METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

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Part 7

I.--PROPERTIES OF METALS

(Continued from pp. 225-230.)

A New Method for the Extraction of Gases from Metals, and Contribution to the Study of Gases Retained by Aluminium. A. Portevin, G. Chaudron, and A. Moreau (Sci. Rep. Tôhoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 933-939).—[In French.] The gas content of aluminium, calcium, and electrolytic iron and nickel is estimated by making the metal the cathode in a vacuum tube operating at voltages up to 150,000. Time must be allowed to permit diffusion of the gas within the metal, and this process is facilitated by heating. The quantities of gas obtained are considerably greater than those furnished by vacuum heating or fusion. It is possible to distinguish between elemental or combined nitrogen in aluminium and calcium.—W. D. J.

"Bell Jar" Test for Gases in Aluminium. Léon Moreau (Bull. Assoc. Tech. Fonderie, 1936, 10, (12), 446-447).—The gas content of molten aluminium contained in crucibles is evaluated by placing the crucible in a bell jar which can be evacuated. Spitting or violent gas evolution commences at approximately 1 mm. pressure. The gas content is estimated by the size of the blow-holes remaining in the frozen sample. The apparatus is recommended for general foundry use.—W. D. J.

The Relaxation of Copper at Normal and at Elevated Temperatures. John Boyd (Amer. Soc. Test. Mat. Preprint, 1937, (June), 14 pp.).—The relaxation of copper at room temperature and probably up to about 200° C. may be represented, for practical purposes, by an expression of the form $\sigma = \sigma^$ $[1 - A . \log (1 + Bt)$, where σ is the stress at any time t, σ^* is the initial stress, and A and B are constants. A marked increase in relaxation takes place when the temperature is increased above about 80° C. At 200° C. the stress is estimated to decrease to about 20–25% of its initial value in a service time of 20 years. Recovery effects tend to decrease the creep rate found in the early part of a relaxation test. The dissimilarity between the speed laws for decreasing and for increasing stress gives rise to rather large amounts of relaxation. Additional creep and relaxation tests are now being carried out and it is hoped that they will throw more light on the subject.—S. G.

*The Reflective Power of Copper. Léon Capdecomme and Pierre Jacquet (Compt. rend., 1937, 204, (19), 1415-1417).—The method of anodic polishing (Met. Abs., 1936, 3, 75-76) does not alter the crystalline structure and appears to be particularly suitable for measuring the true optical constants of a metal. The reflective power of copper was measured using filtered tungsten light ($\lambda = 4500$ A.) and a modification of Orcel's apparatus (Compt. rend., 1934, 198, 462; 1936, 202, 1843, 2061; 1936, 203, 994). Several specimens of electrolytic copper were tested for reflectivity after 3 hrs.' polishing with alumina and after subsequent anodic polishing. The results in the latter case were very concordant, and 3-5% better than in the former. No alteration of the reflective power of the anodically polished surfaces was observed after several weeks. The mechanically polished surfaces showed much greater alteration of the reflectivity at 50° C. than the anodically treated surfaces.—J. H. W.

Indium. —— (Metallurgist (Suppt. to Engineer), 1937, 11, 2-3).—A description of the properties of the metal and of its commercial development.

- † Denotes a first-class critical review.
- σ

^{*} Denotes a paper describing the results of original research.

Indium is used in jewellery and for the electroplating of silver, for fusible metals melting at temperatures down to 46.5° C., for casts and impressions (with impregnated cloth, &c.) which can be subsequently electroplated with copper, &c., and as a surgical substitute for plaster of paris. The price is about \$30 per oz.-R. G.

*Transformation of Manganese. Hiroshi Yoshisaki (Kinzoku no Kenkyu (J. Study Metals), 1937, 14, (3), 91-95).--[In Japanese.] Using distilled manganese, the transformation of the metal was studied by means of differential thermal analysis and the dilatometric and buoyancy methods; the lastmentioned method consists of finding a temperature at which a sample, dipped in a molten salt-bath, changes weight abnormally on heating and cooling. It was found that the melting point of manganese is 1254° C., and that it has 3 transformation points in the solid state, at 1150°, 1087°, and 706° C., respectively.-S. G.

On the "Curie Point " [in Nickel]. Walther Gerlach (Sci. Rep. Tohoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 248-255).-[In German.] Indirect methods of measurement are described for investigating the sharpness of the Curie point for nickel, reasons being given for not using a direct method. The methods of measurement used were: (1) magnetocaloric effect; (2) specific heat; (3) electrical resistance; (4) infra-red emission; (5) change of resistance in magnetic field; (6) H.-T. curves. The measurements all agree in showing that the Curie point is not sharp, but that the magnetic change is asymptotic to the temperature axis.-B. C.

