperatures up to 1000° C. are discussed. The development of such alloys resulting from improved technique in melting operations; the use of materials free from carbon, sulphur, and oxygen, which have a detrimental influence on their qualities; and improvements in wire drawing are considered. The influence of composition in alloys of both series is dealt with, and data are also given relating to sp. resistance, temperature coeff. of resistivity, melting point, sp. gr., tensile strength, and coeff. of thermal expansion for the various commercial alloys manufactured.—J. W. D.

A Study of Alloys of Silver. Léon Guillet, Alfred Petit, and Jean Cournot (*Rev. Mét.*, 1932, 29, 183–207).—Cf. J., this volume, p. 476. A detailed metallurgical investigation of alloys containing silver 39, copper 36, nickel 12, zine 13%, and silver 68, copper 18, nickel 6, zine 8%, is described. The features studied include solidification interval and transformations in the solid state, annealing, microstructure, mechanical properties, stamping properties, density, sonority, weldability, etching, and corrosion properties. The first of the abovementioned alloys is compared with the 835/1000 silver-copper alloy. Marine salts tarnished the quaternary alloy more than the binary, but hydrogen sulphide had much less effect on the former. The second of the two quaternary alloys is compared with a binary silver-copper alloy containing 68% silver. Both alloys were blackened by hydrogen sulphide, but the quaternary alloy was more attacked in sodium chloride solutions and less attacked in anmonia and ammonium chloride, than the binary alloy. Methods of preparing, refining by additions, casting, and pickling the quaternary alloys are described in detail. —H. S.

The Ternary System Silver-Copper-Oxygen. K. W. Fröhlich (Mitt. Forschungsinst. Edelmetalle, 1932, 5, 100-103).—A short review of recent contributions to our knowledge of the effect of oxygen in silver-copper alloys.

-A. R. P.

Babbitts with Tin Base and Low Antimony and Copper. A. M. Bochvar and S. I. Irodov (Zvetnye Metally (The Non-Ferrous Metals), 1931, 1139-1147; C. Abs., 1932, 26, 2157).—[In Russian.] Alloys in the tin-rich region of the ternary system tin-antimony-copper were prepared and studied microscopically. Below 6-8% antimony, the hard cubic β -crystals (solid solution of tin and antimony) are absent; the soft ground-mass consists of a solid solution of tin and antimony in which hard crystals of a solid solution of copper and tin are embedded. The hardness of such alloys is somewhat lower than that of the alloys with higher antimony content. Hardness measurements made at different times after casting showed that the alloys are practically non-ageing.—S. G.

The Ternary System Iron-Carbon-Vanadium. Rudolf Vogel and Erich Martin (Arch. Eisenhüttenwesen, 1931, 4, 487-495; C. Abs., 1931, 25, 4771).— The diagram of the ternary system iron-carbon-vanadium is investigated in the field Fe-V-V₄C₃-Fe₃C. The α - γ transformation of the iron-vanadium solid solution with 1.8% vanadium occurs at 1150° C. With decreasing vanadium content the temperature of the transformation either increases or decreases until above 1400° C. or below 900° C., respectively, the α -phase alone exists. Thus, the iron-vanadium system belongs to that group of iron alloys with a closed γ -field. With increasing vanadium content tho temperature of the magnetic transformation of iron is increased, occurring at 900° C. with 32% vanadium. The α - γ transformation takes place from the system iron-carbon to the system vanadium-V₄C₃. On cooling the alloys, the ternary γ -solid solution breaks up into the corresponding binary γ -crystal of the system iron-carbon, a ferrite phase and a carbide phase separating with the resultant pearlite formation. The temperature of the pearlite decomposition of carbon steels is lowered very little by the addition of vanadium, Although separation of V₄C₃ could not be retarded by quenching, its form was made finer. During these investigations only one vanadium carbide (V₄C₃) was found in the field Fe-V-V₄C₃-Fe₃C. The increase in hardness of carbon steels caused by the addition of vanadium is due to (a) greater hardness of the ferrite phase in the pearlite, (b) decrease in grain-size in the pearlite decomposition even on ordinary cooling, and (c) separation of very hard V₄C₃.-S. G.

Investigations on Technical Casting Alloys. O. Bauer and O. Vogel (Mitt. Material., Sonderheft 18, 1931, 51-83) .- The materials tested include bronze "GBZ10," brass "GMS67," Silumin, and Elektron. The specimens were cast in rods 10-100 mm. in diam. under various casting conditions. Inverse segregation in bronze castings is less marked with bottom pouring into vertical sand moulds than with top pouring. Brass castings have a lower zinc and higher copper content in the outer layers than in the core. Silumin shows no tendency, and Elektron only a slight tendency to segregate. X-ray examination reveals not only the distribution of porcs, but also segregation. Silumin castings contain spherical porcs regularly distributed over the whole of the crosssection, but the tops are quite free from porosity. Horizontally cast Elektron rods are non-porous, as shown by density measurements. The hardness of bronze varies considerably with the conditions of casting, solidification, and cooling; the hardness of brass, Silumin, and Elektron is affected principally by the porosity. The microstructure of the castings was examined exhaustively, and the opinion is expressed that the technical evaluation of a casting necessitates exhaustive and extensive tests .- J. W.

The Nature of Metals in Relation to their Properties. Earle E. Schumacher (Scientific Monthly, 1932, 34, 22-30; and Bell Telephone System Tech. Publ. B-648, 1932, 1-14).—An elementary description of the crystal structure of metals, of the causes of age-hardening, the hardening effects of cold work, and the formation of solid solutions. The solubility curve of calcium in lead is reproduced to explain the hardening produced by the heat-treatment of lead containing small amounts of calcium.—W. H.-R.

On the Question of the Dependence of Tammann's Resistance Limits on the Crystallographic Orientation. R. Glocker and L. Graf (Metallwirtschaft, 1932, 11, 226-227).—In gold-zinc single crystals with 52 atomic-% of gold both the (100) and (110) planes are completely resistant to nitric acid and both planes suffer the same loss in weight in aqua regia, hence the protective action of the gold atoms is independent of the orientation. This rule holds for all lattices in which an atom of one constituent is on every side the immediate neighbour of atoms of the other constituent.—v. G.

On the Existence of Resistance Limits in Solid Solutions with Irregular Atomic Distribution. R. Glocker (Ann. Physik, 1932, [v], 14, 40-50).—The problem of resistance limits is discussed mathematically with reference to the probability of long chains of atoms of the same kind diffusing through a solid solution lattice. A great change in the probability of this happening occurs at an equi-atomic composition of the constituents. This example shows that sharp resistance limits can exist in solid solutions without regular distribution of the atoms in the lattice.—v. G.

Measurements with the Aid of Liquid Helium. XIV.—Systematic Researches on the Superconductivity of Some Alloy Systems. W. Meissner, H. Franz, and H. Westerhoff (Ann. Physik, 1932, [v], 13, 504-554).—The following systems were investigated : indium-lead, which forms a continuous series of solid solutions, zine-thallium, lead-mercury, and indium-thallium, which form limited series of solid solutions but no compounds, and molybdenum-carbon. In the solid solutions a continuous change in the temperature at which the alloys become superconducting occurs up to the limit of solid solution or, in the case of the indium-lead system, to the temperature applicable to the other component. The change in resistance at this temperature is greater with solid solutions than with pure metals. In no case is there any relation between superconductivity and the lattice constants. Very complex behaviour is shown by heterogeneous alloys of two constituents which become superconducting at different temperatures; in this case the change to the superconducting state depends on the structure and previous treatment.—v. G.

III.-CORROSION AND PROTECTION

(Continued from pp. 513-551.) CORROSION

Corrosion of [Copper] Open-Valley Flashings. K. Hilding Beij (U.S. Bur. Stand. J. Research, 1929, 3, 937-952; Research Paper No. 123).—Corrosion, resulting in a narrow line of holes or cracks immediately under the edge of the overlying roofing, has frequently occurred in copper flashings, particularly open-valley flashings on buildings with shingle roofs situated in large towns near the seaboard. This type of corrosion appears to be an accelerated attack due to differential aeration of the water retained by capillarity between the roofing and the flashings after a fall of rain. The presence of sulphur dioxide and sodium chloride greatly increases corrosion, although the action of either alone is relatively slow. Porous, absorbent roof materials, such as wood shingles, materially increase the rate of corrosion, whereas with slate shingles corrosion is slow, as the roof dries quickly. The trouble may be cured by inserting a smooth hardwood strip between the roofing and the flashing.—S. G.

[Contribution] to the Knowledge of the Corrosion-Resistance of Copper, Tin-Bronzes, and Tin in Inorganic Acids. W. Rohn (Z. Metallkunde, 1932, 24, 153).—The scale of stability for the evaluation of the corrosion-resistance of metals proposed by W. Claus and H. Fincke (cf. J., this volume, p. 434) is rejected.—M. H.

The Resistance of Pure Nickel and Inco Chromium-Nickel to Corrosion by Milk. F. L. La Que and H. E. Searle (Internat. Nickel Co. Development and Research Dept., Bull. TS-1, 1-12).—S. G.

Swelling of Canned Prunes [Corrosion of Tinplate]. E. M. Mrak and P. H. Richert (*Calif. Agr. Expt. Sta. Bull.* No. 508, 1931, 3–24; *C. Abs.*, 1931, 25, 4322).—Canned, ready-to-serve, dried prunes are produced only in limited quantities because of spoilage losses from the swelling of cans with hydrogen gas, formed by metal corrosion. Corrosion and hydrogen swelling were reduced by: (1) concentration of the syrup; (2) elimination of oxygen by exhausting with steam or vacuum pump; (3) decreasing the $p_{\rm H}$ of the syrup by the addition of organic acids, and (4) decreasing the blanch or pre-cooking period. Swelling was more rapid in enamel-lined cans than in plain, and greater in coke than in charcoal-plated cans. Pressure cooking increased the rate of swelling; paper and rubber compound gaskets gave similar results. Sun-dried and dehydrated prunes gave similar results as to swelling.—S. G.

Importance of Traces of Sulphur on Corrosion of Food Containers. Ray W. Clough and O. E. Shostrom (*Food Ind.*, 1930, 2, 310-313; C. Abs., 1930, 24, 5074).—Fruit when sprayed with lime-sulphur shortly before being canned rotains sufficient sulphur at times to cause the formation of hydrogen sulphide

and discoloration of the tin cans. In gooseberries as little as 2 p.p.m. of sulphur, sulphide, sulphite, thiosulphate, or flowers of sulphur caused the tins to swell after a short storage period. However, sweet, black cherries when canned with various amounts of different sulphur compounds acted in an entirely different manner, *i.e.* the sulphur prevented swelling and perforation of the tins. It is possible that the soluble anthocyanin pigments of black cherries have some connection with the protective action of sulphur, or the sulphur may protect the iron base of the cans from corrosion, but tends to increase the solubility of the tin. In plain cans where a large area of tin is exposed, if the tin were vigorously attacked, a large quantity of hydrogen would be formed to swell the can. The protective action of the sulphur on the iron, on the other hand, would tend to prevent perforations. This reasoning is theoretical. The addition of small quantities of sulphur to certain pigmented fruits may have commercial applications.—S. G.

"White Rust" on Galvanized Material. E. H. Schulz (Stahl u. Eisen, 1930, 50, 360-362; C. Abs., 1930, 24, 4750).—White zinc rust was observed on galvanized sheet, plates, and wires subjected to long sea transportation. In these cases chlorine and magnesium could be detected in the corroded area. However, cases of white rust were observed on galvanized articles not subject to sea transportation. In this case the corrosion products consisted of zinc hydroxide and carbon dioxide. By using the following procedure it was possible to obtain white zinc rust artificially on galvanized material. Galvanized plates and wires were placed in a closed container over water. The container was heated during the day to 50°-60° C. and allowed to cool at night. Water condensed on the plates and wires; a few hours later the formation of a white covering was observed over the zine coat, which increased in thickness and strongly resembled the white zinc rust. After 7 weeks' exposure the test-pieces were removed and the corrosion product was analyzed ; zine oxide, water, and carbon dioxide were found. The zine oxide forms a porous layer, similar to ferrous oxide, and has the property of retaining water. By the same method zine rust was obtained on pure zine. It is concluded that zinc rust forms through the action of condensed water, which, because of the closely packed plates or wires, does not have a chance to evaporate rapidly. It was observed that a layer of fat or grease on the surface of galvanized articles prevents white zinc rust .--- S. G.

Beers and Metals. René Laneau (Bull. trimest. Assoc. Élèves École sup. Brasserie Univ. Louvain, 1930, 30, 22-32; C. Abs., 1930, 24, 4893).—A review of known facts regarding the action on beer of the various metals used in the brewing industry: tin, iron, steel, copper, chromium, and aluminium, with a bibliography of 26 references.—S. G.

The Electrolytic Corrosion of Underground Metallic Structures by Stray Currents. Claude M. Longfield (J. Inst. Eng. Australia, 1931, 3, 157–168; C. Abs., 1932, 26, 2125).—After describing the mechanism of electrolytic dissociation, the results are described of some tests made on different soils to determine the connection between c.d. of discharge and the amount of corrosion. The nature of results obtained in field surveys and their value for the estimation of damage are discussed. A list of references is appended. —S. G.

Proper Care of Brine Aids Prevention of Corrosion. R. C. Doremus (Heating, Piping, Air Conditioning, 1931, 3, 372-377; C. Abs., 1932, 26, 3221).— A review of the corrosion of refrigerating plant and equipment.—S. G.

Report on the Preparation of Specimens for Exposure Tests of Electroplated Coatings on Steel. Joint Committee of American Electroplaters' Society, American Society for Testing Materials, and the Bureau of Standards (Monthly Rev. Amer. Electroplaters' Soc., 1932, 19, (5), 6-15).—Details of the cleaning VOL. L. R R solutions, electrolytic baths, and thickness of deposited metal are given. For the exposure tests steel sheets plated with nickel, chromium, zinc, cadmium, and zinc-cadmium alloys, with or without intermediate coatings, are being exposed in five different localities in the U.S.A. representative of various types of atmospheric conditions.—A. R. P.

On the Topochemistry of Corrosion and Passivity. II.—Investigation of the Initial Step of the Corrosion of Soft Iron. Erich Pietsch, Bruno Grosse-Eggebrecht, and Wadim Roman (Z. physikal. Chem., 1931, [A], 157, 363-388).— Cf. this J., 1932, 50, 83. A new theory of corrosion based on heterogeneous catalysis is given. The process of dissolution is most active in inhomogeneities of the surface, e.g. in crystal peaks, in grain boundaries. The beginning of the process of dissolution in grain boundaries was proved by corrosion tests of mild steel with ideally polished surface in solutions of hydrogen peroxide with and without addition of acids and salts and in distilled water. The rate of dissolution is dependent on the length of grain boundaries in the surface.—B. Bl.

The Current Limits in the Anodic Polarization of Metals in Aqueous Solutions. Erich Müller and Kurt Schwabe (Z. Elektrochem., 1932, 38, 407–418).— A discussion of the polarization of the metals thallium, lead, cadmium, copper, and zinc in saturated and unsaturated aqueous solutions.—J. H. W.

Corrosion Tests of Metals. R. Cazaud (Aciers spéciaux, 1932, 7, 257-262). —The three types of corrosion tests in liquids are continuous immersion, alternate immersion, and spraying. The effects of corrosion are estimated by the appearance of the specimens, alteration in weight, rise in temperature, and evolution of gas, variation in mechanical properties, and variation in electrical properties. These points are discussed and the standardization of corroding agents, test apparatus, and the measurement of the corrosion is suggested.—J. H. W.

The Corrosion of Metals. J. Chloupek and VI. Z. Danes (Chem. Obzor, 1932, 6, 49-52, 73-76).—A comprehensive consideration of the corrosion of metals from the physico-chemical point of view, with special reference to the electrochemical nature of corrosion, is followed by an account of the corrosion of some technically important metals by gases, liquids, and solids. Finally, a short summary is given of the methods most useful in industry for the prevention of corrosion.—R. P.

Corrosion as a Physico-Chemical Problem. H. Mark (Forschungen und Fortschritte, 1932, 8, (3), 37-38).—The questions of the elementary processes and the absolute values stand to-day in the foreground of corrosion research. Our present knowledge of the effective size of surfaces, their fine structure, and the principles of activation is illustrated by examples. Exhaustive research in heterogeneous catalysis renders possible a successful treatment of the question of corrosion protection.—J. W.

The Velocity of Corrosion from the Electrochemical Standpoint.—II. U. R. Evans and T. P. Hoar (*Proc. Roy. Soc.*, 1932, [A], 137, 343-365).—In continuation of previous work (*Proc. Roy. Soc.*, 1931, [A], 131, 355; cf. this J. 1931, 47, 343) measurements have been made of the corrosion velocities of vertical specimens of iron and steel in aqueous solutions of potassium, sodium, and lithium chlorides, and sodium and potassium sulphates. The corrosiontime curves are linear and the temperature coeff. of the velocity of corrosion is rather low. Curves relating corrosion velocity with salt concentration show a maximum velocity at about 0.5N; the corroded area is smallest in the range of most rapid corrosion. This apparent anomaly is readily explicable by the protection mechanism previously suggested. For high concentrations, corrosion is proportional to the oxygen solubility. At low concentrations, it is much less than that calculated from the oxygen solubility, owing to the necessity of providing an e.m.f. to force current through the circuit, which at low concentrations has considerable resistance. The poten-

tial at the anodic and cathodic areas has been measured in potassium chloride solutions. The corrosion-rate is proportional to the current which the measured e.m.f. would force through the circuit resistance. Specimens cut along the line separating corroded and uncorroded portions (the two parts being connected externally) are attacked at rates only slightly less than the corrosion rate of uncut specimens, and the current measured is equivalent to the corrosion rate. Polarization measurements enable the corrosion velocity over the lower range of concentrations to be calculated, and satisfactory agreement is found between (i) results obtained by combining polariza tion and potential measurements, and (ii) numbers derived from the loss of weight due to corrosion. The agreement between gravimetric and electrical data confirms the conclusion that corrosion is connected with differential aeration currents set up between a cathodic area along the water-line and an anodic area along the bottom and sides of the corroding specimens. Bengough's contention to the contrary is based on results derived from the corrosion of horizontal specimens and can scarcely be applied to results obtained with vertical specimens.-J. S. G. T.

An Electrochemical Method for Measuring the Corrosion of Metals. J. Chloupek and VI. Z. Daneš (*Chem. Obzor*, 1932, 6, 141-146).—A description is given of a new apparatus for determining the resistance of metals to corrosion by which the reproducibility of the results is much improved. The advantages of the new method are illustrated by several examples in the form of tables and diagrams.—R. P.

PROTECTION

Defects of Tinplate and Overcoming Them. V. Krasovitzkii (Domez, 1931, (3), 33-51; C. Abs., 1932, 26, 3216).—[In Russian.] The unsatisfactory state of the Russian tinplate industry and means for improving it are discussed. Numerous photographs, photomicrographs, and tables are given.—S. G.

Investigations on the Mechanism of the Galvanizing Process. H. Grubitsch (Stahl u. Eisen, 1031, 51, 1113-1116).—The dissolution of Armco iron in chemically pure zine at temperatures up to 470° C. is very small and almost independent of the time. At 495° C. the dissolution reaches a maximum and is proportional to the time of contact, whilst at 515° C. it passes through a mininum and then rises again at higher temperatures, but is then only slightly dependent on the time of contact.—J. W.

Formation of "Hard Zinc" and Iron Salts. K. Taussig (Stahl u. Eisen, 1931, 51, 885-886).—The necessity of freeing the iron from iron salts derived from the pickling bath before dipping the metal into the zine bath is emphasized. The combined iron is not volatilized as chloride, but forms "hard zine" in the bath. The dissolution of the iron during pickling and the production of pickling brittleness may be avoided by the addition of inhibitors to the bath.—J. W.

The Effect of Water Soaking Steel upon the Weight of Zinc Deposited. Wallace G. Imhoff (Brass World, 1932, 28, 142-143).—After steel had been stored in water for 3 days the weight of zinc deposited during subsequent galvanizing under unaltered conditions was found to be increased by amounts of the order of 20% compared with material not soaked in water. This may be due to the formation of rust on the soaked steel and the weighing of the rust as zinc or to the chilling of the zinc by the water in the pores of the steel, which would necessitate a longer time of immersion, with consequent formation of a heavier deposit.—J. H. W.

On the Standardization of Methods of Investigation of the Quality of Metallic Coatings. I.—Chemical Methods of Testing Galvanized Iron. N. A. Isgarischev and N. P. Egorova (Zvetnye Metally (The Non-Ferrous Metals), 1931, (6), 713-719).—[In Russian.] In estimating the quality of the zinc coating on iron the factors of importance are: (i) thickness of the coating; (ii) uniformity of covering and existence of pinholes; (iii) mechanical properties, such as resistance to blows and bending, as well as hardness and adhesive power. Only (i) and (ii) are investigated on the basis of published data, the methods of Precee, Aupperle, Bauer, Patrick and Walker, and Wernlund being critically examined. It is concluded that for (i) the best method is Bauer's (treatment of the coating with a solution of As_2O_3 in dilute sulphuric acid); whilst for (ii) the best method is Wernlund's (spraying of the surface with acetic acid and hydrogen peroxide, when bright yellow rust spots develop almost immediately at the pinholes). The method with copper sulphate, widely used hitherto, is condemned as inaccurate.—M. Z.

Brittleness of Zinc-Coated Steel. J. S. Adelson (Mech. World, 1932, 91, 437-439; and Heat-Treating and Forging, 1932, 18, 180-183).—See J., this volume, p. 361.—F. J.