*The Occlusion and Diffusion of Hydrogen in Metals. A Metallographic Study of Nickel-Hydrogen. George A. Moore and Donald P. Smith (Electrochem. Soc. Preprint, 1937, (May), 249-267) .- A continuation of previous work (see Met. Abs., 1934, 1, 549; 1935, 2, 456) on the occlusion of hydrogen by metals. Degassed and hard-rolled nickel foil was charged cathodically for prolonged periods, and photographs are given showing the surface blistering produced by the subsequent desorption of the occluded gas. The blistering in certain cases takes place in rows parallel to the intersection of the slip-planes with the surface. From this evidence, and also from the mechanism of attack by etching reagents, it is concluded that (a) hydrogen enters the metal primarily along slip-planes evidently rifted during rolling; (b) the large quantity of gas taken up electrolytically in excess of that which can be dissolved in the lattice is retained chiefly in other rifts along planes of a family parallel to the plane of rolling; (c) the latter rifts may have been present, at least in an incipient state, before the entry of the hydrogen, and may have been merely enlarged by the gas. It is suggested that slip may take place in nickel along the dodecahedral planes as well as along the octahedral planes.

-C. E. R.

*The Action of Sulphur on Silver. Ernest Toporcscu (Compt. rend., 1937, 204, (17), 125).—Silver-on-glass mirrors were found to be tarnished by sulphur in the benzene used as a solvent for lacquer. The sulphur content of the benzene was of the order of 0.1 grm./100 c.c. The attack on a silver mirror by a crystal of octahedral sulphur having a plane surface of about 160 mm.² in contact with the silver was visible after 30 minutes at the laboratory temperature. It was found that the sublimation of the sulphur was not the same all over the surface of the crystal; it was very small at the sides of acute angles, and large at the sides of obtuse angles, i.e. the interatomic energy was greater at the sides of acute angles .-- J. H. W.

*The Optical Constants of Sodium. Herbert E. Ives and H. B. Briggs (J. Opt. Soc. Amer., 1937, 27, (5), 181-185) .- The authors used the Voigt method of reflection of a monochromatic plane polarized light by the metal through a Babinet compensator, rotary quartz wedges, and analyzing Nicol, and calculation from spot photographs. The reflecting power of distilled sodium metal (calculated) increases from a low value rapidly over a short range of wave-lengths of about 1800-2200 A. The experimental data show that it is then practically constant for all wave lengths from 2500 up to 0000 A. The experimental curve is reasonably near that calculated from Kronig's theory, and in this respect is better than that given by former results with potassium.—R. G.

Diagram of the Recrystallization of Zinc. J. Czochralski and O. Lubinkowski (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 101-103).—[In English.] Sce also Met. Abs., this vol., p. 78.

–P. W. R.

*On the Energy States of Valency Electrons in Some Metals. I.—The Nature of Electrode Potentials of Zinc and Hydrogen and the Mechanism of Catalytic Action at Metal Surfaces (4). Mituru Sato (Sci. Rep. Tohoku Imp. Univ., 1937, [i], 25, (5), 829-870).—[In English.] See also Met. Abs., this vol., p. 133.—S. G.

*On the Energy States of Valency Electrons in Some Metals. I.—The Threshold Value of Overpotential of Hydrogen on Zinc Electrode (5). Mituru Sato (Sci. Rep. Tohoku Imp. Univ., 1937, [i], 25, (5), 871–878).—[In English.] See also Met. Abs., this vol., p. 133.—S. G.

*The Function of Gases in Metals. Albert Portevin, Georges Chaudron, and Léon Moreau (Compt. rend., 1937, 204, (17), 1252-1254).-See also Met. Abs., this vol., p. 277. Compared with annealed metals, electrodeposited metals are much harder, show a widening of the X-ray spectrum lines, and have lower conductivity. A method of gas extraction previously described (Met. Abs., 1935, 2, 704-705) enables these differences to be eliminated without appreciably increasing the temperatures of the metals, and was applied to a study of the variations of the conductivity and crystal parameter of iron after cold degassing, after annealing, and after electrolytic gassing with hydrogen. The results showed that the removal of the hydrogen altered neither the hardness, nor the parameter, nor sensibly the fineness of the lines. Annealing caused the lattice to contract and the lines to become very fine with considerable softening and without appreciable removal of gas. Thus, the presence of a sufficient amount of hydrogen is the initial, but not the immediate, cause of hardening. It is a sort of special cold-working of the metal by the hydrogen atoms. In the reverse process of charging Armco iron with hydrogen electrolytically, a diminution in the elongation was observed, confirming these results and, in particular, that the electrical resistivity can be increased by the temporary addition of hydrogen atoms in the same manner as by cold-working. Similar experiments with very pure aluminium showed that this last phenomenon is not peculiar to iron. When the amount of gas extracted by this method was not too great, the electrical conductivity was unaltered; in other cases, a slight volatilization of the metal was produced which caused an increase in the resistivity of the wire. This is being further investigated .- J. H. W.