Wire Galvanizing Processes. L. D. Whitehead (*Wire and Wire Products*, 1932, 7, 148-151, 166-169).—The final paper of a discussion on "Hot-Galvanizing v. Electro-Galvanizing" between L. D. Whitehead and G. K. Rylands (see J., this volume, pp. 30-31, 235, 306). It is suggested that the results of the tests eited by R. are not conclusive, and his criticism of the results of electro-galvanizing is answered in detail.—J. H. W.

A New Heat Application for Galvanizing. W. H. Spowers, Jr. (*Wire and Wire Products*, 1932, 7, 226-227, 236-237).—In "diffusion flame" combustion, gas is made to burn with an intensely luminous flame, highly radiant within itself, and probably more responsive to control than any other fuel. By this method of heating in hot-galvanizing, work can be brought to temperature with more uniformity and speed than by converted heat alone. Its advantages are low loss in dross, high kettle life, and high quality of product.—J. H. W.

Continental Galvanizing Practice. Heinz Bablik (Met. Ind. (Lond.), 1932, 41, 75–76).—One of the difficulties of pickling iron sheets for galvanizing is the unevenness of the iron oxide layer. Strong hydrochloric acid and short time of pickling are recommended. No general advice can be given as to the use of a pickling controller. The products of pickling, and especially iron salts, are removed by washing in cold and then hot water and dipping into a solution of zinc chloride at 70° C. The sheets are then dried in a tunnel stove and dipped into a zinc kettle. No flux is used in the zinc bath and the zinc is alloyed with aluminium. This process has a relatively small output and high loss of zine, but the resulting sheets can be bent in any manner without the galvanized coat flaking off.—J. H. W.

Improved Pickling Method [for Galvanizing]. Anon. (Machinery (N.Y.), 1931, 38, 205).—A brief note. Articles to be galvanized are fed into a rubberlined drum which rotates at 6 r.p.m. in a bath of sulphuric acid. By reversing the direction of rotation the articles are made to pass through a draining section to a washing section and thence to a section immersed in a fluxing solution of zinc chloride, finally being discharged on a hot plate for drying.

_J. C. C.

The Practical Problems of Corrosion. VII.—Some Tests on Protective Painting. Interim Report. S. C. Britton and U. R. Evans (J. Soc. Chem. Ind., 1932, 51, 211–2187).—The corrosion tests have been conducted on specimens of different steels and irons, but many of the conclusions reached are also applicable to the protection of non-ferrous metals by painting. The general results illustrate the importance of the adherence of the film of corrosion product to the metal, and indicate also that corrosion tests on unpainted specimens are of limited practical value in their applicability to metals exposed in the painted condition. Attention is directed to the deleterious effect of salt enclosed between the paint and the metal, which is far greater than the corrosion due to salt outside the paint film. Salt enclosed below the film draws in water osmotically, and the resulting increase of volume forces the

paint film away from the metal surface, causing a breakdown of the protection. The presence of a thin film of moisture under the paint film (due to painting in the early morning, for example) is also very harmful. The cathodic protection offered by zinc paints has been investigated by incompletely painting the specimens. Metallic zinc can protect small gaps in the coat, although no such protection was observed with red lead or ferric oxide paints. Metallic zinc paints, however, are somewhat pervious, but the addition of zine white improves their physical properties, giving better protection in spite of the reduced zinc content. Other series of experiments bear out the general principle that existing coats must be firm if repainting is to be successful. The deterioration of tarry and bituminous paints through the familiar formation of numerous cracks in the film has been investigated. The results show that this change is not due to shrinkage on drving or to thermal dilatation, but is probably caused by the action of light; the light effect is not confined to the ultra-violet end of the spectrum. The cracking is particularly deep when the bituminous paint is applied over red lead, but in this case temperature changes definitely favour the cracking. This defect is not obviated by the addition of carbon black or aluminium powder, and drying oils reduce the protective power of the paint, whilst delaying the appearance of the cracks. Experiments were also conducted on the best proportions of pigment, oil, thinner, and drier in linseed paints. In red lead paints, both oil and thinner can be varied over wide proportions without affecting considerably the protective power, but in ferric oxide paints the protective value falls off steadily as the proportion of thinner is increased. Tung oil expands eventually on drying, since the film tends to wrinkle, whilst linseed oil contracts, since the films tend to become pervious. It is suggested, therefore, that a mixture of the two would prove a more impervious vehicle. A few experiments show that better protection is given. The best protective effect is obtained in dry weather by reducing the amount of drier to a minimum, but in moist climates a liberal supply of drier is advisable. Quickdrying vehicles may be less protective than linseed oil containing a large quantity of drier. Experiments on the protection offered by sprayed aluminium coats, in some cases " doped " with varnish, suggest that aluminium coats may provide a satisfactory and reasonably permanent protection for steel.

-E. S. H.

Corrosion-Resistant Material Made with Metallic Adhesive. A. W. Coffman (Chem. and Met. Eng., 1932, 39, 144–145).—Fibrous materials when pressed on to metals coated with a suitable metal, adhere at certain spots, even at room temperature. Raising the temperature progressively improves such adhesion, and when conditions of temperature, pressure, and final cooling are adjusted, an adhesion is obtained sufficiently satisfactory to enable the composite material to be worked and formed. Optimum conditions exist near to and above the melting-point of the adhesion metal. Temperature limits of adhesion for tinplate, lead-clad iron, galvanized iron, and terme plate were experimentally determined in a small rolling-mill. The product, a new protected metal called Robertson-Bonded-Metal, consists of a metal base to one or both sides of which a suitable felted material—e.g. asbestos felt—has been attached. This material allows of considerable distortion, offers resistance to heat and fire, has increased insulating value compared with the base metal, is soundless, and has the strength of the metal core. When the felt is saturated with various suitable materials it resists corrosion well.—F. J.

The Technique of High and Very High Resistance Wire-Drawing of Steels. VII.—The Metallization of the Steel Wire. G. de Lattre (Aciers spéciaux, 1932, 7, 123-135).—The processes of coating steel wires with cadmium in a bath of 83:17 cadmium-zinc, hot-galvanizing, and electro-galvanizing are described. It is shown that coating with cadmium is more durable than zinc coating, obviates all the disadvantages of hot-galvanizing, but has relatively low hardness and high melting point. To increase the hardness and lower the melting point, the use of the cadmium-zinc eutectic alloy is recommended. The consumption of metal is comparable with that of pure tin, the resistance to atmospheric corrosion is perfect, and the cadmium coat does not exert any injurious effect on the mechanical properties of the steel wire.—J. H. W.

The Cementation of Iron and Steel by Chromium. W. I. Nikolaev (Korrozia metallov (Corrosion of Metals. First Pan-Union Conference on Corrosion, Moscow, Nov. 1-6, 1929); Transactions of the Institute of Applied Mineralogy, 1931, 72-95).—[In Russian.] The chromium treatment was studied at 900°, 1000°, 1100°, and 1200° C. for periods of 3, 6, and 12 hrs. Between 900° and 1000° C. a border eutectic layer, limiting the region of solid solution, makes its appearance. At 1000°-1080° C. an external bright layer begins to form, and prolonged heating at these temperatures causes the disappearance of the region of solid solution. Iron alloys with a low carbon content are most suitable for chromium treatment. The bright layer consists of a solid solution rich in chromium with small admixtures of the carbides C_4C and $Fe_3C.Cr_4C$; it has a low degree of hardness. Chromium treatment renders the product highly resistant both to nitric acid and to rusting.—N. A.

IV.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 552-553.)

Veining or Sub-Boundary Structures. L. Northcott (Iron Steel Inst., Advance Conv. 1932, 1-13) .-- Experiments in inducing and removing veining or sub-boundaries, i.e. intra-granular network, in iron, nickel, and copper gave the following results : (1) veining may be induced in iron, nickel, and copper by annealing at a high temperature (1000° C.) in an oxidizing atmosphere (air) and (2) in iron by annealing in contact with pure iron oxide; (3) veining may be removed from these metals by annealing in hydrogen; (4) veining was found in cast mild steel, iron, and copper, but not in electrodeposited iron, nickel, and copper; (5) veining could be removed from iron by quenching from above the A₃ point and in copper by quenching from 1000° C.; (6) on slow cooling, veining started to appear in iron below the A_3 point, but was not complete until atmospheric temperature was reached; (7) in iron quenched from above the A₃ point, veining was observed on annealing at 300° C. for 20 hrs., but was not appreciable until 600° C. was reached; (8) veining could be re-formed in quenched copper by slow cooling; (9) slight veining was induced in electrolytic iron in contact with iron oxide below the A₂ point. The explanation put forward is that veining is due to the varying solubility of the metal oxide in the metal; there is evidence that it is not due to the nitride. The non-concordance of the results of high-temperature treatment in hydrogen obtained by previous workers is due to the fact that the first effect of this treatment is to accentuate veining, possibly by decarburization, and the second effect to remove the veining. The experimental results suggest that oxygen has little influence on the age-hardening of mild steels .- J. H. W.

On the Relation between the Deformation and Working Recrystallization Structure of Aluminium. (A) Single Crystals. (B) Polycrystalline Aluminium. W. G. Burgers (*Metallwirtschaft*, 1932, 11, 251–255, 265–267).—A reprint (abbreviated) of a paper by Burgers and Louwerse (cf. this J., 1931, 47, 276).

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-v. G.

Recrystallization of Solid Solutions. Recrystallization of Alloys of Tin with Antimony, Bismuth, Lead, Copper, and Aluminium. A. A. Botchvar and N. E. Merkur'ev (Zvetnye Metally (The Non-Ferrous Metals), 1930, 5, 495-499; C. Abs., 1931, 25, 4501).-[In Russian.] It is shown that a decrease in recrystallization effect can be produced by impurities which form solid solutions with tin. Alloys of tin with 0.5, 1, and 1.5% antimony, 0.5 and 1% lead, 0.5 and 1% bismuth, 0.5 and 1% copper, and 0.2 and 0.5% aluminium were investigated. The recrystallization tests were carried out by heating the alloys to 150°-180° C. The macrostructure of the recrystallized design was brought out by etching with concentrated ferric chloride solution in hydrochloric acid or with a solution of potassium chlorate in hydrochloric acid. All of the impurities investigated lowered the recrystallization tendency of the tin. The effect of antimony, which is soluble in tin up to 10%, was relatively small. The effects of lead and bismuth were greater; those of copper and aluminium, which are almost insoluble in tin, most decided. Thus the influence of additions which form solid solutions in this respect are analogous to their influence on hardness and electrical conductivity.-S. G.

The Arrangement of the Micro-Crystals in Compressed Single-Crystal Plates of Aluminium.--IV. Yoshio Fukami (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1932, [A], 15, 23-30).--[In English.] Cf. this J., 1929, 42, 511; 1930, 44, 557; and this volume, p. 307. The relation between the initial crystallographic orientation of the specimen and the type of fibrous arrangement of the microcrystals produced by compression has been examined. When single-crystal plates of aluminium are compressed until their thickness is 10% of the original value, the crystallographic axis which becomes nearly parallel to the longer side of the specimen is any one of [111], [110], or [100] axes which has initially a slight inclination to the longer side of the specimen.-E. S. H.

Is There a Compound Al₂Zn₃ P M. von Schwarz and O. Summa (*Metallwirtschaft*, 1932, 11, 369–371).—Slowly cooled aluminium-zine alloys exhibit only the X-ray lines of the individual metals, but when the alloy with 21% aluminium is quenched from 350° C., a face-centred cubic phase, a=3.978 A., appears. After prolonged storage at room temperature or more rapidly by annealing at 100° C. this phase disappears, and lines due to hexagonal zine are once again visible in the röntgenogram. The cubic lattice cannot be ascribed to a molecule Al₂Zn₃, but it is suggested that this new phase is a polymorphic modification of zine which cannot exist in pure zine, but only in certain of its alloys (see following abstract).—v. G.

Is There a Compound Al₂Zn₃? E. Schmid and G. Wassermann (*Metallwirtschaft*, 1932, 11, 386–387).—The experimental results of von Schwarz and Summa (preceding abstract) are confirmed, but the β -phase is considered to be identical with the solid solution of zinc in aluminium, but possibly separated therefrom by a gap of immiscibility.—v. G.

therefrom by a gap of immiscibility.—v. G. Precision Determination of the Lattice Constants of Beryllium. M. C. Neuburger (Z. physikal. Chem., 1932, [B], 17, 285-292).—The lattice constants of pure beryllium are as follows: $a = 2.2680 \pm 0.0002$ A., $c = 3.5942 \pm 0.0003$ A., whence c/a = 1.5847.—v. G.

On the Mechanism of the Allotropic Transformation of Cobalt and Thallium. U. Dehlinger (*Metallwirtschaft*, 1932, 11, 223-225).—In the allotropic transformation of pure metals work must be performed in increasing the surface. In the case of thallium crystals the transformation takes place by the folding over of the lattice along such crystal planes that the surface change remains as small as possible. The surface work is greater the smaller the grain-size, and can reach the same order of magnitude as the heat of transformation. From this it follows that temperature hysteresis must occur in this case, and this hysteresis, as Wassermann has observed with cobalt, can be sufficient completely to suppress the transformation.—v. G.

On the Arrangements of the Micro-Crystals in Copper and Gold Deposited by Electrolysis. Hideki Hirata and Yoshio Tanaka (Mem. Coll. Sci. Kyötö Imp. Univ., 1932, [A], 15, 9-22).-[In English.] The arrangement of the micro-crystals in electrodeposited copper and gold has been examined by an X-ray method. Under ordinary conditions there is no regularity, but under certain conditions the micro-crystals of copper tend to become arranged in a fibrous manner, having the [110] axis in common: occasionally the rotation of crystals about this axis is so small that the specimen resembles closely a single crystal. In such a case, the direction of maximum growth and that of the normal to the largest face are closely related to those in a "parallel growth" natural crystal. Some of the fibrous specimens were observed to consist of two groups of micro-crystals rotating about the same common axis as above: a micro-crystal in one of these groups is so placed as to form a spinel-type twin with a micro-crystal belonging to the other group. The micro-crystals of electrodeposited gold have no marked tendency to a regular arrangement.-E. S. H.

Diffraction of Low-Speed Electrons by Single Crystals of Copper and Silver. H. E. Farnsworth (Phys. Rev., 1932, [ii], 40, 684-712) .- The diffraction of low-speed electrons from the (100) faces of single crystals of copper and silver has been studied in detail with special reference to the variation in intensity of the various diffraction beams with the angle of incidence. The results are highly complex, and show the number of beams to be greater than that required by the simple diffraction theory. The two metals behave differently, the deviations from simple theory being greater for silver than for copper. Whilst the classification of results is different for the two metals, the general effect is that each theoretical beam is accompanied by additional beams. For copper, further beams due to a "surface gas lattice" were observed, but diminished in intensity after prolonged heat-treatment. When the gas lattice becomes very thin its structure changes from a simple cubic singlespaced lattice to a face-centred double-spaced lattice. These structures are also found when the surface is exposed to hydrogen, the face-centred structure being formed at low pressures (less than 0.5 mm. mercury). The general effect of surface action on the diffraction of electrons is discussed.-W. H.-R.

Crystal Structure of Gallium. F. Laves (*Naturwiss.*, 1932, 20, 472).—A short preliminary notice. Gallium is not tetragonal, but the lattice has a pseudo-tetragonal, rhombic holohedral symmetry with a unilateral face-centred translation group.—J. W.

The Arrangement of the Micro-Crystals in the Film of Molybdenum Obtained by Deposition. Takeo Fujiwara (Mem. Coll. Sci. Kyötö Imp. Univ., 1932, [A], 15, 31-33).—[In English.] The arrangement of micro-crystals in a film of molybdenum, formed by sputtering through bombardment with electrons in a vacuum, has been studied by means of Laue photographs. The arrangement is such that the (110) plane is almost in the flat surface of the film and a cube edge is nearly parallel to the lengthwise direction. Some films were observed to be composed of somewhat large micro-crystals, arranged in a fibrous manner with the [110] axis as fibre axis, normal to the flat surface of the film.—E. S. H.

On the Structure of the Reaction Products of Alkali Metals on Graphite. A. Schleede and M. Wellmann (Z. physikal. Chem., 1932, [B], 18, 1-28).— The products of the reaction of potassium, rubidium, and cæsium on graphite have been examined by means of X-rays. In all cases the atoms of the alkali metal are arranged in planes parallel to the basal plane of the graphite lattice and separated from one another by one or two planes in which the carbon atoms are arranged as in the graphite lattice.—v. G.

The Molecular Process of Crystal Growth in Hexagonal Metals. Deposition upon Monocrystalline Hemispheres of Zinc. Paul A. Anderson (Phys. Rev.,

1932, [ii], 40, 596-606).- A single-crystal rod of zinc was grown under conditions in which one end became hemispherical. The monocrystalline hemisphere was contained in an evacuated vessel with molten zinc, and the temperature adjusted so that the hemisphere was just below, and the liquid just above the melting point. Under these conditions zine slowly distilled from the liquid to the monocrystalline hemisphere, and the crystal growth was studied. The first stage was the development of (0001) polar planes which truncated the sphere. These were first circular, but later developed bands and became roughly hexagonal, and below each polar plane a series of steplike plane-surfaced shoulders appeared, each hexagonal in form. The results are explained by a method analogous to that of Kossel (Z. physikal, Chem., 1928, 136, 259) and Stranski (Z. physikal. Chem., 1930, [B], 11, 342). This assumes that the force acting on an atom which has struck the crystal surface is the sum of four force terms, each of which is proportional to the number of neighbours in a given shell, and each of which is weighted by the radius of that shell. A table is constructed showing the " condensation probability " series, and agrees with a rapid growth parallel to, and a slow growth normal to, the (0001) plane. The explanation is also in agreement with the later stages of growth .- W. H.-R.

On the Meaning of the Texture of Cold-Deformed Metals. W. E. Schmid (Z. tech. Physik, 1931, 12, 552-555).—The theory of the mechanism of the development of the deformation structure of cold-worked metals put forward by Wever and Schmid (this J., 1929, 42, 519; 1930, 44, 555) is preferred to that of Boas and Schmid (this J., 1929, 42, 519).—J. W.

Crystal Lattice Distortion in Stretched Wire. W. A. Wood (*Nature*, 1932, 129, 760-761).—By longitudinally stretching wires of Constantan, copper, nickel, and brass the lattices are definitely distorted. By means of X-ray spectra, proof is given that the diffuse lines produced through the stretching are due to real distortion of the lattice, and not to the formation of a more finely-grained structure.—E. S. H.

The Structure of Thin Crystal Films. F. Kirchner (Z. Physik, 1932, 76, 576-596).—The method of electron interference is applied to investigate the crystal structures of extremely thin films of materials, including, inter alia, bismuth, gold, silver, thallium, lead, selenium, antimony, tellurium, arsenic, zinc, and cadmium. The results indicate the presence of ordered crystal orientation; a fibre structure characterized by a plane network (accompanied by more or less scattering) oriented parallel to the plane of the support was found in most cases; it was absent in the case of zinc and cadmium. When a thin film is slowly evaporated in vacuo the width of the interference rings increases. With increasing thickness of film and increase of the rate of evaporation of the film the size of the crystal nuclei increases.—J. S. G. T.

Electronic Structure of Polyatomic Molecules and Valence. II.—General Considerations. Robert S. Mulliken (*Phys. Rev.*, 1932, [ii], 41, 49–71).— In view of the close connexion between the covalent and metallic types of linkage, a note may be made of this paper, which describes some of the applications of the quantum theory to the problems of valence and atomic attraction.—W. H.-R.

Note on Molecular Structure [Metallic Cohesion]. John C. Slater (*Phys. Rev.*, 1932, [ii], 41, 255–257).—A note. A discussion, with special reference to the problem of metallic cohesion, of the relative advantages of the mathematical methods of S. (*Phys. Rev.*, 1931, 38, 1109) and Pauling (*J. Amer. Chem. Soc.*, 1931, 53, 1367), and of Hund (*Z. Physik*, 1931, 73, 1, 565; 1932, 74, 1) and Mulliken (*Phys. Rev.*, 1932, [ii], 41, 49) concerning the motion of electrons in polyatomic molecules, of which 'a metal crystal may be considered as an extreme example. The latter investigators treat each electron as moving in a wave function which is a solution of a problem of many centres, a so-called

molecular orbital; the former treat the same problem from a starting-point in which each electron moves as in a single atom, *i.e.* in an atomic orbital. The atomic orbital method has the advantage of taking better account of the ionic states, and of separating the ionic from the covalent case. Otherwise the methods are essentially equivalent, and are to be regarded as complementary and not antagonistic.—W. H.-R.

V.-ANALYSIS

(Continued from pp. 553-556.)

Spectrum Analysis in Metallurgy. C. E. Eddy (*Chem. Eng. Min. Rev.*, 1932, 24, 239-240).—A brief review of the more commonly used methods in the spectroscopic analysis of metals and the ranges for which they are available, is given.—J. H. W.

Sampling Aluminium Scrap and Waste. Robert J. Anderson (Amer. Metal Market, 1930, 37, (133), 4, 10; C. Abs., 1930, 24, 4727).—The importance of securing accurate samples is emphasized, and the principles of sampling, the size of sample, and its preparation are briefly discussed. Methods are recommended for sampling aluminium and aluminium alloy scraps and wastes.—S. G.

Electrographic Analysis of Alloys. A. Glazunov (*Chem. Listy*, 1931, 25, 352-354).—This new method for the qualitative analysis of alloys depends on the fact that when a current is passed between the alloy and an Al cathode separated from the alloy by a piece of filter paper impregnated with a solution of a reagent which gives a characteristic colour with one of the constituents of the alloy, sufficient of this constituent will be dissolved to produce this colour in a few minutes. Hence by selection of suitable reagents (table given) all the constituents of an alloy can be detected in a short time without appreciably destroying the specime.—R. P.

The Analysis of Red Brass and Brass. Otto Niezoldi (Z. ges. Giesserei-Praxis: Das Metall, 1932, 53, 246-268).—The Cu and Pb in the filtrate from the stannic acid are determined electrolytically, Al and Fe are precipitated as oxides with NH_4OH and weighed together, again brought into solution, and the Fe determined by titration with $KMnO_4$ and the Al by difference. Ni is determined with dimethylglyoxime in the filtrate from the Fe and Al. Cu is determined in the filtrate from the Ni by precipitation with H_2S , filtering, igniting, and weighing as CuO. Zn is determined from the same solution by acidifying and precipitating with H_2S and eventually weighing as ZnO or by titration with $K_4Fe(CN)_6$. S is determined in the same manner as in iron and steel. (See J., this volume, p. 487.)—J. H. W.

A New Qualitative Test for Aluminium. K. Kershner and R. D. Duff (J. Chem. Education, 1932, 9, 1271-1273).—An ether solution of purpurin is used to detect Al by means of a stabilizing effect of the dye lake on the foam produced by agitation of an $NH_4OH-(C_2H_5)_2O$ mixture. The test is performed on the solution obtained by pouring 6N- NH_4OH over the mixed hydroxides on the filter. 0.5 mg. of Al can be detected in the presence of 50 mg. of Cr, Fe, and other metals. In the presence of minute quantities of other elements, 0.001 mg. of Al can be detected without preliminary treatment. It is claimed that this test compares favourably with the "aluminon" test (ammonium salt of aurin tricarboxylic acid) and Atack's test (alizarin).

-J. H. W.

On the Reduction of Sulphur Dioxide to Hydrogen Sulphide and the Analytical Application of this Reaction [to the Detection of Arsenic and Antimony in Tin]. Ed. Donath (*Chem.-Zeit.*, 1932, 56, 483).—The Sn is dissolved in HCl and KClO₃ and to the boiling solution is added an excess of freshly-propared SnCl₂ in concentrated HCl, followed by Na_2SO_3 solution drop by drop. A yellow precipitate (As₂S₃) indicates the presence of As. With more Na_2SO_3 a red

precipitate of Sb_2S_3 forms if Sb is present. The reactions depend on the reduction of SO_2 by SnCl₂ in concentrated HCl to yield nascent H_2S_2 .—A, R, P.

The Formation and Properties of Precipitates. Theory of Co-Precipitation.— II-VII. I. M. Kolthoff (Chem. Weekblad, 1932, 29, 307-310, 332-338, 346-348, 362-363, 378-380, 395-400).—The adsorption of ions by precipitates containing a similar ion (e.g., Ba" by BaSO₄, Ag' by AgCl) is discussed. Recent work on the modification of the formation of precipitates by the adsorption of similar or dissimilar ions is reviewed. The increase of solubility of precipitates with degree of subdivision is discussed and an explanation is given of the fact that many finely-divided precipitates are easier to filter after remaining for some time in contact with the solution. Von Weimarn's laws of precipitation are criticized and the influence of adsorbed ions is emphasized. The crystalline state of a precipitate is less complete the greater the co-precipitation of foreign ions.—E. S. H.

The Use of Manganese Sulphate in the Determination of Antimony by Low's Method. W. G. Leemann (J. Soc. Chem. Ind., 1932, 51, 284r).—The endpoint in the volumetric determination of Sb by Low's method in white bearing alloys is difficult to determine, as the pink colour of the KMnO₄ disappears almost immediately. By following the original procedure, but adding MnSO₄ solution, the colour remains for 1–3 minutes, and satisfactory results are obtained. The MnSO₄ solution is made up by dissolving 110 grm. of MnSO₄ crystals in 500–600 e.e. of H₂O, adding 138 e.e. of H₃PO₄ (d 1.7) and 130 e.e. of H₂SO₄ (d 1.84), and diluting to 1000 e.e.—E. S. H.

On the Gravimetric Determination of Beryllium and its Separation from Fe⁻⁻, UO₂⁻⁻, Th⁻⁻, Zr⁻⁻⁻, Tl⁺, CrO₄^{-'}, MoO₄^{-'}, Cu⁻⁻, AsO₃^{-''}, SbO₃^{-''}, VO₄^{-''}, and WO₄^{-''} by Guanidine Carbonate. Ant. Jilek and Jan Kota (Z. anal. Chem., 1932, 89, 345–354).—See also J., this volume, p. 309. The separation of Be from all the above constituents can be satisfactorily effected by the method previously given for separating Be from Al (cf. J., this volume, pp. 88, 441). —A. R. P.

Separation of Copper in the Presence of Aluminium by 8-Hydroxyquinoline. Application to Aluminium Alloys. Jean Calvet (Compt. rend., 1932, 195, 148-150).—A method of determining Cu with great accuracy in the presence of Al and a number of other metals said to interfere, and also when the Cu is present only in a small amount, consists of precipitating Cu by hydroquinoline in the presence of sodium tartrate in either an acetic acid or an ammoniacal solution, no Al being precipitated. The temperature is 70°-80° C. and the hydroxyquinoline a 3% solution in 2N-CH₃·COOH. The solution is allowed to cool after precipitation, the volume being 200 c.c., and after 2 hrs. the precipitate is filtered, washed with warm water, and dried at 108°-110° C. The precipitate has the formula Cu'(C₉H₄ON)₂ and contains 18·08% Cu. Excess hydroxyquinoline or Na₂C₄H₄O₆ and <6-7% CH₃·COOH do not interfere. Mg, Be, Mn, Zn, and Cd have no effect. Ni and Co are precipitated and may be determined by this method. Small quantities of Fe do not interfere. The method is particularly applicable for small proportions of Cu in Al, *i.e.* for Al alloys, but is less convenient for Cu-rich Al alloys.—J. H. W.

Quantitative Determination of Manganese as Dioxide. Erika Wohlmann (Z. anal. Chem., 1932, 89, 321-338).—Mn is quantitatively deposited on a gauze anode by electrolysis from $MnSO_4$ solutions containing a large excess of CH_3 ·COONH₄ and C_2H_5OH or a small excess of H·COONa and H·COOH. The deposit should be heated to constant weight at 250° C.; in the acetate method the true MnO_2 content of the deposit is obtained by multiplying its weight by 0.9459 and in the formate method by 0.9085. As the deposits contain some MnO, volumetric methods are useless. Accurate titrations of Mn" salts with KMnO₄ are obtained only in the presence of ZnSO₄ and ZnO, provided that after the first permanent pink colour is obtained sufficient

 CH_3 ·COOH is added to the boiling solution to redissolve the ZnO, and the titration then continued to a second pink end-point. Divalent cations other than Be and those oxidized by $KMnO_4$ do not interfere, but all ter- and quadrivalent cations cause erratic results to be obtained.—A. R. P.

A New and Simplified Colorimeter Especially Designed for the Colorimetric Estimation of Manganese by the Periodate Method. G. Frederick Smith and U. R. Sullivan (J. Chem. Education, 1932, 9, 1461-1471).—A new design of colorimeter for the determination of Mn by the periodate method is described. A comparison of the results obtained with this colorimeter with those obtained using the Duboscq colorimeter and applying the Kober colorimeter correction formulæ shows that these results may not agree when the nature of the colour is materially altered, as, for example, in the use of the yellow colour produced in the determination of Ti by H_2O_2 or in the case of other colour ranges. The characteristics of the new apparatus are sturdy construction in cast Al, simple but convenient arrangement of working parts, low original cost, and inexpensive renewals.—J. H. W.

A New Rapid Method for the Determination of Mercury. G. Spacu and P. Spacu (Z. anal. Chem., 1932, 89, 187–191).—The neutral or feebly ammoniacal Hg solution is treated with KI to convert the Hg into K_2HgI_4 and the boiling solution treated with a boiling solution of dipropylenediaminecupric sulphate and cooled. All the Hg is precipitated in dark bluish-violet tabular crystals of dipropylenediaminecupric tetraiodomercuriate; the crystals are washed with a cold 0.1% KI solution containing 0.1% of the CuSO₄ complex, then with 96% C₂H₅OH, and finally with (C₂H₅)₂O, dried in a vacuum desiccator, and weighed. They contain 21.81% Hg.—A. R. P.

Spectroscopic Identification of Traces of Nickel and Chromium. A. J. de Andrade Gouveia (*Rev. Chim. Pura Applicata*, 1930, 5, 41-43; *C. Abs.*, 1932, 26, 2670).—In a mixture of NiSO₄ and SiO₂ 0.05% of Ni may be detected by visual observation of the line at 5476.9 A.; in a mixture of $K_2Cr_2O_7$ and SiO₂ 0.005% of Cr may be detected by observation of the triplet at 5204:5-5208.4 A. The dimethylglyoxime method for Ni is, therefore, more sensitive than the spectroscopic, but the latter method is more sensitive for Cr than are any of the chemical reactions commonly employed.—S. G.

On the Separation of Nickel and Cobalt and their Quantitative Determination by the Filtration Method. H. Th. Bucherer and F. W. Meier (Z. anal. Chem., 1932, 89, 161–171).—Ni and Co may be titrated together at 60°–70° C. in feebly CH₃·COOH solutions containing 4–5 grm. of CH₃·COONa per 100 c.c. by means of a 0.6% solution of 8-hydroxyquinoline using the filtration method of ascertaining the end-point. Ni alone may be determined by titration in 2% CH₃·COOH solution containing 4–5 grm. of CH₃·COONa at 60°–70° C. using a 0.3% solution of dimethylglyoxime in 50% CH₃·CO·CH₃; if more Co than Ni is present, the results are erratic, as Co forms brown compounds with the reagent which obscure the end-point, but good results may be obtained by adding sufficient standard NiSO₄ solution to make the Ni : Co ratio greater than 1 : 1.—A. R. P.

Potentiometric Determination of Platinum and Gold with Cuprous Chloride Solution. Erich Müller and K. H. Tänzler (Z. anal. Chem., 1932, 89, 339– 344).—Pt may be accurately determined by potentiometric titration of the H_2PtCl_6 solution with a solution of Cu_2Cl_2 in N-HCl at 50° C., provided that the Pt solution contains not more than 1–2 c.c. of HCl per 50 c.c.; the endpoint appears when all the H_2PtCl_6 has been reduced to PtCl₂. Similarly, HAuCl₄ is reduced to metallic Au by the Cu_2Cl_2 solution, and the end-point may be determined potentiometrically. Although Au is precipitated before reduction of H_2PtCl_6 occurs, the end-point is not sharp when the solution contains both metals, but the sum of the metals may be obtained correctly by potentiometric titration.—A. R. P. The Colorimetric Determination of Small Amounts of Silver. E. E. Jelly (J. Soc. Chem. Ind., 1932, 51, 191–1937).—Ag can be determined in very dilute solution by reducing the ammoniacal liquid with $Na_2S_2O_4$ in the presence of gelatin. The clear yellow colloidal solution of Ag thus produced is matched colorimetrically against a standard. Salts of Cu, Co, Ni, and Cd interfere with the determination and must be removed previously.—E. S. H.

Rapid Method for Determining Tin and Antimony in Alloys with a High Copper Content. A. M. Belousov (Zhurnal Prikladnoi Khimii (Journal of Applied Chemistry), 1930, 3, 437-439; C. Abs., 1930, 24, 5001) .-- [In Russian.] Introduce a 0.3 grm. sample in a 150-200 c.c. beaker, add carefully 3 c.c. HNO3 (d. 1.2), and cover the beaker with a watch-glass. When the reaction loses its violence, add again 4 c.c. HNO2. After the sample has dissolved, expel the red fumes by careful heating and leave the beaker on a steam bath for 20-25 minutes. Then bring the mixture to the boiling point, add 15 c.c. of a boiling 3% NH, NO, solution, boil for 2-3 minutes, and leave on the waterbath for I hr. Remove the watch glass, rinse it with water, and collect the washings in a 250-300 c.c. Erlenmeyer flask. Pour the mixture from the beaker into centrifuge tubes which have very narrow bottoms. Rinse the beaker with water and collect the washings in the above-mentioned Erlenmeyer flask. Centrifuge, decant, and discard the supernatant liquid. Carefully wash out the sediment in the Erlenmeyer flask and evaporate its contents to a small volume. Add 15 c.c. HCl (d. 1.19) and heat until the residue dissolves and all of the nitrous fumes disappear. Determine either Sn (I2 titration) or Sb (KMnO, titration). If both metals must be determined, two samples are needed. In the absence of Sn some of it should be added to the original sample, as otherwise part of the Sb dissolves in HNO3 and the results are low .- S. G.

VI.—LABORATORY APPARATUS, INSTRUMENTS, &c. [See also "Testing" and "Pyrometry."]

(Continued from pp. 556-557.)

Temperature Regulator for Electrical Resistance Furnaces. R. F. Proctor (J. Sci. Instruments, 1932, 9, 192–195).—This instrument consists of two glass bulbs filled with air at atmospheric pressure, and connected by a mercury manometer. Each bulb contains a heater filament, the one being connected so as to be heated in proportion to the voltage across the furnace, and the other in proportion to the current flowing through the furnace. The relative heating of the two bulbs is thus affected by a change in resistance of the furnace, and suitable relays are worked by the movement of the mercury. A regulation of $\pm 0.5\%$ change in resistance of the heating element is obtained. —W. H.-R.

A Precision Thermostat for Temperatures from -26° C. to 500° C. James A. Beattie (*Rev. Sci. Instruments*, 1931, 2, 458–465).—Two electrically-controlled thermostatic vessels employing either oil or a mixture of the nitrates of lithium, sodium, or potassium as thermostatic material are described. Temperature regulation to within 0.001° C. is possible.—J. S. G. T.

A Sensitive Flexible Thermostat. J. R. Rocbuck (*Rev. Sci. Instruments*, 1932, 3, 93-100).—A thermostatic device employing the temperature change of resistance of one or two coils to unbalance a Wheatstone bridge in which the galvanometer controls the heating current by means of a photoelectric cell and vacuum tube current amplifier, is described. Temperature control between -190° C. and $+300^{\circ}$ C. can be effected to within 0.01° C.—J. T.

The New Brown Potentiometer Recorder. T. R. Harrison (*Rev. Sci. Instruments*, 1931, 2, 618-625).—A recording potentiometer which can be used as a self-balancing Wheatstone bridge for purposes of resistance thermometry, and which incorporates a compensator for the effect of varying

humidity on the paper on which the record is produced, is described. It is made in forms taking from one to six records on the same chart.-J. T.

The Wenner Potentiometer. Leo Behr (*Rev. Sci. Instruments*, 1932, 3, 109-120).—A two-range, five-dial potentiometer in which the upper range is 1.9111 v. in steps of 10 micro-v. and the lower range is 1/10th of this, is described. The effects of contact resistances, thermal e.m.f.'s, and errors of adjustment are discussed in detail. The limit of error of the instrument is 0.005% or 2 micro-v. for the high range and 0.1% or 0.2 micro-v. for the low range.—J. S. G. T.

An Improved Feussner Type Potentiometer. Marion Eppley and William R. Gray (*Rev. Sci. Instruments*, 1931, 2, 242–249).—[Note by Abstractor.—The Feussner potentiometer is a modification of the Rayleigh potentiometer. In the latter, two P.O. boxes are connected in series and their total resistance is maintained at a constant value, say 10,000 ohms. The e.m.f. to be determined and a source of standard e.m.f. are successively connected to the ends of one of the boxes. In the Feussner instrument, direct-reading dials, convenient to operate, are used, and a switch which maintains the total resistance in the battery circuit constant is introduced.] Details of a precision Feussner potentiometer are given. Examination of 3 such instruments after 2 years' use shows the correction necessary to the readings is of the order 0-003% or less. —J. S. G. T.

Theory of a Combined Series and Potentiometer Rheostat. J. Rud Nielsen (*Rev. Sci. Instruments*, 1931, 2, 184–186).—The theory of the Dodge rheostat, which permits a rapid change from the series to the potentiometer circuit, whereby large or small currents respectively may be employed, is given.—J. T.

An Apparatus for the Evaporation of Various Materials in High Vacua. C. Hawley Cartwright and John Strong (*Rev. Sci. Instruments*, 1932, 3, 189-193).—An apparatus suitable for the evaporation and deposition of most metals and some non-metals in high vacuum, is described. Material to be evaporated is heated in a heating coil made of tuncsten or platinum. Among the metals successfully evaporated are aluminium, antimony, beryllium, bismuth, calcium, chromium, cobalt, copper, gold, iron, lead, magnesium, manganese, nickel, selenium, silver, tellurium, tin, and rine. Amongst alloys, speculum metal was satisfactorily evaporated, probably because tin and copper have approximately the same vapour pressure at the evaporating temperature. Brass distilled fractionally, rine being deposited first. Jeweller's silver was fractionated, silver being first evaporated, then copper. Bismuth black was deposited on one side of gold leaf. Alloys may probably be evaporated in the apparatus by explosion with a condenser discharge.—J. S. G. T.

A Vacuum Calorimeter for High Temperatures. L. G. Carpenter and T. F. Harle (*Proc. Phys. Soc. (Lond.)*, 1932, 44, 383-399).—A form of the platinum-thermometer type of vacuum calorimeter is described, in which the heat is transferred from the heating coll to the calorimeter by radiation, and which, being constructed without the use of organic insulating material, is suitable for use up to 500° C.—J. S. G. T.

An Automatic Constant-Level Device for Liquid Air. R. B. Scott and F. G. Brickwolde (*Rev. Sc. Instruments*, 1931, 2, 171–172).—A liquid air cryostat, in which the supply of liquid air to the container is controlled by an electric circuit which is made or broken in accordance with the position of a float on the surface of the liquid air, is described.—J. S. G. T.

The Use of Rhodium Apparsius in the Investigation of Oxide Systems. Gernard Tromel and Franz Wever (1962, 11, 255).-With further reference to the work of Westermann (1964, 1962, 11, 152; see J., this volume, p. 489) is pointed out the crucibles made from rhodium sheet can be used in the H.-F. induction furnace up to 1840° C, and rhodium wire-wound furnaces can be used up to 1750° C.--v. G.

Laboratory Apparatus. &c.

An X-Ray Micrograph for the Examination of Metallic Specimens. S. Zeidenfeld (J. Sci. Instruments, 1932, 9, 195-198).-Describes a spectrograph for investigating metallurgical problems formerly solved by the Laue method (e.g. effects of heat and mechanical treatment). The new method obviates the necessity of preparing thin sections. It utilizes large Bragg glancing

angles where θ is approximately $\frac{\pi}{2}$, which means that the diffracted X-rays

are deviated about 180°, so that the photographic film must be coincident with the source of X-rays. This is accomplished by making the X-ray collimator pass through the centre of the flat X-ray camera, a central hole being punched in the film. Holders suitable for wires, rods, plates, &c., are provided, and the outfit is made by Messrs. Adam Hilger, Ltd.-W. H.-R.

New Microscope Designed for Production. Anon. (Metal Progress, 1932, 22, (2), 21-30).-An improved metallurgical microscope with camera attachment is described. It is designed for the rapid routine examination of samples, and carries adjustments for vertical or horizontal photography of specimens, for monocular or binocular examination, and for the measurement of inclusions, &c. The easy and comfortable adjustments of the various portions are designed to minimize fatigue; these include the fitting of stops and click springs to the iris diaphragm, the polarizer, the prism assembly, and the locating apparatus attached to the rotating stage. Detailed descriptions of the

new features are given and frequently illustrated.—P. M. C. R. A Universal Object Table [Mechanical Stage]. M. Straumanis (Z. tech. Physik, 1931, 12, 576-578).- A simple mechanical stage for crystallographic and metallographical examination in reflected as well as in polarized light is described and some of its applications are indicated .-- J. W.

Constant-Temperature Cells for Microscopic Observations. J. B. M. Coppock, J. Colvin, and J. Hume (Chem. and Ind., 1932, 51, 700-701).-Two cells for the purpose of taking photomicrographs of changes in crystals at constant temperature and for other similar purposes are described and illustrated. One is suitable for temperatures below about 40° C., and the other over the range 150°-400° C .--- E. S. H.

Precision Measuring Apparatus for the Workshop. Ernst Preger (Maschinenbau, 1932, 11, 249-256) .- Gauges, measuring microscopes, apparatus for measuring diameters, the pitch of screws and toothed wheels, &c., are described .- v. G.

An Instrument for Measuring Small Displacements. B. F. Langer (Rev. Sci. Instruments, 1931, 2, 336-342) .- The instrument comprises two coils wound on laminated iron cores separated by an air gap in which is arranged a laminated iron armature and inserted in two of the arms of a Wheatstone bridge. Any change in the reluctance of the two coils due to displacement of the armature upsets the balance of the Wheatstone bridge, and the consequent deflection of an oscillograph element is recorded photographically. The instrument has been applied to measure stresses due to dynamic loads, e.g., in the mechanical parts of locomotives .-- J. S. G. T.

An Experimental Machine for Measuring Fine Wire. F. H. Rolt and C. O. Taylerson (J. Sci. Instruments, 1932, 9, 256-260) .- Describes and illustrates a machine for measuring the diameter of fine wire such as is used for lamp filaments. In this the wire is passed over a flat horizontal anvil, and the diameter is measured by lowering into contact a small horizontal cylinder with its axis at right angles to the wire. The cylinder is attached to a system of compound levers which magnify the vertical displacement of the cylinder about 15,000 times on to a glass scale. Arrangements are made for rotating the wire so that its diameter may be measured in different directions. Variations in diameter can be measured to a millionth part of an inch, and the absolute diameter at any point can be determined to within $\pm 0.000,003$ in.

The Mounting of Thin Metallic Membranes under Tension. C. K. Stedman (*Rev. Sci. Instruments*, 1931, 2, 818-819).—A method of mounting thin beaten gold leaf under tension on steel rings up to 6 cm. diameter is described. The edge of the leaf is cemented to a plate of aluminium, which is then heated to about 150° C. A cold steel ring coated with shellae on its under surface is lowered on to the heated gold film and lifted off with the taut membrane cemented to its under surface. An apparatus for carrying out the operation is described.—J. S. G. T.

A Practical Electrolysis Stand. Erich Reichel (Z. anal. Chem., 1932, 89, 173–177).—The stand is designed for carrying out electrolyses using stationary anodes and heated electrolytes; it comprises a heavy vertical rod fixed in a foot carrying a stout metal handle for moving the apparatus conveniently. The rod carries an attachment for holding an adjustable micro-burner, a ring covered with gauze to support the beaker, and an adjustable arm for the lead-in wires to the electrodes. This arm carries 2 parallel horizontal side-arms, between which the beaker is placed and to which are connected the electrodes through short vertical slits on opposite sides of the beaker. In this way corrosion of the arms and wires by the vapours and spray formed in electrolysis is avoided, and there is no danger of contamination of the electrolyte by corrosion products falling from the wires or arms.—A. R. P.

An X-Ray Camera for Powder Diagrams at any Temperature. Nelson W. Taylor (*Rev. Sci. Instruments*, 1931, 2, 751-755).—An X-ray spectrometer employing the Hull-Debye-Scherrer powder method and suitable for measurements on materials at temperatures up to 1000° C. and down to that of liquid air, is described. Good diagrams are obtained in 10-120 minutes. The apparatus can be applied to the study of crystal modifications which are stable at high or low temperatures and unstable at room temperatures. Lattice constants can be determined with an accuracy of 0.2%.—J. S. G. T.

Reciprocal Lattice Projecting Ruler and Chart. Lucien J. B. Lacoste (*Rev. Sci. Instruments*, 1932, 3, 356–364).—A graphical method of performing the calculations involved in Gruner's method of interpreting the secondary spectra of oscillating crystal X-ray spectrograms, in which reflecting planes in the crystal are plotted as points in the reciprocal lattice, is described. The theory of the method and the method of construction of the necessary ruler and chart are given.—J. S. G. T.

A Pantograph for Enlarging X-Ray Photographs. C. J. Ksanda (*Rev. Sci. Instruments*, 1931, 2, 305-306).—A parallelogram pantograph for enlarging X-ray spectra photographs obtained by the rotation or oscillation method, or Laue photographs, is described.—J. S. G. T.

An Experimental Oil-Immersed X-Ray Apparatus. R. D. Bennett, N. S. Gingrich, and W. C. Pierce (*Rev. Sci. Instruments*, 1931, 2, 226-230).—Details of an oil-immersed X-ray tube and the exciting circuit are given.—J. S. G. T.

A New X-Ray Spectrograph for Wave-Length Determinations in Air. S. Zeidenfeld (*Rev. Sci. Instruments*, 1931. 2, 153-163, 308).—An X-ray spectrograph suitable for wave-length determinations over the range 0.5-2.0 A. is described. Errata are referred to on p. 308.—J. S. G. T.

An X-Ray Spectrometer with Stationary Ion Chamber. Rudolf C. Hergenrother (*Physics*, 1932, 2, 211-216).—A Bragg type ionization X-ray spectrometer designed for quantitative measurements of integrated X-ray intensities from crystals is described. The ionization chamber is fixed, permitting a short fixed connection between it and the electrometer.—J. S. G. T.

A Double Crystal X-Ray Spectrometer. P. A. Ross (*Rev. Sci. Instruments*, 1932, 3, 253-260).—A high-precision X-ray spectrometer employing two crystals on which the X-ray beam is successively incident, is described.

_J. S. G. T.

VII.—PHYSICAL AND MECHANICAL TESTING AND RADIOLOGY

(Continued from pp. 557-560.)

Discussion by the French Association for Testing Materials, on Subjects Dealt with at the Zürich Congress. A. Portevin. L. Guillet. —— le Thomas, et al. (*Rev. Met.*, 1932, 29, 306-314).—A *resumé* of the contributions on mechanical testing of cast iron is given by P., and discussed by G., le T., and others.—H. S.

Laboratory Investigations are Secondary to Service Tests. J. L. McCloud (*Metal Progress*, 1932, 22, (2), 35–37).—The testing of materials must enable the investigator to appraise the effects of two kinds of wear—the abrasive action met with in operation, and the complex stresses to which the structure concerned is exposed in service. It is obvious that after some preliminary laboratory investigation, actual working, with controlled variation of relevant details, is the most reasonable method of testing, since accelerated laboratory testing is likely, under the conditions necessary to achieve acceleration, to lose the balance of normal working stresses which the structure is designed to bear in practice.—P. M. C. R.

Sperry Develops Flaw Detector Having Automotive Possibilities. Anon. (Automotive Ind., 1932, 67, 112).—Sperry Products claim to have developed an electrical method of non-destructivo testing, applicable to any magnetic material or electrical conductor. The current axis along a sound section is practically straight, but is deflected by fissures or substantial inclusions. An inductive searching device registers variations in magnetic flux as this is affected by deflections of the current axis, and the principle is applied to testing of various types of material in use.—P. M. C. R.

Preliminary Communication on Metal Contacts with a Very Thin Film of Impurity. R. Holm (Z. tech. Physik, 1931, 12, 663–665).—A thin corrosion film forms rapidly on base metals and very slowly on noble metals exposed to the air. This film prevents metallic adhesion, but changes the electrical resistance of contacts only slightly at room temperature. The electrical conductivity of these films changes little at low temperatures, but they allow the current to pass at superconductivity ranges probably owing to their partial destruction by the contact pressure. No explanation of these phenomena is put forward.—J. W.

The Study of Local Deformation, and Practical Methods of Carrying it Out. Georges Ivanow (Science et Industrie, 1932, 16, 237-240, 287-291).—The working conditions of complex and heterogeneous structures can be most effectively studied by the investigation of local deformations in the case of parts subjected to fatigue. Various types of extensometer are described and illustrated, and practical directions for their use are given, with certain sources of error. Methods of adjustment and mounting are discussed, and also the relative merits of mechanical and optical amplifying apparatus and of the "Ritz" recording extensometer; electrical methods are only briefly touched on. Many illustrations are appended.—P. M. C. R. Plasticity as Applied to Steel Products. A. Nadai (Proc. Eng. Soc. Western

Plasticity as Applied to Steel Products. A. Nadai (Proc. Eng. Soc. Western Pennsylvania, 1932, 48, 65–79).—Although actually concerning mild steel, the observations made have a general metallurgical application. From a study of surface changes observed on plastically deformed specimens, N. passes to the consideration of various types of model designed to illustrate the actual distribution of stresses. Further instances are considered during the discussion on the paper, and certain limitations, deductions, and improvements are suggested.—P. M. C. R.

VOL. L.

The Determination of Time-Extension Limit in Endurance Tests. E. Siebel and M. Ulrich (Z. V.d. I., 1932, 76, 659-663).—It is proposed to define the endurance yield-point as the load which at high temperature is just sufficient to produce a rate of clongation not exceeding 1×10^{-4} %/hr. after a permanent elongation of 0.2% has been produced. A short method of determining this property in a test extending over 50 hrs. is described.—v. G.

On the Time of Relaxation of Some Metals under Dynamic Stresses. A. Esau (Z. tech. Physik, 1931, 12, 492-495).—The time of relaxation, 1/R, according to Maxwell and Becker, has been determined from the damping at various frequencies in torsional vibration tests. The time is dependent on the amplitude of the deformation, and is much greater with heterogeneous alloys than with pure metals. For brass 1/R = 1/1500, for Duralumin 1/750, and for Elektron, which has small damping, 1/50-1/100.—J. W.

Recommendations for Determining the Permissible Stresses in Machine Construction. Fr. P. Fischer (Z.V.d.I., 1932, 76, 449-455).—A graphical method of representing the permissible stresses is proposed in which the endurance strength and the sensitivity to notches and the effect of surface imperfections are taken into account.—v. G.

Variability of the Damping of Metals. P. Ludwik and R. Scheu (Z.V.d.I., 1932, 76, 683–685).—The damping capacity of various steels, electrolytic copper, Silumin, and Elektron was determined on a rotating vibrational machine first from the rise in temperature of the test-piece, and also by a graphical method from the distortion turning moment curve. The results agreed closely in both cases. The effect of rise of temperature was overcome by cooling the specimen in water, which reduced the damping appreciably. In all the tests the damping capacity of copper fell to a minimum, at which point the hardness reached a maximum, and then again increased. With Silumin and Elektron the damping capacity fell continuously. These changes are ascribed to the opposing effects of crystal recovery and hardening.—v. G.

Autographic Stress-Strain Curves of Deep-Drawing Sheets. Reid L. Kenyon and Robert S. Burns (Amer. Soc. Steel Treat. Preprint, 1932, Oct., 1-24) .-- A description is given of the design and manipulation of an autographic apparatus for drawing stress-strain curves for sheet tensile testspecimens. A special curve-measuring ruler and its use are also described. Tensile stress-strain curves obtained with the new autographic attachment are shown, some of which give an experimental confirmation of the theory that the sharp yield-point in mild steel is related to stretcher-straining. A method is developed for computing the depth of the stretcher-strains from the amount of elongation through the yield-point. Curves are given for sheet material that has received various percentages of cold-rolling. True stress curves have been constructed from autographic stress-strain curves of sheet samples and these are briefly discussed. The stress-strain curve is shown to furnish considerable information concerning the behaviour of deep-drawing sheet material in addition to that obtained from the ordinary tensile test. The yield-point elongation and the uniform elongation are specific examples of significant values that can be determined only from accurate autographic stress-strain curves.-S. G.

The Results Furnished by Stamping Tests and their Relation to Tensile Tests. Henri Fournier (Compt. rend., 1932, 195, 327-329).—The effect of the amount of cold-working of different metals and alloys on the results given by the Siebel and Pomp, the Persoz, and the Erichsen stamping tests, and their relation to the tensile strength were examined. The metals tested were ordinary half-hard steel, an austenitic steel, 67:33 brass, commercial aluminium (99.5%), Duralumin, and magnesium. By each of the 3 methods of testing, increasing amounts of cold-work caused a corresponding decrease in the deflections obtained. According to Siebel and Pomp, the following relation exists between the tensile breaking stress, R, and the stamping breaking

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stress, $R_{\rm E}: R = \frac{R_{\rm E}}{\pi} = \frac{1}{\pi} \times \frac{C}{e(D + e - d)}$, where C = maximum load, D = the diameter, e = the thickness of the specimen, and d = the initial diameter of the impression. It is shown by this investigation, however, that the ratio $\frac{R}{R_{\rm E}}$ for the above metals is affected by the amount of cold-work they have received. For the Persoz and Erichsen tests, the empirical relation : $R = \frac{e}{Kcf}$, where f = the deflection at the moment of fracture and K is a coeff. varying somewhat according to the nature of the metal, the thickness of the specimen, and the pre-treatment. It is concluded from this investigation that the Siebel and Pomp test is suitable for metals having a high percentage elongation, and that the Persoz and Erichsen tests are better for less extensible metals. None of these tests has a simple relation to the tensile strength, but approximate relationships can be determined for specific cases.—J. H. W.

Torsion Testing Machine. R. Guillery (*Rev. Mét.*, 1932, 29, 52–54).—A simple machine for torsion tests of wires and rods is described.—H. S.

The Avery Torsion Testing Machine. P. Field Foster (Machinery (Lond.), 1932, 39, 465-467).—The stress distribution in bars or tubes under torsion is briefly discussed, and an account given of the construction and use of the Avery torsion testing machine.—J. C. C.

Portable Hardness Tester. Anon. (Iron and Steel Canada, 1932, 15, 85).— Describes the "Duroskop." See J., this volume, pp. 246 and 369.—J. H. W.

Self-Indicating Universal Testing Machine. Anon. (Engineer, 1932, 153, 644).—An illustrated article, describing a new testing machine in which both weighing and straining are effected through the medium of hydraulic power. A feature of the machine is the fact that one operator can carry out any of the usual tests—tensile, shearing, &c.—W. P. R.

The Tinius Olsen Multi-Lever Testing Machine. P. Field Foster (Machinery (Lond.), 1931, 39, 273-276).—An account of the construction and operation of the Tinius Olsen testing machine and autographic recorder. For work at high temperatures, suitable electric furnaces to surround the test-specimen are supplied. The Olsen autographic wire testing machine is also briefly described.—J. C. C.

RADIOLOGY

X-Rays in the Aluminium Industry.' N. C. Hypher (Metallurgia, 1932, 6, 115–117).—The usefulness of radiology in the aluminium industry, where penetration of castings and forgings up to 6 in. is obtained, is considered. The type of apparatus and equipment employed is briefly described, and it is stated that the best suited is one capable of producing high-tension voltages stepping up gradually from 50,000 to 200,000 v. The technique developed in the X-ray examination of specimens is discussed with special reference to visual and photographic examination; exposure times; the use of screens, diaphragms, and other accessory devices to eliminate scattered radiation; immersion in barium chloride solution; and the value of stereoscopic radiographs. The interpretation of radiographs is also dealt with and illustrations are given showing blowholes and porosity in various types of engineering materials.—J. W. D.

The Physical Characters of Penumbral Shadows and their Significance in **Röntgenography**. Paul M. Andrus (*Canad. J. Research*, 1930, 3, 252-259).— A new observation regarding the visual characters of penumbral shadows is recorded. It is pointed out that penumbral shadows appear to be laid down as a series of bands arranged serially as to density. This occurrence results in far-reaching effects in radiography as well as in other sciences concerned with the observation of images.—S. G.

VIII.—PYROMETRY

(Continued from pp. 561-562.)

Temperature Measurements in Commercial Silicon Carbide Furnaces. Ravmond R. Ridgway (Electrochem. Soc. Preprint, 1932, April, 225-236) .- For the innermost furnace core, a pyrometer tube made up as follows was used : a 7-in. graphite electrode was bored out to 3 in, inside diameter, and within this was a small carbon tube to control the flow of gas past a disc at the end. In order to sweep the tube entirely free of fumes, a vacuum was applied to the space within the outer and inner tubes. Shorter tubes were used for taking temperatures at points away from the centre line of the furnace. Calibration at temperatures above 1000° C, has been undertaken against standard optical pyrometers. Below 1000° C. platinum-rhodium thermocouples with alundum tube protectors were used. Data from two commercial runs are presented. The operating temperature for the development of silicon carbide is about 2000° C., whilst the maximum temperature in the interior of the core may be 2600° C. It is noted that a green colour is observable in the tube, which interferes somewhat with the accuracy of the optical results, unless a sufficiently high suction is maintained.-W. A. C. N.

Hints on Pyrometers. Anon. (Met. Ind. (Lond.), 1932, 41, 185-186).---Notes on the use of pyrometers, taken from booklet No. 48 of the Foster Instrument Co.-J. H. W.

The Application of Optical Pyrometry to the Measurement of Luminous Flame Radiation and Temperature. H. C. Hottel (*Proc. Amer. Gas Assoc.*, 1930, 1172–1176; *C. Abs.*, 1931, 25, 4683).—A method proposed for determining the true temperature and emissivity of flames by the use of the doublescreen pyrometer is described. Experimental work is still incomplete and no data are reported.—S. G.

A Precision Thermo-Junction Needle. Roy W. Brown (J. Sci. Instruments, 1932, 9, 198-200).—Describes a thermocouple made for determining the temperature under the tread of pneumatic tyres after road tests, but which is suitable for other cases in which it is necessary to measure the temperature of a small region quickly. The hot junction is contained in a hypodermic needle, and the details of construction are for the elimination of errors due to heat loss along the thermocouple wires, &c.—W. H.-R.

On New Noble Metal Thermocouples for High Temperatures. Wilhelm Goedecke (Z. Metallkunde, 1932, 24, 126).—Abstracted from Festschrift zum 50-jährigen Bestehen der Platinschmelze G. Siebert G.m.b.H., Hanau, 1931, 72-99; cf. J., this volume, p. 94.—M. H.

Recording Automatic Temperature Controller. Anon. (Mech. World, 1932, 91, 422-423).—An instrument, consisting of a combination of two Foster instruments, the electrical resistance thermometer, and the recording temperature controller, is described. It is designed for the purpose of maintaining electrically-heated apparatus at a constant temperature of 50° C. within limits guaranteed not to exceed 0.1% C.—F. J.

Thermostat Studies. III.—The Time-Lag of Various Thermometers. Shuu Kambara and Mototaro Matsui (Kogyo Kwagaku Zasshi (J. Soc. Chem. Ind., Japan), 1931, 34, (483-491); C. Abs., 1931, 25, 4158).—[In Japanese, with full English abstract in Supplemental Binding, pp. 167-1728.] The time lag of several typical thermometers was measured by determining the temperature-time curves of a bath, the temperature of which was varied automatically 0.2° C. every 2 minutes. Beckmann thermometers graduated in 0.01° were found to have a lag of between 1.1 and 2.5 seconds, platinum resistance thermometers 0.2-1.0 second, and bare thermocouples 0.0 second.

-S. G.

IX.-ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Continued from pp. 562-565.)

ELECTRODEPOSITION

Chromium Plating of Silver Articles. Hugo Krause (Mitt. Forschungsinst. Edelmetalle, 1931, 4, 98-101, 107-111) .- Although silver may generally be satisfactorily chromium plated directly, it is preferable to apply a nickel laver to the silver before plating with chromium. To determine the best thickness of nickel, samples of 925 and 835-fine silver sheet were plated for periods varying from 1 to 45 minutes in a bath containing nickel sulphate crystals 100, anhydrous sodium sulphate 20, magnesium sulphate crystals 5, sodium chloride 2.5, and boric acid 15 grm. per litre; the nickel-plated sheets were then plated with chromium and tested for flaking by bending through 180° and back again. Sheets plated with nickel for 3-2 minutes showed no flaking of the chromium deposit even with a heavy deposit, whereas sheets with thicker nickel deposits behaved well in the bending test only when a light outer coat of chromium was present. Direct deposition of chromium on silver yielded invariably a matt deposit, which, however, was strongly adherent, but rather difficult to polish. It is therefore recommended that a 5 minutes' deposit of nickel be given from the above bath at 1 amp./dm.2, followed by polishing and a 15 minutes' deposit of chromium at 15 amp./dm.² This treatment provides a coating which is perfectly resistant to sulphide tarnishing .- A. R. P.

Chromium Plating in the Glass Industry. N. H. McKay (Nat. Glass Budget, 1931, 47, (19), 3; Ceram. Abs., 1931, 10, 833).—Applications involving resistance to abrasion have been particularly successful in the field of small tolerance or low permissible wear because chromium plating on these surfaces has greatly increased their life. Chromium plating is widely used in the glass industry for (1) heat resistance, (2) corrosion resistance, and (3) reclamation work.—S. G.

Chemical and Physical Actions in Chromium Plating Bath. Marvin J. Udy (*Metal Progress*, 1932, 221, (6), 23–27).—The complications introduced into the plating process by the secondary reactions of chromic acid are described, and advantageous temperature conditions, current densities, compositions of bath, and choice and adjustment of anodes are discussed, partly with reference to the type of coating desired.—P. M. C. R.

Chromium Plating. W. E. Rogers (*Elect. Times*, 1930, 78, 1109–1111; C. Abs., 1931, 25, 4803).—Some particulars of the metal are given, and for comparative purposes the physical properties of chromium are set out in a table. It seems advisable to adopt a 3-stage process with chromium deposition, viz., (1) an initial deposit of copper, (2) a secondary deposit of nickel, and (3) transfer to the chromium vat. The purposes of this 3-cycle process are explained. For chromium plating the only anode economically applicable is lead. Some of the complications in connection with this are described. Chromium plating is usually struck at about 6 v., although the voltage recommended in the initial stage is 8 v. It is essential that the temperature of the electrolyte should be maintained within 2° of that found necessary by experience for various qualities of deposit. R. discusses the troubles of "shading" and the means to avoid it, and remarks briefly on the utility and application of chromium plating.—S. G.

Hydrogen in Electrolytic Deposits of Chromium. H. Gernet (Zhurnal Prikladnoi Chimii (Journal of Applied Chemistry) Chimitcheskii Zhurnal, 1931, [B], 4, (4), 429–437).—[In Russian.] In the electrolysis of aqueous solutions of chromic acid, the deposition of metal is only 10–30% of the theoretical value, the rest of the current being consumed in reducing the acid with the evolution of large quantities of hydrogen at the cathode. The properties of the chromium deposited, owing to the hydrogen occluded in it, differ markedly from those of the pure metal. Thus, the density is 6.77 instead of 7.03, it has greater resistance to acids, and is more brittle. The nature and degree of hydrogen occlusion were investigated at different current densities (from 5 to 80 amp./dm.²) and temperatures (0°-65° C.) in a solution containing 25% chromium trioxide and 0.2% sulphuric acid. The deposits on heating in a vacuum begin to evolve hydrogen at 135–150° C., the bulk of it coming off below 350° C., and the rate being determined by the temperature. The total amount of hydrogen generated was about 40–100 volumes, and was independent of the current density as long as the amount of metal deposited remained unaltered. When the latter varied (at low temperatures), the volumes of occluded hydrogen varied also, decreasing with increase of metal deposited. The time of deposition also had no effect on the occlusion. It is pointed out that the results dimer from those of other published investigations.—M. Z.

Materials for the Electrolysis of Chromium. II.-Electrolysis of the Chloride, A. W. Pamfilov, W. A. Grekk, and A. A. Troitzkaia (Zhurnal Obstchey Chimii (Journal of General Chemistry). Chimitcheskii Zhurnal, 1931, [A], 1 (63), (7), 803-812).- [In Russian.] This is the conclusion of a paper published in the Zhurnal Russkogo Fiziko-Chimicheskogo Obshchestva (J. Soc. phys.-chim. russe), 1928, 61, 2221. The results of that paper are summarized here. The electrolysis of chromium chloride was investigated over a wide range of concentration (5-100 grm. /litre), alkalinity (N/1000 to 3N/10), acidity, current density, and time. It is concluded that both the sulphate and the chloride give precipitates of metallic chromium within wide limits of the above variable factors. Such deposits, however, are not of practical interest, since even when they are apparently free from oxides and possessed of a good appearance, they have a very low density, and easily flake off. The conditions of deposition are unreliable and not easily reproducible: the bath deteriorates rapidly, giving an uneven deposit, variable in quality. The profound influence exerted by the current density is, in general, characteristic for all tervalent chromium baths and is the reason why it is impossible to obtain a regular deposit over a wide area. The use of complex baths has so far not yielded any tangible results which might compare with those of hexavalent chromium. The true function of the latter ion has not yet been completely clucidated. It is possible that intermediate formation of di and ter-valent ions takes place which influence the result. It is concluded, in general, that the data usually published on electrodeposition from tervalent baths do not represent consistent results and are, therefore, unreliable .- M. Z.

Chromium Plating. R. Schneidewind (Electricitestro (Electricity), 1930, (19), 737-754).—[In Russian.] A short summary of the study of chromium plating published in Univ. Mich. Dept. Eng. Res. Circ., No. 3, 1930, 1-60. See this J., 1930, 43, 591, 596.—N. A.

Works Control of Chromium [Plating] Baths. A. Wogrinz (Chem.-Zeit., 1932, 56, 571).—A sample of the bath is taken and 50 c.c. are diluted to 500 c.c. Determination of total chromium: 5 c.c. of this solution are treated with an excess of sodium hydroxide and evaporated to dryness in a nickel dish; the residue is fused with sodium peroxide, and the filtered, aqueous extract is boiled to decompose hydrogen peroxide, acidified with sulphurie acid, and treated with potassium iodide, the liberated iodine being titrated with sodium thiosulphate. Determination of chromic acid: 10 c.c. of the solution are diluted to 200 c.c., treated with 5 drops of nitrie acid and an excess of saturated mercurous nitrate solution, and heated to boiling. The dark red precipitate is collected, washed with dilute mercurous nitrate solution, and ignited to chromic oxide for weighing.—A. R. P. The Gravimetric Determination of Sulphuric Acid in Chromium [Plating Baths]. K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1932, 5, 127-131).—Methods involving reduction of the chromic acid to chromic chloride, followed by precipitation of the sulphate, yield low results, as part of the sulphuric acid exists as a complex chromisulphuric acid which is not affected by barium chloride. Addition of acetates breaks up this complex and liberates all the sulphuric acid. The following procedure has therefore given good results : 5-10 c.e. of the bath are treated successively with 10 c.c. of hydrochloric acid (d 1-19), 5 c.c. of alcohol, 10 c.c. of glacial acetic acid, and 3 grm. of sodium acetate free from sulphate, the mixture is heated just below boiling for 30 minutes, diluted to 250 c.c., and treated with 20 c.c. of hot 5% barium chloride solution, and, after allowing the solution to cool for 2 hrs., the precipitate is collected, washed, dried, ignited, and weighed as BaSQ.—A. R. P.

Influence of Hydrogen-Ion Concentration on the Crystal Structure of Electrodeposited Cobalt. H. Kersten (*Physics*, 1932, 2, 274–275).—Cobalt crystallizes in the cubic and hexagonal systems. By X-ray analysis, it is shown that cobalt electrodeposited from cobalt sulphate solutions containing sodium chloride and boric acid together with sulphuric acid or ammonium hydroxide (added to adjust the H-ion concentration) has a hexagonal crystalline structure when the $p_{\rm H}$ value of the bath is high, e.g. 6.5, and assumes a mixed hexagonal and cubic structure as the $p_{\rm H}$ value of the bath is reduced.—J. S. G. T.

Direct Manufacture of Finished Products in Electro Copper. Maurice Altmayer (*Cuivre et Laiton*, 1930, 3, (26), 5–8).—Processes, such as that of Elmore for the direct production of tubes, are mentioned. The electrolyte employed contains copper sulphate crystals 12–13%, free sulphuric acid 2–3%. Operating details are freely given (see also Billiter, this J., 1930, 43, 606).—W. A. C. N.

Sheet Copper by Electrolysis. Anon. (Chen. Eng. Min. Rev., 1932, 24, 294).—Short abstract from Metal and Mineral Markets describing the production of sheet copper from 1 oz. to 7 oz./ft.² by electrolysis on a slowly revolving cathode.—J. H. W.

On the Electrolytic Deposition of Copper from Nitric Acid Solutions and on a Simplified Method for the Electrolytic Separation of Copper and Lead. H. Bjørn-Andersen (Z. anal. Chem., 1932, 89, 178-187).-In the electrolytic deposition of copper from nitric acid solutions, nitrous acid is formed simultaneously with the deposition of copper at the cathode, and this retards the precipitation of copper and prevents the removal of the last traces from the electrolyte. Quantitative deposition of copper may be effected by neutralization of the acid or, less satisfactorily, by addition of urea which destroys the nitrous acid formed. The following procedure is recommended for the determination of lead and copper in the same solution (as nitrates) : The volume is adjusted to 125 c.c. of 1.5N-nitric acid and the solution is electrolyzed in a platinum dish (anode) with a gauze cathode for $\frac{1}{2}$ hr. at 70° C., whereby most of the lead is deposited as lead dioxide on the dish; 10 c.c. of 25% ammonia are then added to neutralize about 3 of the acid, and electrolysis is continued for a further 1/2 hr. to deposit the remaining lead dioxide and most of the copper on the cathode. Finally, 2.5 grm. of urea in 10 c.c. of water are added and electrolysis is continued for a further 11 hr. or until all the copper is deposited. Both anode and cathode are washed with water without breaking the current; the cathode is then washed with alcohol and dried at 50° C., and the anode is dried at 200° C. before weighing.

-A. R. P.

The Deposition of Copper and Brass from Cyanide Solutions. G. M. Smith and J. A. Southers (J. Tenn. Acad. Sci., 1931, 6, 191-198; C. Abs., 1932, 26, 2124).—Cf. Smith and Breekenridge, this J., 1929, 42, 592. Cathode efficiency decreases with increasing c.d. and decreasing molal ratio of copper ion to NaCN, and is very low for ratios below 1:4. Anode efficiency increases as the molal ratio of copper to NaCN decreases and as c.d. decreases. For a brass bath with $Cu(CN)_2$ 15.87 grm./litre and $Zn(CN)_2$ 16.32 grm./litre in 0·1*N*-NaCN, corrosion is increased at the anode by the presence of zinc. Increase of c.d. decreases the rate of anode corrosion. The rate of anode corrosion decreases with increasing c.d. Temperature has little effect. Increase of zinc concentration increases cathode efficiency in dilute solutions, but has the reverse effect in concentrated solutions. The percentage of copper in the plate formed is decreased by increasing zinc in the electrolyte, by increasing c.d., and by lowering the temperature.—S. G.

Complex Cyanides in Brass Plating Solutions. L. C. Pan (Electrochem. Soc. Preprint, 1932, Sept., 145–151).—In the literature on cyanide solutions containing both copper and zinc, the complex cyanides have been generally represented by $Na_2Cu(CN)_3$ and $Na_2Zn(CN)_4$. By analyzing brass electroplating solutions of known composition by various volumetric methods, P. proved that the complex compounds in such solutions are $Na_2Cu(CN)_3$ and $NaZn(CN)_3$, and not $Na_2Zn(CN)_4$.—S. G.

Co-Deposition of Lead and Bismuth. Colin G. Fink and Otis H. Gray (*Electrochem. Soc. Preprint*, 1932, Sept., 189–194).—Good, adherent, smooth deposits containing both bismuth and lead are obtained with : lead 9 grm., bismuth 9 grm., and perchloric acid 93 grm./litre, 5 drops of oil of cloves as addition agent, the temperature being kept at 40° C., c.d. at 1.2-3.0 amp./ft.² (0.13-0.4 amp./dm.²). Good deposits of bismuth, smooth and adherent, are obtained under similar conditions excepting that bismuth alone is present in the bath. The percentage of lead in the deposit increases with increase in c.d. The alloy deposits, containing about 75-85% of lead, and the balance bismuth, are most resistant to dilute hydrochloric and sulphuric acids.—S. G.

Influence of Various Factors on the Cathodic Deposition of Nickel from Nickel Sulphate Solutions. A. Glazunov and J. Kriegelstein (*Chem. Obzor*, 1931, 6, 202-203, 225-232).—The effects of nickel concentration, temperature, current density, agitation, and p_{Π} of the bath have been studied. The presence of iron in the bath is without action on the nature of the nickel deposit, which, however, contains less iron the lower the p_{Π} of the bath and the higher the temperature. Increase in current density at first increases the iron content of the deposit to a maximum, then decreases it at very high densities.—R. P.

Platinum Plating. Anon. (*Met. Ind. (Lond.)*, 1932, 41, 160).—A new process for platinum plating is now in use in Birmingham. It is claimed that the deposit is untarnishable, tough, and adherent, and that the thickness of the deposit can be regulated according to the purpose required.—J. H. W.

On the Matt Silver-Plating of Brass. E. Raub and W. Stein (Mitt. Forschungsinst. Edelmetalle, 1931, 5, 11-14) .- Good results may be obtained by pickling the brass to produce a matt surface before plating with silver. The best pickling solution is made by dissolving 30 grm. of zinc in 2 l. of nitric acid and adding 1 l. of sulphuric acid and 5 grm. of sodium chloride; the pickle is used at 60°-80° C. and, owing to its high zinc content, it gives a regular and even attack over the whole surface of the brass, which becomes coated with a film of zinc and copper sulphates. By alternate immersion in the pickle and in water any desired degree of matting may be obtained. The prepared surface is then cleaned by immersion for a few seconds in 1:1 nitric acid, rinsing in water, and pickling in 2-3% hydrochloric acid until all stains disappear. The article is plated directly, without further cleaning, in a solution containing 14 grm. of potassium cyanide and 25 grm. of silver per litre, using 0.25 amp./ dm.² for 30-60 minutes. The plated article is washed in succession in warm water, 5% acctic acid, and warm water, and dried in sawdust: if desired, it may then be coated with a colourless matt varnish or lacquer to preserve it from discoloration .- A. R. P.

The Recovery of Silver from Old Silver [Plating] Baths. E. Raub and K. Bihlmajer (Mitt. Forschungsinst. Edelmetalle, 1931, 5, 30-35, 37-46).-Three types of method are available, viz., precipitation of the silver as a mixture of evanide and chloride by addition of acid, as metal by means of zinc, aluminium, or magnesium, and as metal by electrolysis. Acidification of the solution is the simplest but most dangerous method, owing to the large amount of hydrogen cyanide liberated; the washed precipitate is reduced with zinc, the metal dissolved in nitric acid, and the silver nitrate fused to remove copper, &c., then again reconverted into cyanide for use. Electrolysis effectively removes the greater part of the silver, but the current efficiency falls rapidly as the solution becomes poorer in silver, and it is almost impossible to strip the solution of silver completely; the deposited metal is usually contaminated by copper, zine, and sometimes mercury. Precipitation of silver by aluminium is complete only if sufficient sodium hydroxide is added to the bath to promote vigorous effervescence ; the precipitate is impure, and an unpleasant and penetrating odour is produced, as well as much frothing. Similar objec tions apply to the use of magnesium, but no extra sodium hydroxide is required. Precipitation with zinc appears to be the most satisfactory procedure; 1.5-2 grm. of zine dust are required per grm. of silver deposited; vigorous agitation is essential. Completion of the reaction is indicated by a white precipitate when a drop of solution is treated with sodium sulphide .-- A. R. P

Tin Plating Cast-Iron Pistons. G. W. Glasson (*Brass World*, 1932, 28, 141). —Cast-iron pistons are tin plated to secure more accurate fit, and the tin also acts as a bearing metal. The process is as follows : the pistons are accurately machined and cleaned in a d.c. cleaner for 2–3 minutes, rinsed, dipped in 5– 10% hydrochlorie acid for 3–5 minutes, rinsed, dipped in caustic soda solution (2 oz./gall.), rinsed, and stored in a tank of cold running water. Plating is semi-automatic with a current density of 20–25 amp./ft.² at 5–8 v. and 140°– 160° F. (60°–71° C.) in a solution of sodium stannate, 55–65 minutes being required to deposit 0.00175–0.00225 in. on the diameter. After plating, the pistons are rinsed and cooled in water, checked, and finally machined.

-J. H. W.

On the Polarization Potential in the Cathodic Deposition of Zinc from the Aqueous Solution of Zinc Sulphate. Tomimatu Isihara, Kingo Mihara, and Katuo Umetu (Kinzoku no Kenkyu, 1932, 9, (6), 244-278).—[In Japanese.] The cathodic polarization potential, the anodic overvoltage, and the total polarization potential in the electrolysis of aqueous solutions of zinc sulphate of different concentrations, acidified with sulphuric acid, or not acidified, were measured by a direct method with the normal calomel electrode and a potentiometer. The anode consisted of a platinized platinum plate, but the starting cathode was of a zinc-plated platinum plate having an inner layer of copper. With the exception of the surface of the cathode, all portions were completely covered with lead glass by fusion. The effect of c.d. and the composition of the solution on the quantities referred to above was also measured. The experiments were all carried out at 35° C. in an electric thermostat of large capacity.—S. G.

Plating of Cast Aluminium and Composite Assemblies. E. Smith and C. A. Velarde (*Met. Ind. (Lond.)*, 1932, 41, 15-16).—The method of ensuring adherence of nickel plate to rolled aluminium by plating the nickel on to the aluminium and then alloying it (see this J., 1931, 47, 289) does not always give satisfactory results with cast aluminium. Blisters are frequently caused by the porosity of the casting. The process was therefore modified, as follows: stove at 600° F. (315° C.) for 1 hr., polish; degrease with a trichlorethylene immersion; dip in strong caustic potash for 15 seconds; swill; dip in strong nitric acid for 4 minutes; swill; nickel-plate at 15 amp./ft.² in a single nickel sulphate solution for 30 minutes; swill and dry out; stove at 900° F. (430° C.) for

15 minutes, starting up from cold. For plating composite assemblies, all joints must be welded, not riveted or elinched. For cleaning plating in deeply recessed parts, the article is made the anode in a strong sulphuric acid solution (sp. gr. 1.6) for 30-45 seconds and then swilled. For stripping chromium from an aluminium article without damaging the intervening nickel coat, the article is made the cathode in a strong sulphuric acid solution, using the tank as the anode. The results of 6 weeks' exposure to salt spray with periodic drying are given.—J. H. W.

Electrolytic Deposits of Metals on Porcelain. F. Dobrovosky (Keram. Runds., 1930, 38, 449–451; Ceram. Abs., 1931, 10, 476).—Electrolytic deposits of metal on porcelain insulators are often made over a conducting base coating, usually a mixture of graphite with a small amount of petroleum; the porcelain insulator must be unglazed and the surface must be clean. Graphite base coatings are better than metallic coatings, although poorer conductors, because they give a smooth flat surface. The base coatings must fill all surface pores and cracks and be without imperfections. To obtain a uniform coating of metal in the electrolytic bath the current distribution over the surface of the insulator must be uniform. Rough base coats produce non-uniform current distribution,—S. G.

Thickness of Plating Films. F. W. S. (*Machinery (Lond.*), 1931, 38, 798; 39, 272).—Criticizes the "specific gravity" method of calculating the thickness of films (see Larke, J., this volume, p. 493) as inapplicable to composite films unless the thickness of each film is first known, and as liable to inaccuracies on account of variations in the apparent sp. gr. of the plated object.—J. C. C.

Thickness of Plating Films. E. C. L. (*Machinery* (Lond.), 1931, 39, 110).— Replying to criticism (see preceding abstract), a formula is developed for calculating the thicknesses of the films on a triple-plated article, knowing the weight and sp. gr. of each film. Variations in the apparent sp. gr. of the base are not thought likely to be serious, and can be determined by experiment.—J. C. C.

The Cause of the Adherence of Electrodeposits. G. Dubpernell (Monthly Rev. Amer. Electroplaters' Soc., 1932, 19, (3), 9–17; and Metal Cleaning and Finishing, 1932, 4, 235–239).—The force of cohesion, interlocking of the deposited metal with the roughened surface of the basis metal, continuous crystal growth of the deposit on crystals of the basis metal and theories of adherence of electrodeposits are briefly discussed and the causes of non-adherence of deposits are described with reference to specific examples.—A. R. P.

Electrolysis Under the Microscope. A. Glazunov (*Chim. et Ind.*, 1932, Special No. (March), 401-404; *C. Abs.*, 1932, 26, 3443).—Electrodeposition is a process analogous to crystallization, and the nature of the deposit depends on the linear rate of crystallization and on the number of centres of crystallization which form in unit time; these in turn are functions of the concentration of the electrolyte, temperature, current density, agitation of the electrolyte, nature of the electrolyte, &c. An apparatus is described by which the progress of electrodeposition can be observed under the microscope, and the results of a number of such experiments are described and illustrated by means of photomicrographs.—S. G.

The Throwing Power of Plating Baths. Max Schlötter and Joachim Korpiun (*Electrochem. Soc. Preprint*, 1932, Sept., 95–106).—A number of mathematical equations are derived with the aid of which the throwing power of commercial plating baths may be calculated. The equations embody cathode polarization voltage, conductivity of the bath, operating current densities, and current efficiency. The equations derived apply to electrodes of a wide diversity in shape, in size of bath, and in spacing of electrodes.—S. G.

Practical Plating. I.—II.—Theoretical Considerations. E. A. Ollard (Met. Ind. (Lond.), 1932, 40, 645–646; 41, 61–62, 157–159, 205–206).—The underlying principles of electrodeposition are explained in simple language and the application of Faraday's law to the theory of the process is discussed. S. also discusses how the total voltage across the plating cell is employed, the factors governing the structure of the deposited metal and overvoltage, throwing power, and the choice of solutions. The regulation of ion concentration by "buffering" is explained.—J. H. W.

The Bright Dipping of Metals and the Adherence of Electrodeposits. G. Dubpernell (*Metal Cleaning and Finishing*, 1932, 4, 133-136; C. Abs., 1932, 26, 2925).—A discussion of bright dipping methods and the advantages of this practice in obtaining a high degree of adherence in electrodeposits.—S. G. The Significance of a Quantitative Analysis of a Plating Solution. Lawrence

The Significance of a Quantitative Analysis of a Plating Solution. Lawrence E. Stout (Monthly Rev. Amer. Electroplaters' Soc., 1932, 19, (6), 17-23).—Emphasis is laid on the necessity of maintaining continuous strict analytical control of plating baths in order to ensure constant production of high-class work with a minimum of rejects. Baths should be regularly tested not only for their content of essential constituents, but also for the presence of impurities, accumulation of which will frequently give rise to serious trouble in plating.—A. R. P.

Salvaging Expensive Parts by Electrodeposition. A. Eyles (Mech. World, 1932, 91, 287-288).-F. J.

Repairs to Diesel Engine Parts by Electrodeposition. Charles H. Faris (Diesel Engine Users Assoc., No. 89, 1929, 1-25) .- The process of nickel deposition which is different in its results and applications from nickel plating is considered as a sound and reliable method of building up worn or undersized parts. It is stated that perfect adhesion is obtained by deposition both on steel and cast iron, and this statement is supported by laboratory tests and service reports. The resistance to wear of nickel deposits is also dealt with, and examples in various branches of the engineering industry are given of wear in such built-up parts as gudgeon pins, turbine spindles, rams, and plungers. Such deposits are also extremely resistant to corrosion in caustic soda, ammoniacal liquors, and brine. Several typical examples of nickel deposits on Diesel engine parts such as water-cooled exhaust valves, east-iron piston valves, inlet and exhaust valve spindles, bronze impellors, camshaft journals, cams, and pistons both for the reinforcement and repair of worn parts and the strengthening and protection of new parts are considered. In the discussion W. P. Sillince points out that the process is not suitable for the repair of cracked or broken parts, and G. W. Horner discusses its probable application to the repair and protection of Diesel engine cylinders.

_J. W. D.

ELECTROREFINING, &c.

Contribution to the Electrometallurgy of Aluminium. P. P. Fedotieff (Z. anorg. Chem., 1932, 206, 267-269).—A theory of the electrolysis of cryolitealumina melts is developed; the mechanism of current flow and the reactions at the electrodes are discussed.—M. H.

Norddeutsche Affinerie [The North German Refinery]. Anon. (Metallwirtschaft, 1932, 11, 376-377).—A description of the copper, lead, and silver recovery plants and a discussion of the economics of the processes.—v. G.

The Refining of Copper by the Series System. M. Altmayer (Cuivre et Laiton, 1931, 4, 375–378, 401–405).—The Baltimore Copper and Smelting Co.'s plant is taken as typical of this lesser-used system. Briefly, the copper to be refined is cast into larger ingots, which are rolled before they can be used in the bath. The circulation of the electrolyte is carried out individually for each cell. The modifications adopted in the Nicholls series system are discussed. Larger anodes are employed. The cathode copper produced is 99.965-99.98% fine. The cells themselves are of concrete lined with mastic, and each carries 23,500 kg. of anodes and 11,500 kg. of electrolyte containing 2.8% copper. As compared with the multiple system, the series system of Nicholls works

with much greater capacity cells, less copper necessarily immobile for the yearly output, less electrolyte per ton of copper produced, and less floor area. The electrolyte contains 17.5% sulphuric acid and is worked at a temperature of about 50° C. The precious metals appearing in the mud are worked up separately.—W. A. C. N.

Linear Rate of Crystallization of Cathode Copper in the Electrolysis of Copper Sulphate. A. Glazunov and A. Roskot (*Chem. Listy*, 1932, 26, 308-311).—The apparatus used was similar to that used in determining the rate of crystallization of silver (cf. abstract below). The rate for copper is 10-20 times lower than that for silver, hence the deposit is more compact; otherwise the curve is similar to that of silver.—R. P.

Selenium and Tellurium. S. Skowronski and M. A. Mosher (*Electrochem. Soc. Preprint*, 1932, April, 285–293).—The metallurgy involved and the methods employed in the removal of selenium and tellurium from the copper-refining cycle, as well as a description of the recovery process for the commercial production of these metals, are briefly presented. Supplementing this, notes and tables are given of selenium and tellurium production; their commercial uses; their effect on the conductivity of copper; and the electrodeposition of tellurium. A review of the bibliography of selenium and tellurium is appended.—S. G.

Linear Rate of Crystallization of Cathode Silver in the Electrolysis of Silver Nitrate. A. Glazunov, O. Rada, and L. Balcar (*Chem. Listy*, 1932, 26, 12–15). —The tests were made under the microscope in a cell comprising an object glass, two strips of platinum, tin or silver, a glass ring, and a cover glass. In one series the concentration was kept constant and the current density increased, and in another series the current density was kept constant and the concentration increased; the effect of colloids was also studied. The results show that increase of current density increases the rate of crystallization, the crystals which grow out from the cathode in arboreal shape becoming more elongated and less branched. With increasing concentration of silver in the solution the deposits become more compact, and the rate of crystallization decreases. After addition of colloids the rate of crystallization is slow even in dilute solutions and at high current densities and the deposits are compact. —R. P.

Electrolytic Production of Thorium and Uranium. F. H. Driggs (Eng. Min. J., 1930, 130, 119-120; C. Abs., 1930, 24, 4714) .- Metallic uranium is prepared by converting the nitrate to potassium uranium fluoride and then adding to a molten bath of calcium chloride and sodium chloride when it is electrolyzed. The process is somewhat similar to the electrolysis of alumina to metallic aluminium. Metallic thorium is obtained in a similar manner from the nitrate. A diagram indicates the differences in the 3 types of fused baths used in electrolysis : aluminium, magnesium; calcium, barium, beryllium, and uranium; thorium. The deposit on the cathode consists of a spongy mass of metal interspersed with calcium chloride and sodium chloride from the bath. The metal is purified by leaching out these salts with water, washing, and drying in vacuo. The powdered metal is solidified by either melting or sintering in a high vacuum. These metals need not be melted to make them workable. Uranium or thorium after heat-treatment can be cold-rolled, hammered, or drawn to almost any extent. Thorium is very soft, and uranium is of about the same hardness as a normalized steel (0.1%). Other properties are noted.-S. G.

Electricity in the Tin Industry. E. W. Lewis (*Elect. Times*, 1930, 78, 1113-1114; C. Abs., 1931, 25, 4801).—Modern electrical practice is described in the production of tin, the electroplating of tin, and tin recovery, and reference is made to the technical advances which have taken place. The development of a combined chlorine and electrolytic process is also discussed.—S. G.

ELECTROCHEMISTRY-GENERAL.

On the Passivity of Metals. W. J. Müller (*Trans. Faraday Soc.*, 1931, 27, 737-751).—A lecture, in which M. reviews his own work on passivity phenomena.—A. R. P.

On the Theory of Passivity Phenomena. XIV.—On the Passivity of Nickel. Wolf Johannes Müller, H. K. Cameron, and W. Machu (*Monatsh.*, 1932, 59, 73—92).—The naturally-occurring oxide film on nickel is much less readily attacked by sulphuric acid than is the film on iron, and hence the time of passivation of a new nickel surface is very short. The current-time curves for the passivation of nickel are of the $1/i^2$ character, showing that the whole of the electrode becomes coated with a film. When a nickel electrode is passivated with a potential of less than 1.5 v., addition of a nickel salt causes coating passivity. In N-hydrochloric acid the coating appears to consist of a basic salt. With potentials of more than 2 v. chemical passivation occurs, owing to the formation of a porous coating of higher oxide; this coating is more difficult to remove than is the case with iron, but is removed by cathodic polarization. Immersion of clean nickel in sodium sulphate solutions renders it instantaneously passive. Theso results afford an explanation of the high resistance to corrosion of nickel, which is apparently due to the high stability of the oxide film.—A. R. P.

The Potentials of Ferro-Manganese and of Ferro-Chromium Anedes at Different Current Densities and Hydrate Concentrations. M. de Kay Thompson and R. B. Morrissey (*Electrochem. Soc. Preprint*, 1932, April, 259-266).— Measurements have been made of the electrode potentials of ferro-manganese and of ferro-chromium anodes for different current densities and concentrations of hydrate solutions in which they were electrolyzed. The current density-electrode potential curves for the different reactions vary in position with the hydrate concentration. The curve for the sum of the different reactions remains constant over considerable ranges of concentration.

-W. A. C. N.

The Electrochemical Oxidation of Molybdenum in Potassium Hydroxide Solutions. M. de Kay Thompson and Albert L. Kaye (Electrochem. Soc. Preprint, 1932, Sept., 271-281).-The current efficiencies and electrode potentials were determined at 25° C. for the simultaneous electrolytic oxidation of molybdenum to soluble molybdate and to insoluble oxide at c.d. between 0.005 and 0.4 amp./cm.² in potassium hydroxide solutions ranging between 0.2N and 5N. The c.d.-electrode potential relation for the formation of molybdate and of oxide is shown by curves. At high c.d. and low concentrations of potassium hydroxide, the oxide product consisted of a mixture of greenish $Mo(OH)_4$ and the colloidal blue Mo_3O_8 . The average valence of the molybdenum in this mixture was 5.3. The two molybdenum compounds could not be satisfactorily separated for analysis. The current efficiency for molybdate formation, which takes place according to the reaction Mo + $6F + 80H^- = MoQ_- + 4H_2O$, increases with increasing concentration and decreasing c.d. The curves showing the relation between electrode potentials at given c.d. and the concentration of potassium hydroxide are similar to those found for ferro-manganese anodes (Chem. and Met. Eng., 1919, 21, 680). On the other hand, no minimum was found in the curves of current efficiency plotted against concentration of electrolyte, as appears for both ferro-manganese and ferro-chromium anodes (Trans. Amer. Electrochem. Soc., 1924, 46, 51). Results indicate that with increase in c.d. the polarization in the anodic oxidation of molybdenum to molybdate is greater than the polarization in the oxidation to oxide.-S. G.

X.-INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 566-569.)

Tests Show Importance of Correct Babbitting. J. S. Dean (*Elect. Railway* J., 1930, 74, 532-533; C. Abs., 1930, 24, 4742).—In general, the Babbitt metals used in railway motors are divided into tin-base and lead-base alloys which contain 80-90% of tin or lead, respectively. The tin-base alloy is usually considered best for armature and axle bearings. Analyses are tabulated of 5 of each type of Babbitt metal, and also strength tests. One curve shows results of hammer tests of Babbitt metal of various compositions and another shows the results of hammer tests of Babbitt metal poured under various conditions. The correct pouring temperature is highly important, as is evidenced by the curves. The results of actual service tests indicate that railway motor armature bearings, lined with an approved grade of either tin-or lead-base alloy, will operate satisfactorily in service.—S. G.

Examination and Adjustment of Large Crankshaft Bearings. A. S. Willis (*Mech. World*, 1932, 91, 42).—The crankshaft bearings of large horizontal engines are now invariably of the wedge-block and side "brass" pattern, the wedge-blocks acting on the corresponding shaped backs of the side-"brasses," and operated by screws. These side "brasses" take the forward and backward thrust transmitted along the connecting-rod and crank at each stroke of the piston, whilst the weight of the crankshaft and its revolving parts is taken by a bottom "brass." Methods for the removal for testing (for wear) of these brasses are described.—F. J.

The Aluminium Exhibit at the 13th Exhibition of Milan. Anon. (Alluminio, 1932, 1, 166–175).—An illustrated description of the special section of the annual exhibition at Milan, devoted to aluminium and its alloys, and to their uses in transportation, electricity, aeronautics, shipbuilding, chemical industry, architecture, radiators, and insulating materials, &c.—G. G.

Diesel Pistons in Aluminium Alloys. G. Mortimer and J. F. Paige (Alluminio, 1932, 1, 145-159).—See J., this volume, p. 320.—G. G.

Lubrication of Aluminium Alloy Pistons. Alfred R. Code (Indust. Australian, 1932, 87, 168).—Light alloy pistons are employed because of their lightness and high thermal conductivity. Their comparative softness does not necessarily imply poor wearing qualities, but it must connote increased susceptibility to abrasion by grit, hence sump oil must be frequently drained. The oil to be used must not have too high a viscosity, but its high-temperature performance must be good; more attention is required than is the case with steel or cast-iron pistons.—P. M. C. R.

The All-Metal Aeroplane "Breda 32." A. Parano (Alluminio, 1932, 1, 36-40).—A description of a new all-metal Breda monoplane (1931) with 3 motors to carry a useful load of 2550 kg. or 14 persons, with a maximum speed of 235 km./hr. The metals used are aluminium, Duralumin, and Elektron. Particulars of wings, coverings, &c., are illustrated.—G. G.

Aluminium as Electrical Material. N. Hubert (*Rev. Aluminium*, 1932, 9, 1729–1740).—An account of the applications of aluminium and aluminium alloys in the manufacture of material for use in the electrical industry.

-J. H. W.

Application of Aluminium Alloys on High-Voltage Transmission Lines. B. M. Lahtin (*Elektrichestvo (Electricity*), 1930, (17-18), 678-680).—[In Russian.] L. describes the properties of new aluminium alloys of high mechanical strength, compares them with older kinds of conductive materials (copper, steel, aluminium), and gives some operating data concerning the service on transmission lines of conductors made of new materials.—N. A. Aluminium Foil as a Basis of Insulation. Max Breitung (*Refrigerating Eng.*, 1931, 22, 11-14; C. Abs., 1931, 25, 4327).—Aluminium foil insulation is built up by applying successive layers of foil at intervals of approximately $\frac{1}{3}$ in. The foil may be in the form of flat sheets or crumpled to provide irregular surfaces. The foil used is about 0.0003 in. in thickness. Aluminium foil insulation has the advantage of being very light in weight; it weighs only 3 oz. per ft.³ of insulation, whilst cork and magnesia weigh 10 lb. and 17 lb. per ft.³, respectively. As an insulator the crumpled aluminium foil is equal to cork at low temperatures and superior to magnesia at high temperatures. Aluminium foil operates as an insulator because of its high reflectivity for radiant heat, about 95% of the radiant heat being reflected. Long exposure of the foil to the atmosphere even at high temperatures did not change the reflectivity.—S. G.

Aluminium Foil Heat Insulation. T. A. Solberg and W. P. Sinclair (J. Amer. Soc. Naval Eng., 1932, 44, 200-205).-Commercial pure aluminium in the form of sheets 0.00045 in. thick is crumpled by hand, so that the sheet presents a series of small mounds which have sharp points or edges as their apices, and is applied in a number of successive layers depending on service conditions; these layers are protected by a thin outside sheathing of galvanized iron or aluminium. Each layer of crumpled foil occupies a space of 3 in., and the insulating efficiency of the material depends on 3 factorsnamely, the large number of self-contained air spaces formed between successive layers of the foil, the small amount of metallic contact between layers, and the heat-reflecting properties of the numerous bright metallic surfaces in each layer. In addition to having equal, and very often better, heat-insulating properties than other insulating materials of the same overall thickness, when used for temperatures from 0° to 1000° F. (- 17.78° to 593° C.), aluminium foil shows a saving in weight, is cleaner, is more resistant to disintegration from vibration, is impervious to water and moisture, and has a low heat storage. It is also easily manufactured, requires less space and weight for storage before application, and is fireproof.-J. W. D.

The Alfol System of Heat Insulation. Anon. (Mech. World, 1932, 91, 87).— The new Alfol system consists in having aluminium foil obtainable in rolls, highly polished, and ready for application. The foil is 0.0003 in, thick, and is embossed with a diamond pattern, which assists in the crumpling operation, whereby three layers of the foil are made to form about an inch of insulation thickness, the whole being protected by a strong cover or steel lagging. The advantages of this system are described, results of tests given, and applications indicated.—F. J.

Heat Insulation Developed for Every Purpose. B. Townshend and E. R. Williams (*Chem. and Met. Eng.*, 1932, 39, 219-222).—The effectiveness and development of insulation materials are discussed, the most recent of which is stated to be aluminium foil. Charts are given, showing the variation in conductivity of typical low-temperature, medium-temperature, and high-temperature insulating materials, the highest temperature mentioned being 1317° C. The measurement of conductivities at mean temperatures of 820° C. is now possible with modern apparatus. The physical and thermal properties desirable in insulating materials for the various ranges of temperature are tabulated and other requirements enumerated.—F. J.

Aluminium in Architecture and Building Construction. N. Minaur (Aluminium Broadcast, 1931, 3, (8)).—Brief particulars are given of the use of aluminium in recent buildings.—J. C. C.

Use of Aluminium vs. Ceramics. Anon. (Ceram. Ind., 1930, 14, 423; Ceram. Abs., 1930, 9, 479).—Aluminium shingles, roofing, and corrugated sheets which are standard products of growing importance have been joined in this field by ornamental castings for crestings, spandrels, cornices, finials, and other metal accessories. Several recently constructed office buildings earry from 50 to 100 tons of aluminium, mainly in the form of cast spandrels or ornamental exterior wall plates and sills.—S. G.

A Wider Use for Aluminium Paint. C. H. Butcher (*Master Builder*, 1931, April; and (reprint) *Aluminium Broadcast*, 1931, 3, (10), 8–10).—Aluminium paint should be freshly mixed, as it loses its characteristic "leafing" power on standing. A varnish vehicle is preferable to oil, but kettle-bodied linseed oil, although slow in drying, gives excellent durability. For painting hot surfaces to reduce radiating power, a resin varnish is the most satisfactory vehicle. Aluminium paint is valuable for masking underlying colours and may be used as a foundation coat on wood previously stained or coated with bituminous paints or some crossote wood preservatives.—J. C. C.

[Aluminium Paint.] Methods for Protecting and Maintaining Marine Turbines. H. Masseille (*Peintures, pigments, vernis,* 1931, 8, 1520–1522; C. Abs., 1931, 25, 5047).—The French Navy has obtained good results by painting the interior of turbines partly with aluminium paint and partly with a heatthickened linseed oil containing a drier.—S. G.

Beryllium Alloys have Commercial Possibilities. Anon. (Iron Age, 1932, 129, 1346–1383).—An account of the commercial applications of metallic beryllium as a plating material, for X-ray tube construction, and as a deoxidizer, and of its alloys with aluminium, magnesium, and, more particularly, with copper is given.—J. H. W.

Bismuth, Essential to Fusible Alloys, has Additional Possibilities. Walter C. Smith (*Metal Progress*, 1932, 21, (5), 61-64).—A description of the properties of metallic bismuth is followed by an enumeration of its commercial applications. Its addition to east-iron increases fluidity and appears to facilitate cleaning; little bismuth is retained by the iron, which shows higher machining qualities and lower tensile strength and Brinell hardness than untreated iron. Bismuthhardened tin alloys east better and at lower temperatures than those employing copper as hardener, but perhaps the most important industrial application of bismuth is in the manufacture of fusible alloys. The properties, constitution, and special uses of many of these are tabulated; fuller descriptions are given in some cases.—P. M. C. R. Cobalt. Paul M. Tyler (U.S. Bur. Mines Information Circ. 6331, 1930,

Cobalt. Paul M. Tyler (U.S. Bur. Mines Information Circ. 6331, 1930, 1-33; C. Abs., 1930, 24, 4740).—T. gives a description of cobalt under the following headings: uses, occurrence, identification, metallurgy, production, imports and exports, foreign industry, prices, and buyers' lists. A 5-page bibliography is included.—S. G.

A New Metallic Joint Ring. Anon. (Marine Eng., 1932, 55, 254).—A description of a high-pressure metallic joint ring consisting of a metallic tube of copper, nickel, or other suitable metal having the ends welded together by electric butt welding and containing a non-explosive gas under a pressure of 300 lb./in.².—J. W. D.

[Copper-Lead Bearing Metal.] Anon. (Machinery (N.Y.), 1930, 36, 375).— Brief note on the use of 75:25 lead-copper alloy for lining heavy motor-car bearings. The bearings require much less attention than when Babbitt metal is used.—H. F. G.

Magnesium and Beryllium. Wm. C. Hirsch (Elect. Manufacturing, 1931, 7, (Aug.), 24-25; C. Abs., 1932, 26, 3462).—Magnesium and beryllium are rapidly increasing in importance in the electrical industry. Their character and uses are reviewed.—S. G.

Quicksilver. C. N. Schuette (U.S. Bur. Mines Bull. 335, 1931, 1-168; and (abstract) Indust. Australian, 1932, 87, 54; C. Abs., 1931, 25, 3940).—S. discusses (1) prospecting, development, and mining, (2) metallurgy, and (3) economies of mercury. The mechanically-operated furnace has largely replaced the shaft furnace; the factors influencing this change are discussed. The consumption of mercury by uses (determined by direct inquiry of customers) is reported.—S. G.

XV.-FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 580-581.)

The Testing and Evaluation of Core Sands and Core-Binding Materials. Th. Klingenstein (Giesserei u. Masch., Zeit., 1932, 5, (2), 1-9) .- After reviewing the various ingredients of a good core sand and their properties, K. proceeds to inquire into the qualities necessary in a satisfactory oil core. They are strength in the dry state, high binding power in the green condition, high gas permeability, and no action under the influence of gases during casting. The ideal sand so far as gas permeability is concerned is one in which the grain-size is uniform and comparatively large. The influence of grain-size and of clay content and all the above factors is displayed in curves. The clay content has considerable influence on the oil necessary in manufacture. It is stated that the clay content should not exceed 1%, and that at least 70% of the sand should be of 0.2-0.4 mm. size. Investigations into the properties of various binding materials are recorded. As regards oils, those of the animal variety are almost entirely excluded on account of their odour. The mineral oils have comparatively small strengthening properties, and are rarely used, except as thinners. Vegetable oils are essentially the best variety, although a pure oil is rarely to be bought. A good oil should not be sticky, should not attack the material of the boxes, and should not absorb moisture in the green mixtures or become hygroscopic. A method has been devised for determining the gas permeability with mixtures of different oils with a standard sand. Standard specifications for oils are discussed. Cores with raw linseed oil have the greatest strength and those with boiled linsced oil the lowest strength. On the other hand, as regards penetration of gases the order is reversed. A formula connecting the factors under investigation is proposed .-- W. A. C. N.

On Some Fundamental Problems Relating to the Testing of Moulding Sands and Practical Testing in the Foundry. P. Aulich (Internat. Foundry Congress, Milan, Memoirs, 1931, 357-371) .- [In Italian.] A classification of sands into nine groups is proposed in order to simplify the problems of marketing. The testing of new and used sands, their characteristics, and the factors

which govern their selection, mixing, &c., are also discussed.—G. G. Contribution to the Study of Permeability of Foundry Sands. H. Viez (Internat. Foundry Congress, Milan, Memoirs, Sept. 1931, 595-403) .- [In French.] The permeability of sands and its variation during mixing in the preparation of cores and moulds is discussed, together with the effect of grain-size with reference to photographs and diagrams.-G. G.

Removal of Dust from Used Moulding Sands. B. Trevis (Internat. Foundry Congress, Milan, Memoirs, 1931, 381-391) .- [In Italian.] The characteristics of used moulding sands and their reclamation are discussed .- G. G.

Use of Pure Cast Silicon for Cores and Moulds in the Foundry. Quartz et Silico S.A. (Internat. Foundry Congress, Milan, Memoirs, 1931, 375-377).-[In French.] The advantages of pure, fused silica for cores and special moulds in the casting of aluminium, bronzes, steels, &c., are described. Its use has solved some problems hitherto insoluble .--- G. G.

Sand Cores Ground with Modern Abrasive Machinery. Anon. (Abrasive Ind., 1930, 11, (11), 26; Ceram. Abs., 1931, 10, 4).-The core used in a mould is subject to stringent conditions; it must (1) be high in refractory, (2) possess enough strength to support its own weight, and (3) be accurate in size and shape. A grinding wheel operating at approximately 4000 surface feet per minute provides a quick, accurate means of finishing the cores. Since the baked cores are comparatively soft and coarse-grained, an 18-24 grit, TT

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silicon carbide medium-hard wheel should prove satisfactory. The vertical spindle machine is another well-designed machine for grinding cores.—S. G.

A New Vertical Mechanical Core Stove. Anon. (Iron and Steel Ind., 1932, 5, 407-408).—A description of a vertical, mechanical core stove 8 ft. 4 in. by 6 ft. in which the cores are carried on pivoted trays through two compartments and are delivered completely cooled-off for handling. Drying is effected in two stages in combination with a forced draught system, and a "trapped exhaust" at both the feed and discharge ends of the stove is very effective in preventing the escape of either heat or fumes from the stove.—J. W. D.

XVI.-FURNACES AND FUELS

(Continued from pp. 582-583.)

Oil-Firing for Industrial Furnaces. Anon. (Mech. World, 1932, 91, 368-370).—Considerable advantages in oil-firing lie in the simplicity and compactness of the plant and the unvarying calorific value of the fuel, these assisting accurate heat regulation. The secret of successful oil-firing lies in the proper combination of a well-designed furnace with efficient burners. A form of furnace construction and several types of oil-fired furnaces are illustrated and described.—F. J.

The Use of Gas as a Fuel in Industry. C. M. Walter (Gas J., 1932, 198, 715-732).—The progress in the use of towns' gas for industrial purposes in England, in Europe, and in America is briefly reviewed. In Birmingham an increase of 500% in the amount of gas so used has occurred since 1913. Thermodynamic considerations relating to waste-heat recovery are discussed. The economics of processes, including forging, case-hardening, reheating, metal melting, japanning and drying, food production and central heating, are referred to. The economic value of coke-oven gas is in some cases $2-2\frac{1}{2}$ times that of solid fuel. In processes where temperatures must be controlled within close limits and where furnace temperatures must be under complete control and where furnace atmospheres must be free from contamination, the economic value of coke-oven gas is 3-5 times that of coal.—J. S. G. T.

Comparative Values of Heat in Coal, Oil, and Gas. S. H. Viall (*Chem. and Met. Eng.*, 1932, 39, 234).—Charts, taking into consideration only the tangible factors of heat content, thermal efficiency, and price, are given to enable a rapid comparison to be made between coal and oil, coal and gas, and oil and gas for heating purposes. Comparative worth of fuels may also be influenced by intangible factors such as cleanliness and ease of control.—F. J.

Mechanical Stokers for Metallurgical Furnaces. H. Clifford Armstrong (Fuel Econ. Rev., 1932, 11, 48-52).—Mechanical stokers for metallurgical coalfired furnaces are briefly described and illustrated.—J. S. G. T.

The Rôle of Moissan in the Development of Industries Based on the Electric Furnace. G. Flusin (Chim. et Ind., 1932, Special No. (March), 113-119).— An address.—S. G.

Use of Electric Furnaces for Heat-Treatment and Fusion of Metals. André Micg (Bull. Soc. Ind. Mulhouse, 1932, 98, 133-160).—A review describing types of electric furnaces, their application to metallurgical processes (especially in the case of copper, brass, and aluminium), and their special advantages.—E. H.

Electric Furnaces for Melting Metals and the Preparation of Ferro-Alloys. Reinhold Gross (Z.V.d.1., 1932, 76, 353-358).—A short description of some new are, induction, and resistance furnaces.—v. G. High-Powered Uni-Phase Furnaces. E. N. Padalka and R. B. Popov

High-Powered Uni-Phase Furnaces. E. N. Padalka and R. B. Popov (Zvetnye Metally (The Non-Ferrous Metals), 1931, (6), 739-753).—[In Russian.] The theory and practice of the Miguet uni-phase furnaces for ferro-alloy manufacture are examined (chiefly from French sources of information). The efficiency, capital, and running costs are compared with those of multi-phase furnaces.—M. Z.

[Rhodium Alloys for Electric Furnace Windings.] Anon. (Machinery (N.Y.), 1930, 36, 368).—Brief note that such alloys have been produced at the (U.S.). Bureau of Standards as a substitute for platinum.—H. F. G.

Electric Melting Pots Have Been Simplified. P. H. Clark (Elect. Manufacturing, 1931, 7, (6), 48-53; C. Abs., 1931, 25, 4185).-Melting pots having electric heating units dipping into the metal or substance to be melted (the temperature of which can be automatically controlled) are described. The space between the melting pot proper and the outside casing and ring support is filled with a suitable insulating material. The spiral heating coils have thick nickel wire leads, which can be made long enough to allow the heat from the coil to be concentrated at the bottom of the pot. The heating coil and leads are placed under tension in a straight tube of suitable material (usually steel) and the tube is filled with finely-powdered magnesia. The tube is then reduced in diameter by swaging, the magnesia becoming rock-hard and fairly conductive to heat (but not electricity) during the process. By careful annealing after the swaging process the unit can be formed into intricate shapes without injury. The unit can then be made more serviceable by placing it in a mould and casting iron around it. Ten points of superiority (among which are more even heating and easier temperature control) over older type pots are listed, cost data tabulated, and 3 pages of photographs, showing typical applications of the

new type of melting pot, are given.—S. G. Electric Furnace Improvements. F. Horner (*Mech. World*, 1932, 91, 63).— Two new features in the construction of Wild-Barfield electric furnaces are illustrated and described. The first concerns the quick renewal of heating units while the furnace remains at working temperature. The second consists of low-temperature furnaces with forced-air circulation, and a device for indicating when the work is uniformly heated, such as is necessary when tempering steel parts and heat-treating aluminium and its alloys—F. J.

Electric Resistance Furnace with Metallic Heating Elements. M. M. Mihailow (*Elektrichestro* (*Electricity*), 1930, (19), 725-732).—[In Russian.] Presents a fundamental scheme of calculation of an electric furnace with Nichrome heating elements. The calculation is based on the data obtained from a study of previously manufactured furnaces of this type.—N. A.

Some Fundamentals of Open-Hearth Design. V. H. Legg (Fuel Econ. Rev., 1932, 11, 53-56).—Fundamental principles dealing with the transfer of heat and the flow of gases in open-hearth furnace practice are briefly discussed. Among topics discussed are, gas flow to furnace, regenerator design, optimum degree of preheat of gas and air, heat transfer and storage, and exposed area in regenerators.—J. S. G. T.

Heat-Resisting Paint. James Thorn (*Mech. World*, 1932, 91, 343).—A formula for a paint that will resist any temperature up to a red heat is given as follows: powdered graphite, 1 lb.; lampblack, 1 lb.; black oxide of manganese, $\frac{1}{3}$ lb.; Japan gold size, $\frac{1}{3}$ pint; turpentine, $\frac{1}{2}$ pint; boiled linseed oil, $\frac{1}{3}$ pint. These ingredients are mixed to a uniform consistency.—F. J.

Smoke Indicators for Commercial Use. J. Fraser Shaw and T. F. Hurley (*Fuel Econ. Rev.*, 1932, 11, 101-103).—Characteristics of smokes and available smoke indicators and recorders are briefly discussed. Because of the inherent nature of smoke, instruments cannot be installed indiscriminately to give results capable of general application. Discretion must be exercised in locating the apparatus and in interpreting readings.—J. S. G. T.

The Removal of Sulphur from Metallurgical Coke. I.—Chlorination of the Coke. E. V. Britzke, I. V. Shmanenkov, and A. N. Blazhenova (J. Chem. Ind. (Russia), 1932, (1), 37-41; C. Abs., 1932, 26, 3651).—[In Russian.] Chlorin-

ation of coke at 500° -1000° C. removes almost all the sulphur present as sulphide, but not the organic sulphur. The porosity of the coke also has an effect on sulphur removal.—S. G.

A Survey of the Progress of Standardization in Relation to Coal and Coke. Anon. (Fuel Econ. Rev., 1932, 11, 8-12).—The work of the British Standards Institute in the matter of the issue of two specifications for the sampling and analysis of coal is briefly referred to.—J. S. G. T.

Is Classification or Nomenclature of Coal Possible or Desirable? Clarence A. Seyler (Chem. and Ind., 1932, 51, 531-533).—A discussion.—E. S. H.

XVII.-REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 581-587.)

Solving the Crucible Problem. Anon. (Ceramic Age, 1932, 19, 175-176).-Zirconium silicate may be used up to 1750° C. It has a low coeff. of expansion and will bear sudden changes of temperature without breaking. Basic materials attack it at high temperatures. It is well suited for metal melting of all kinds. Aluminium oxide (melting point 2050° C.) resists the action of reducing gases, and acid and alkali fusions can be carried out at high temperatures in vessels made therefrom without appreciable attack. Various easily oxidized metals (especially aluminium and its alloys) can be melted in alumina vessels without the melt being rendered impure by the material of the crucible. Hard-burned alumina has great electrical resistance, even at high temperatures, and good resistance to thermal shock. Spinel (melting point 2135° C.) has a low thermal conductivity, and its hardness and mechanical strength are lower than those of alumina. Spinel is well suited for melting the noble or other metals. Beryllium oxide (melting point 2500° C.) has high thermal conductivity, is unattacked by alkalis, but attacked by acids; it has great resistance to reducing agents. Refractory metals and alloys (e.g., zirconium and beryllium) can be melted in crucibles of beryllium oxide without danger. Zirconium oxide (melting point 2700° C.) can be used up to about 2500° C. It has great resistance to acids and alkalis, particularly at high temperatures. The coeff. of expansion is high and the thermal conductivity low; vessels are therefore comparatively sensitive to temperature shocks. Magnesium oxide (melting point 2800° C.) has a high coeff. of thermal expansion, but the correspondingly high thermal conductivity makes the material comparatively insensitive to thermal shock. It is very resistant to basic materials, even at high temperatures, but in strongly reducing atmospheres, and in presence of carbon it is volatilized at high temperatures. In oxidizing and neutral atmospheres, magnesium oxide can be used up to 2500° C. Thorium oxide (melting point 3000° C.) may be used at temperatures above 2500° C. The resistance to basic materials is very high, but carbon attacks it. Vessels made of thorium oxide are sensitive to sudden changes of temperature. Crucibles made of each of these materials are now obtainable. All the noble metals, and most of the less valuable metals which oxidize with comparative difficulty (e.g., nickel), can be melted in any of them. Easily oxidized metals (e.g. zinc) are best melted in crucibles made of material which is very difficult to reduce (e.g. beryllium oxide); in such cases an atmosphere of inert gas is helpful.-E. S. H.

Metallurgical Refractories. J. F. Hyslop (Iron and Coal Trades Rev., 1931, 123, 429; Ceram. Abs., 1931, 10, 504).—H. deals with high-alumina frebrick, the action of fluxes on refractories, and the cost of production. Reference is made to the resistance of refractories (1) to temperature, (2) to solution, disintegration by fluxes, and dust-laden gases, and (3) to rapid temperature changes. High-alumina bricks are used more in non-ferrous than in iron and steel furnaces, but there is little doubt that in ferrous metallurgy they will eventually be widely used in positions where high resistance to temperature and corrosion is required.—S. G.

Refractory Materials for Air-Heating Furnaces. Alfred B. Searle (*Metallurgia*, 1932, 6, 133–134).—Many refractory materials fail to give satisfactory service because the conditions under which they are used are not understood by manufacturers. Essential factors such as refractoriness, strength, thermal conductivity, and resistance to corrosion and crosion are discussed with respect to refractoriness for the regenerator and recuperator parts of air furnaces. Structural details are also dealt with, and the selection of suitable materials for such parts as foundations, walls, roofs, checker-work, and flues, indicated.—J. W. D.

Coreless Induction Furnace Larger; Lining Improved. E. F. Northrup (Steel, 1931, 88, (23), 39-42; C. Abs., 1931, 25, 4184).—An effective and inexpensive method is described for using a pure zirconium silicate sand as a refractory lining for coreless induction furnaces. Florida zircon of the grade known as "Tam" to which has been added 15% of powdered zircon is packed, with the aid of an air or electric hammer, between the coil lining consisting of Carborundum brick, and a conical steel mould surrounded by a layer of asbestos lumber. The top is scaled off with slightly damped thermolith and the whole apparatus dried by heating the steel mould to dull redness. The first charge, made after the mould has been removed, melts out the asbestos and completes the lining by sintering the zircon. The lining is highly resistant to sudden temperature changes and does not affect the chemical composition of the melt. The requisites of an induction-furnace refractory, melting efficiency, alloy losses, and superheating of metals are discussed.—S. G.

Structural Materials for Modern Heat Technology. F. H. Norton (Chem. and Met. Eng., 1932, 39, 226-228).—Refractories are classified into five main groups, viz.: (1) those used to confine heat within a definite space; (2) those for containing a charge; (3) those used to protect structural members from the influence of high temperatures; (4) those used for conducting heat from the furnace gases to the charge through a tight wall and (5) those used for absorbing heat, e.g. regenerator checkers. The properties of refractories, the number of types available, considerations in selecting the best refractory for a given purpose, and refractory cements are discussed. The more important properties of the common types of refractories are tabulated and variations of thermal conductivity and expansion with temperature are plotted.—F. J.

Types, Uses, and Testing of Refractory Cements. W. Raymond Kerr (Chem. and Met. Eng., 1932, 39, 331-332).--Refractory cements may be classed as mixtures ordinarily used for bonding and coating firebrick walls. They vary so as to be suitable for temperatures up to and above 3000° F. (1649° C.). Air-setting cements and cements with high-temperature bonds are discussed, the former depending on the admixture of a binder such as sodium silicate, which sets on drying, and the latter on the development of a bond under the action of heat; such cements are useful in providing a cushioned joint which allows some expansion and contraction before the bond hardens. The importance of fine grain-size and the uses and methods of applying cements are discussed. The desirable properties of cements are as follows : (1) chemical inertness to the refractory brick at high temperatures, to furnace gases, and to slags; (2) low drying and firing shrinkage excessive firing shrinkage results in peeling; (3) refractoriness at least equal to that of the brick with which it is used; (4) coeff. of expansion practically equal to that of the wall to which it is applied-differential expansion causes cracking and peeling and ultimate failure; (5) workability, to minimize labour costs; (6) quick-setting in the case of air-setting coments-any tendency to creep and set slowly may result

in the brickwork settling when further additions are built upon it. Some methods of testing the chief properties of cements are briefly outlined.—F. J.

Refractory Jointing Cements. A. T. Green, F. Wheeler, and H. Booth (Inst. Gas Eng., 22nd Rep. Refract. Materials Joint Sub-Cttee., Copyright Communication No. 39, 1931, 33-41).—See J., this volume, p. 199.—S. G.

Progress in the Field of Refractory Materials. E. H. Schulz, F. Hartmann, and A. Kanz (*Stahl u. Eisen*, 1930, **50**, 1677–1681; *C. Abs.*, 1931, **25**, 4993).— The progress made in the refractory industry throughout the world is discussed in regard to: (1) raw materials, their properties and preparation; (2) kiln construction and operation; (3) testing methods and contrivances; (4) properties of refractory materials; (5) standard specifications; (6) separate blocks, new refractory materials; (7) mortars, cements, and sand for moulding, and (8) literature.—S. G.

Refractories. Anon. (*Mech. World*, 1932, **91**, 527).—Editorial note on the British Refractories Research Association and the difficulties in the way of a continuance of its work, owing to lack of funds.—F. J.

Refractories, Ceramics, and Cements. J. H. Chesters and W. J. Rees (Ann. Rep. Prog. App. Chem., 1931, 16, 267–279).—Summarizes, with full references, work published during 1931 dealing with refractories, notably fireday, silica brick, magnesite, magnesia, and spinels. Discussion of the properties required in induction furnace limings demonstrates that magnesia and silica, respectively, are the most satisfactory basic and acidie liming materials, provided that sufficient thickness of sinter can be obtained. Advances in methods of testing refractories are noted; the X-ray method is promising, but at present is difficult to carry out. Rapid progress is being made in the determination of the melting point of refractories. Reference is made also to the use of molybdenum and tungsten wire windings for use up to 2000° C., in a reducing atmosphere, and to tensile tests of magnesia and magnesia-chrome mixtures at high temperatures.—H. F. G.

On the Infra-Red Radiation of Refractories. B. Wrede (Mitt. K-W-Inst. Eisenforschung, 1931, 13, 131-142).—The infra-red thermal radiation of silica, chamotte, sillimanite, corundum, and magnesite bricks has been determined spectrometrically and compared with the thermal spectrum of the black body at the same temperature. From the results the absorptive power as a function of the wave-length has been calculated; this is of importance for the evaluation of the heat transfer in technical furnace. Further, the absorptive power of the materials tested for black total radiation at the temperature of the test has been determined by integration.—J. W.

The Total Radiation of Some Oxides and Oxide Mixtures. K. Hild (Mitt. K-W-Inst. Eisenforschung, 1932, 14, 59-70).—The total radiation from pure alumina, magnesia, lime, silica, chromium sesquioxide, ferric oxide and zine oxide, and of lime-magnesia, alumina-chromium sesquioxide, and alumina-zine oxide mixtures have been determined. The effects of grain size and of temperature are described and conclusions are reached for the radiation of technical refractories.—J. W.

Examination of Refractory Products.—II. Marcel Lepingle (*Rev. mat. constr. trav. pub.*, 1931, (257), 24B; *Ceram. Abs.*, 1931, 10, 505).—Cf. this *J.*, 1931, 47, 620, and this volume, p. 200. It is impossible to determine the P.C.E. of refractories from their chemical composition, but the temperature at which refractories will fail under rapid heating may be estimated from flux content and silica/alumina ratio. The use of broken brick for grog is recommended.

-S. G.

Reversible Thermal Expansion of Refractories. Anton Kanz (Mitt. Forsch. Inst. Ver. Stahlwerke A.G. Dortmund, 1931, 2, (5), 77-96; C. Abs., 1931, 25, 4994).—To measure reversible expansion, the method of Steinhoff was used (Gas u. Wasserfach, 1927, 70, 989-993, 1019-1023) on chamotte, silica, quartz schist, magnesite, magnesia, bauxite, chromite, zirconia, and elay refractories. The average coeff. of each material varied considerably, and depended on temperature. In most cases it increased almost linearly with rising temperature, with the exception of those materials containing free silica. Siliccous materials showed variations due to modification changes, although the sp. gr. agreed with the thermal coeff. With elay free from quartz, the grain-size and the temperature have little effect on the thermal expansion below the burning temperature. Expansion was very low.—S. G.

Structure and Thermal Conductivity of Refractory Brick. E. Maase (Stahl u. Eisen, 1931, 51, 860-861; Ceram. Abs., 1932, 11, 37).—A short review is given of the values of thermal conductivity at temperatures up to 1000° C. for different refractory materials. Non-metallic amorphous substances show a low thermal conductivity which increases with rising temperature, whereas crystalline substances show a high thermal conductivity which decreases with rising temperature. The thermal conductivity decreases with increasing porosity, but the decrease is less at very high temperatures. Large pores conduct the heat better than small ones. The thermal conductivity increases with increased temperature while firing the refractory material.—S. G.

Gas Permeability of Refractory Materials. K. Endell (Arch. Wārmewirtschaft, 1931, 12, 146; Ceram. Abs., 1931, 10, 645).—The investigations on the gas permeability of refractory materials carried out by A. Kanz are reviewed. The values received show large variations for the different types of refractories. The gas permeability seems to be a function of the forming and distribution of pores, whereas other properties such as porosity have no influence. The main factor for the gas permeability lies in the making of the brick, especially in the firing temperature.—S. G.

The Permeability of Refractory Materials to Gases. I.—Experiments with Fireclay and Silica Products at Ordinary Temperatures. F. H. Clews and A. T. Green (Inst. Gas Eng., 22nd Rep. Refract. Materials Joint Sub-Cttee., Copyright Communication No. 39, 1931, 5-15; and Brit. Refract. Res. Assoc. Bull. No. 25, 1931, 24-47).—See J., this volume, p. 275.—S. G.

The Permeability of Refractory Materials to Gases. II.—Experiments with Fireclay and Silica Products at Temperatures up to 500°. F. H. Clews and A. T. Green (Inst. Gas Eng., 22nd Rep. Refract. Materials Joint Sub-Cttee., Copyright Communication No. 39, 1931, 16-23; and Brit. Refract. Res. Assoc. Bull. No. 26, 1931, 44-56).—See J., this volume, p. 275.—S. G.

XVIII,-MISCELLANEOUS

(Continued from pp. 518-524.)

Retrospect [Development of the Precious Metal Research Institute of Schwäbische-Gmünd]. H. Moser (*Mitt. Forschungsinst. Edelmetalle*, 1932, 5, 89-100).—An illustrated article describing the development, aims, and equipment of the Forschungsinstitut für Edelmetalle.—A. R. P.

Results of the Degree of Fulfilment of the Non-Ferrous Industrial Plan during the First Nine Months of 1931. D. I. Schteinbok (*Opyt Predpriatie* (*Experience of Undertakings*), 1931, (11), 3-5).—[In Russian.] A review of the results achieved by the non-ferrous metal industry during the first 9 months of 1931 and a summary of the objectives for the last quarter. The poor results (40.1% of the annual plan) are ascribed primarily to excessive fluidity of labour, lack of co-ordination, and "wrecking."—M. Z. Real and Fictitious Lowering of Production Costs in the Non-Ferrous Metal-Working Industry [of U.S.S.R.]. G. Chlebnikov (*Opyt Predpriatie (Experience of Undertakings)*, 1931, (11), 16–18).—[In Russian.] A critical survey of the results in costs achieved by the non-ferrous metal-working industry during the first half of 1931. The total cost of production was lowered by 2·37%, although the cost (exclusive of raw materials) rose by 15·82%. The over-all lowering was thus entirely due to the fall in metal prices. It is pointed out that the results cannot be regarded as satisfactory, since they indicate an uneconomic treatment of the raw material. Real reduction of costs can be achieved only by increasing the output per productive unit and eliminating waste.—M. Z.

The Life of Metals. A. Thum (Forschungen und Fortschritte, 1931, 7, 413-414).—A general review of problems of the science of metals.—J. W.

On the Importance of Researches on Non-Metallic Materials for the Understanding of the Tensile Properties of Metals. A. Smckal (Forschungen und Fortschritte, 1931, 7, 398-399).—A short review.—J. W.

Cadmium Poisoning. I.—The History of Cadmium Poisoning and Uses of Cadmium. Leon Prodan (J. Indust. Hyg., 1932, 14, 132-155).—S. G.

Removing Enamel from Enamelled Copper Wire. Anon. (*Emaillewaren-Ind.*, 1931, 8, 245; *Ceram. Abs.*, 1931, 10, 827).—Enamelled copper wire is not covered with an ordinary enamel, a fusing product, but with an enamel fired at a high temperature. For removing such a layer the wire is fired and then pickled for several seconds in nitric acid or a mixture of nitric and sulphurie acids.—S. G.

Casting Fever and its Prevention. M. Grünewald (Zentral. Europ. Giess. Zeit., 1930, 3, (6), 6-8).—The effects of zinc fumes are felt mostly some 6 to 8 hrs. after they have been inhaled, and consist principally of a high temperature and shivering. Usually by the next morning the effects have worn off. The intensity of the attack appears to be a personal factor. Hot milk is preferred as a hot drink in these instances. The wearing of respirators, although a hindrance, serves to prevent some of the fumes from getting into the mouth and thus to the throat. Adequate air space in the foundry is essential. Weiss has introduced a material, "Kuprit," which when laid on the top of the molton zine alloys is said to prevent the evolution of zine fume. Apparently this is due to the formation of a slag.—W. A. C. N.

Brass Fever and its Prevention. M. Grünewald and E. Kalisch (Schmelzschweissung, 1930, 9, 89-90; C. Abs., 1932, 26, 3470).—Because of the great difference of melting points of the constituents of brass (copper at 1084° C. and zine at 419° C. with a boiling point at 925° C.), the zine in the alloy will already have begun to evaporate when the brass melts and will burn to ZnO, which forms a fume and is condensed again as a white deposit in the vicinity. This ZnO is injurious to the lungs and respiratory organs and causes fever to those inhaling the vapour. The symptoms are described and, as remedy, hot milk and tea of a certain herb are recommended. Melting of brass should, therefore, be done only in large shops and the vapours exhausted before the melter can inhale them.—S. G.

Utilization of Gold, Silver, and Platinum Residues. José Uhthoff Ferrán (Quim. e Ind., 1932, 9, 29–32; C. Abs., 1932, 26, 2947).—A metallurgical process for recovering rare metals from sweepings, filings, and ingot residues is described, which consists of a combination of fusion with litharge and fluxes followed by cupellation. Details of a subsequent chemical and electrochemica refining process are given.—S. G.

Working-Up Lead Refining Liquors. F. Vogel (Metall u. Erz, 1930, 27 88-91; C. Abs., 1931, 25, 4801).—A cyclic process for the recovery of the whole of the sodium is proposed; it is applicable to liquors from the Harris and Betts processes.—S. G. Extensor Weakness in Those Working with Mercury. B. B. Koiransky and E. J. Benediktova (Zentr. Gewerbehyg. Unfallverhüt., 1931, 18, 169–173; C. Abs., 1932, 26, 2801).—As in the case of lead poisoning, extensors of the right hand of workers in mercury are 3-4 times weaker than those of workers who do not come in contact with the metal.—S. G.

History of the Mirror. Anon. (Sprechsaal, 1930, 63, 177; Ceram. Abs., 1930, 9, 496).—The origin of the mirror is not known, but the first mirrors were made of highly polished metals. During the time of the Roman Empire thin metal plates (gold, silver, copper, iron, tin) were used for mirrors. It is also possible that panes of glass were coated with thin layers of melted metal. Mirrors coated with law been found.—S. G.

Organization, Equipment, and Operation of a Foundry Laboratory. Henry Thyssen (*Rev. Univ. Mines*, 1930, [viii], **3**, 157-162; *Ceram. Abs.*, 1931, 10, 330).—T. advocates the establishment of laboratories in connection with foundries and gives an illustrated description and plans of an ideal laboratory that was built by the Compagnic Général de Conduites d'Eau.—S. G.

XIX.-BIBLIOGRAPHY

(Continued from pp. 587-589.)

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XX.-BOOK REVIEWS

(Continued from pp. 589-592)

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

Metallurgy. By Edwin Gregory. With an Introduction by C. H. Desch. Demy 8vo. Pp. xv + 284, with 188 illustrations. 1932. London and Glasgow: Blackie and Son, Ltd. (17s. 6d.)

As the author points out, the volume under review cannot deal exhaustively with the whole subject, but is intended to form an introduction to the study of metallurgy, and as a means of contact with more specialized information. These purposes appear to be adequately fulfilled, and Mr. Gregory's book should be of value to a wide variety of readers. In particular, engineers who have little opportunity for the lengthy study of metallurgy will find in it much to assist them in dealing knowledgeably with their materials and with the common forms of defect and fallure.

A remarkably large amount of matter, with considerable detail, has been compressed into the space available, and is presented in well-arranged and readable form. All the information given appears reliable, and its usefulness is enhanced by numerous illustrations, which have been well selected and clearly reproduced. The sections dealing with special and rust-resisting steels are particularly useful summaries of present knowledge of these materials, and are in general up to date. The newer types of austeritic steels free from susceptibility to intercrystalline corrosion are, however, not mentioned. Perhaps the only serious criticism of the book as a whole is that the enormous field of non-ferrous metallurgy, much of which is of practical importance to the engineer, is too scantily treated, whilst space is devoted to the relatively unimportant subjects of the blast-furnace and pig iron. The references given are not numerous, but are probably adequate for a work of this type, and are suitably most frequent in the non-ferrous section. Both the text and figures are admirably printed.

The book should supply a want often expressed by technical students and engineers, and is to be confidently recommended.-R. GENDERS.

The Heat-Treatment and Annealing of Aluminium and its Alloys. By N. F. Budgen. With a Foreword by D. Hanson. Med. 8vo. Pp. xvii + 341, with 231 illustrations. 1932. London: Chapman and Hall, Ltd. (25s, net.)

The remarkable development during the last 20 years or so of the heat-treatment of alloys from the laboratory investigations of pure science to the large-scale application to works practice is one which is of immense importance both to the scientist and to the practical man in industry. That laboratory experiments should have resulted in the development of such an industry surely emphasizes the fact that the much-despised pure academic researches have a far-reaching practical importance, which, however, may not at first be recognized. Who, for instance, would have thought that the examination of constitutional diagrams would have led to the development of an important industry in such a comparatively short space of time 2

Dr. Budgen is to be congratulated on having written such a complete treatise on the heattreatment and annealing of aluminium and its alloys, for by so doing he has met a very great need. No book has been devoted solely to this subject, which is one of growing importance, and the author has summed up very clearly and concisely, and arranged in a scientific manner, all matter pertaining to it. Frequent reference throughout has been made to original work and other subject-matter, and a very full, indexed bibliography is given at the end of the volume, together with six appendices on certain practical problems. There are many errors in the index, however, due, it would seem, to the repaging of a section of the volume after it had been indexed.

The subject-matter has been divided into four main groups: I.—Heat-treatment of wrought pure aluminium; II.—Heat-treatment of cast pure aluminium; III.—Heat-treatment of wrought aluminium alloys; IV.—Heat-treatment of cast aluminium alloys. These groups are each again subdivided as follows: (a) To increase strength; (b) To soften or anneal. Under these headings the author has dealt with the whole problem of heat-treatment.

To our mind, Dr. Budgen has made one big mistake, however, in referring to "commercially pure" aluminium as "puro" aluminium, because—as he explains—"so many non-technical people refer loosely to aluminium alloys as 'aluminium," that he "felts afer in prefixing the word 'pure' to make differentiation clear." Unfortunately, "he hath dug a pit and is fallen into the ditch which he made," for he has got hopelessly involved over "pure" aluminium. For example, having defined "pure" aluminium, he immediately refers to "commercially pure" aluminium in the subsequent paragraph. One would not have expected to find the term "commercially pure" aluminium in the book at all, but we read on p. 21 "... higher temperatures ... than are necessary for pure or commercially pure aluminium." By definition these are one and the same, although the author means two grades of aluminium." By definition these meads the words, "This has a bearing on the annealing of aluminium." By definition to have in an alloy if When comparing alloys made with aluminium. of high purity with those made from the normal material, the author becomes desperate, flings his definition to the winds, and heads his section "Commercially pure Cast Aluminium." By definition to the winds, and heads his section

We sympathize with him, but we think that he would have been better advised if, instead of trying to write down to the non-technical man, he had endeavoured to train him up to use the recognized scientific terms. The above are a few instances of the confusion caused by defining "pure" aluminium.

The early pages of the book naturally deal with the theoretical aspect of the heat-treatment of alloys: this part is not so well explained as the more practical part. The author does not always express his meaning in the clearest possible way, and tends to repeat himself. This is emphasized by the excessive use of paragraphs, a fault which pervades the book; paragraphing causes the reader's mind to expect the presentation of a new idea and unconsciously the mind responds by expecting discontinuity of thought. Dr. Budgen, however, uses paragraphs, in many instances, as one would use a sentence.

He is to be commended for the very clear way in which he has described the various heattreatment and annealing apparatus. No pains have been spared to give a complete account of the specific treatments necessary for individual alloys in order to obtain particular results. The general outlay necessary in a foundry for carrying out these treatments is fully described, and the need for accurate control and the means by which such control can be obtained are emphasized. Full details are given of the mechanical properties which should result from the specified heat-treatment, as also are examples of the general microstructure of certain alloys. In addition to stating what the heat-treatments are, the reason for them and possible causes of failure to attain the desired results are explained.

In the case of the binary alloys, the effect of the addition of one or two constituents is described, whilst the ternary and more complex alloys are dealt with in some detail. The uso industry makes of such alloys is described with illustrations.

Dr. Budgen is to be congratulated on having written a very comprehensive account of the heat-treatment of aluminium and its alloys; it should be of immense value both to the industrialist and to the "academician"—to use the author's term. The former will find at least in this book the "reason why" of the heat-treatment, and will come to realize, if he has not already done so, the importance of scientific investigation, whilst the "academician" will find much to learn about the industrial application of his efforts.—M. L. V. GAYLEE. Practical Dental Metallurgy. A Text and Reference Book for Students and Practitioners of Dentistry, Embodying the Principles of Metallurgy, and their Application to Dentistry, Including Experiments. By Joseph Dupuy Hodgen. Revised by Guy S. Millberry and John S. Shell. Seventh Edition. Demy 8vo. Pp. 470, with 86 illustrations. 1932. London: Henry Kimpton, 263 High Holborn, W.C. (18s. net.)

The fact that this book has now reached its seventh edition would seem to indicate that it has found considerable favour among dental students, but after a careful perusal the reviewer has come to the conclusion that if this is the case, the standard of metallurgical knowledge required by such students is remarkably low. The preface to the first edition states that the student using the book is presupposed to possess a fair knowledge of the principles of inorganic chemistry, and yet the author devotes a great deal of space to the description of such simple reactions as the dissolution of metals in acids with the evolution of hydrogen, the equation being given in all cases, to very elementary accounts of the properties of the oxides of the common metals, and to qualitative tests for the detection of the metals. As methods of separating the metals from one another qualitatively are not given, it is difficult to see the value of wasting space on the description of what are really only confirmatory tests. The metallurgical sections of the chapters dealing with the individual metals are extraordinarily scrappy, and frequently contain information which is years out of date, and in many cases quite misleading. This is particularly true of the section on iron, which would make a modern steel metallurgist shudder; for example, the reader is told that iron carbide "may be represented pretty nearly by Fe_4C " and plg iron is "assorted and classed as Nos. 1, 2, 3, . . . No. 1 is most highly carburized. . . . The first melts and runs so fluid that it . . . furnishes cast-iron cutlery from which the carbon is subsequently extracted." Copper steel is said to contain 5 to 20 per cent. of copper! The annual output of aluminium in 1910 is given as 40,000,000 tons ! Two pages further on the uses of the metal are stated to be for the manufacture of aluminium weights, especially milligram riders, scientific instruments, parts of bicycles, tablewear, and cooking utensils; no mention is made of its use in constructional work. In dealing with aluminium alloys it is casually mentioned that those with " a small content of copper cannot be used industrially "! " Tin and aluminium form alloys little affected by acids " and " 0 005 of 1 per cent. of aluminium in wrought iron serves to lower its fusing point about 500° F. so that castings may be made from it as readily as from the highly carbonized cast iron," are further examples of inaccurate statements. The section on gold contains much ancient history on the extraction of the metal from Californian alluvials and very little on modern extraction methods. The portions dealing with the uses of gold and its alloys are, together with the chapters on amalgams, undoubtedly the best parts of the book.

The selection of illustrations is not always happy; it is not quite clear of what interest to dental students are photographs of a primitive iron blast-furnace used by native Filippinos, or of Californian gold prospectors, especially when the reproduction is not as clear as it might be. Quite a number of this type of illustration is included, but there are also a few illustrations of furnace equipment suitable for dentists, and half a dozen or so photomicrographs of dental alloys. The book contains numerous printer's errors and many sentences the meaning of which is at least ambiguous, e.g. in the article on zine phosphate cements. Although it has apparently been revised at least twice since the first edition, there is still much material which could with advantage be excised. This also applies to statements which are repeated in different parts of the book almost word for word. With judicious pruning the size could be reduced by at least not book appears to the reviewer to be excessive.—A. R. POWELL.

La Cromatura Elettrolitica (Electrolytic Chromium Plating). By Osvaldo Macchia. Med. 8vo. Pp. xvi + 489, with 204 illustrations. 1932. Milano. Ulrico Hoepli. (Lire 50.)

Owing to its æsthetic appearance, hardness, and high resistance to corrosion, chromlum plating holds a prominent position among the various electrolytic methods which are used for decoration of metals and for protecting them against corrosion. The process is, however, one of the most difficult plating operations in commercial use, and much care and attention are required to obtain consistently satisfactory results. Professor Macchia has had a wide experience of the problems associated with chromium plating, and his able exposition of the present position of the theory and practice of the subject presented in this book should prove of great interest and value to all who are interested in this field. The book comprises ten chapters and a bibliography containing more than 200 references to the most important articles on chromium plating, with a short abstract to every reference; in addition, the text is liberally supplied with references to papers on all phases of the subject.

The first few chapters deal with the history, properties, and applications of chromium plating, the composition and physical and chemical properties of the bath and their relation to the nature of the deposit obtained, the theory of chromium plating, the effect of the solution and spray on the health of the workmen, and problems associated with the heating and ventilation of the baths. Subsequent chapters are devoted to costing, mechanical aids to rapid plating, inspection of the work, the use of intermediate coats of copper and nickel, and various other practical details.

The book is well written and provides thorough instruction in the theoretical as well as in the practical sides of the subject, hence the French translation which is now in preparation will be widely welcomed as rendering the book available to a larger circle of readers. The diagrams and illustrations with which the book abounds are all excellently reproduced; and the photographs of modern Italian and American chromium-plating shops are of special interest. To sum up, the book will prove a valuable addition to the literature of this most difficult branch of the plater's art.--G. GUZ20NI.

Décapage et Polissage des Métaux. Abrasifs, Meules et Roues à polir, Polissage, Brillants commerciaux, Traitement des Métaux, Démétallisation. Par An Engineer. Mcd. 8vo. Pp. 170, with 51 illustrations. 1931. Paris et Liége : Ch. Béranger. (28 francs; 33 francs post free.)

This is a useful little book (one of a series by the same author, whose pseudonym, "An Engineer," suggests an English origin) with an essentially practical bias on the cleaning, polishing, and allied treatment of metals. The theoretical side of metal cleaning, which has received considerable attention by technologists in recent years, is unfortunately relegated to the background, consideration of the modus operandi of the cleanesing action, the function of emulsification, peptization, colloid addition, and the use of soaps and the newer detergent agents being omitted. Many practical formulæ of special cleaners for individual metals are, however, included which should be valuable to the artisan and the feweller. Thus, the special treatment of iron, steel, brass, copper, and its alloys; polishing liquids and materials for nickel, aluminium, lead, th, zine; and the cleaning of sliver and the precious metals are all dealt with in some detail. The section on polishing methods should be useful to the layman, to whom, *inter alia*, the possibilities of transforming parts of a bicycle into a polishing methode metals are practical appeal on the score of economy t

Whilst a considerable amount of information is imparted, the appearance of the book leaves much to be desired. In the worst traditions of Continental publications, the book is paper covered, with the pages irritatingly uncut, and is printed on poor quality paper; 170 pages in all, the unfortunate impression is created that the price is somewhat excessive.—S. WERNER.

The Structure of Crystals. By Ralph W. G. Wyckoff. (American Chemical Society Monograph Series.) Second Edition. Demy 8vo. Pp. 497, with 274 illustrations. 1931. New York: The Chemical Catalog Co., Inc. (\$7.50.)

As every reader of the first edition would wish, the second edition follows closely the form of the first. Thus, every chapter in Part I dealing with crystal structure methods is followed by a "conclusion" where the pros and contras of every method are summed up in some few concluse and carefully-worded sentences, thus affording to the beginner and to the student of X-ray technique a most welcome and reliable guide.

As, however, advances of the last few years have been so rapid, most of the chapters have been rewritten. Thus, the theory of space-groups, based on the work of Fedorov, Schoenfliess, and Barlow, and further developed by Hilton and Niggli (recently illustrated by the author's drawings in "The Analytical Expression of the Results of the Theory of Space-Groups") is dealt with, and Chapter II, on the symmetry of crystals, makes an excellent introduction to the theory.

Another important point which is dealt with at some length in Chapters IV and VII, is the theory of imperfect crystals, where the latest contributions of C. C. Darwin and of W. L. Bragg are fully taken into account. The view is brought forward that "nearly all crystals are more or less imperfect " and that a second kind of ideal crystal would be one that is "ideally imperfect." Thus a single crystal would be composed of tiny crystal fragments so arranged that they are nearly but not exactly parallel, forming what may be conveniently called a "mosale" structure. To the members of the Institute of Metals who are already conversant with the work of Goucher, Gough and Taylor, and Elam on metallic crystals, these chapters may present an additional interest, although they may regret that it has been impossible, as was originally planned by the author, to add a special chapter on alloy systems and to discuss there the whole problem of the intermetallic compounds. As it stands, the alloy chapter was sacrificed and some of the more definite intermetallic compounds were dealt with in appropriate chapters. An important feature of this edition, as well as of the previous one, is the Appendix, containing a bibliography of crystal structure data (pp. 397-475). For

the years 1012-1023 it is practically identical with that of the first edition (pp. 307-417), but an additional 60 pages deal with the work done between 1024 and the end of 1030, and every student of the subject will be sincerely grateful to the author for these.

In Part II, special chapters are devoted to the structures of silicates and of organic compounds, and thus within its somewhat narrower field the descriptive part is as complete as possible.

In point of detail it may be mentioned that the growing importance of the gnomonic projection is fully acknowledged in the chapter on Laue photographs, and that some of the recent maps of the Fourier electron distribution illustrate the work of W. L. Bragg on silicates.

The book is excellently produced, and will be indispensable to every student of the subject for many years to come.-N. T. BELATEW.

Chemical Analysis of Iron and Steel. By G. E. F. Lundell and James Irvin Hoffman and H. A. Bright. Pp. xvi + 641, with 63 illustrations. 1931. New York : John Wiley & Sons, Inc.; London : Chapman and Hall, Ltd. (Price 42s. net.)

This volume may be considered as a companion volume to Hillebrand and Lundell's treatise on inorganic analysis reviewed in this J., 1930, 43, 744, as it is compiled on the same principles and in a similar style. The book is divided into five parts, the first of which deals with apparatus, reagents, qualitative analysis as applied to steels, common analytical operations, and volumetric analysis. In Part II methods for the determination of the constituents of iron and steels are discussed, attention being paid to " umpire " methods as well as to rapid " routine " methods for use during the process of manufacture of the metal; this section includes procedures for the determination of all the uncommon constituents of steels as well as the common alloying elements in amounts varying from minute traces up to the maximum met with. Part III should prove of great value and interest to the steel chemist, as it deals with the difficult subject of determining the gas content of, and slag inclusions in steels. Part IV will prove of equal value to the ferrous and non-ferrous analyst, as it comprises procedures for the analysis of ferro-alloys and the commercially pure metals which are used as additions to steel, viz., manganese, silicon, chromium, and cohalt; strangely enough, tungsten and molybdenum are considered only as ferro-alloys, whilst nickel is entirely omitted from this section. Part V deals with the analysis of ores (of iron, manganese, and chromium only), limestones, thuorspar, refractories, slag, moulding sands, and coal and coke.

The authors have undoubtedly done their work well; the methods selected for description represent the best modern practice, and are admirably and lucidly described, with a wealth of detail, the effect of interfering elements is discussed, and all precautions necessary for obtaining results of the highest accuracy in the shortest time are mentioned. Whilst the authors have personally tested most of the methods given, they have also supplied copious references to the literature. The book is well printed on good paper, and is in every way a great credit to all concerned in its production. No steelworks or steel analyst can afford to be without a copy, and the non-ferrous analyst will find much of value to him in its pages.—A. R. POWELL.

Handbook of Chemistry and Physics. A Ready-Reference Book of Chemical and Physical Data. By Charles D. Hodgman and Norbert A. Lange. Sixteenth Edition. Fcap. 8vo. Pp. xiii + 1545. 1931. Cleveland, O.: The Chemical Rubber Co. (§5.00; Special price to Students: U.S.A. and Canada, §2.75; Foreign countries, §3.00.)

The sixteenth edition of this reference book of chemical and physical data has been enlarged by rather more than 100 pages. New tables have been added dealing with the characteristics of vacuum tubes, the lowering of the freezing point of aquecus solutions, natural trigonometric functions for decimals of a degree, the physical properties of wood, and the reduction of barometer readings to sca-level. The collection of units and conversion factors has been revised and extended, as also has the section dealing with definitions and formulæ. The necessary changes have been made in the table of atomic weights and all other tables of values involving the atomic weight. The sections dealing with acceleration due to gravity, latitude, longitude, integrals, radioactivity, surface tension, thermo-cleetric power of vapour tension of aqueous vapour above 100° C. have been revised completely. The remainder of the volume is exactly as described in the notice of the fifteenth edition (cf. this J., 1931, 44, 760). The great utility of this book is amply evidenced by the frequency with which new editions are demanded. A new edition in the case of this work signifies that the data have been brought up-to-date, and, this being the case, the new edition becomes a necessity to chemists, physicist, and engineers. The book is thoroughly reliable, and may be strongly recommended.—JAMES F. SPENCER.