*Impact- and Static-Torsion and Bending Diagrams of Fatigued Metals. Mititosi Itihara (Sci. Rep. Tohoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 1041-1049).—[In English.] Ono's uniform bending moment fatigue tester was used to produce fatigued specimens of a 0.2% C steel which were then tested in an impact torsion test machine of special design, and in static torsion by the Amsler machine; other specimens were fatigued in Mohr's repeated impact bending machine and subsequently tested in impact and static bending machines of special design. The impact values or the total deflection of the torsion or bending diagrams decrease, with fatigue, in stages, but the static values decrease linearly. The static test is the more reliable.—W. D. J.

*On the Fatigue of Metals and the Internal Friction. Yôichi Kidani (Sci. Rep. Tôhoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 1050-1055).--[In English.] Copper, and steels containing 0-1, 0-3, and 0-6% carbon are tested in fatigue under constant alternating torque. The curves obtained by plotting angular amplitude of torsion against number of repetitions are similar in each case, and show an initial decrease in the angular amplitude due to work-hardening, followed by a final increase before fracture. The theoretical expression $0^{-}N_{F} = \text{constant}$, where 0 is the amplitude of torsion in degrees and N_{F} is the number of repetitions to fracture, is confirmed experimentally. Measurements of the rate of damping of specimens after being tested in fatigue give results which are confirmatory. Fatigue in copper is accompanied by slip or twinning.—W. D. J.

*Shearing Phenomena at High Pressures, Particularly in Inorganic Compounds [Including Metals and Intermetallic Compounds]. P. W. Bridgman (Proc. Amer. Acad. Arts Sci., 1937, 71, (9), 387-459).—Cf. Met. Abs., 1936, 3, 2. Experiments are described in which mean hydrostatic pressures up to 50,000 kg./cm.2 combined with shearing stresses up to the plastic flow point were applied to thin discs of material confined between hardened steel parts so mounted that they could be subjected to normal pressure and torque simultaneously. Results are given for 50 metallic elements, and for the intermetallic compounds CaSi2, Cu5Sn, CuZn, Cu5Zn8, Cu5Cd8, AgZn, Ag5Zn8, AgCd, Ag5Cd8, SnSb, PbSe, PbTe. Data are given showing the shearing strength at different hydrostatic pressures, and the general nature of the distortion is noted. With the majority of the metals rotation took place smoothly, but with silicon and germanium grinding, snapping, or irregularities were observed. Both β and γ phases of the copper and silver alloys gave smooth rotation in spite of the brittle nature of the γ phases under ordinary conditions. In general, the shearing strength under high pressure is greater the higher the melting point of the metal, but barium and zirconium have lower shearing strength than would be expected from this rule. The paper contains much interesting information about polymorphic changes, chemical decomposition, detonation, and the general behaviour of matter under shearing stress at high pressures, but for this the original must be consulted .- W. H.-R.

*The Phenomenon of Creep Recovery. H. J. Tapsell (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 1-3).-[In English.] The creep recovery over a given period after removal of the stress is proportional to the original applied stress, and the estimated total recovery increases with the duration of the preceding creep test. This recovery may become a relatively large fraction of both the creep strain and the initial elastic strain if the initial stress is such that the creep strain is small. Preliminary experiments indicate that the rate of recovery increases considerably with increase in temperature. The experimental results are in accord with the hypothesis that the crystal grains of an aggregate show very variable resistance to the creep stress, so that deformation occurs more readily in the "weak grains," leaving the "strong grains" heavily stressed. When the external load is removed, the elastic contraction of the heavily stressed "strong grains" produces a reversed deformation of the "weak grains" resulting in creep recovery. An alternative hypothesis that creep recovery is due partly to an extra-clastic effect was not supported by experiments on a single crystal of aluminium which gave no evidence of creep recovery .--- P. W. R.

On Some Questions in the Study of Fatigue of Metals. Yukiti Asakawa and Shun Fudita (*Sci. Rep. Tõhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 1056–1059).—[In English.] The stress-repetition curve indicates only the stress below which complete breakdown will not occur in fatigue. At stresses less than the fatigue limit, considerable changes in impact strength and hardness occur and impact observations are considered to be a suitable means of recording the progress of fatigue. The equation $F = A\left\{1 - \left(\frac{B}{B+N}\right)^n\right\}$ is developed correlating F, the degree of fatigue, and N the number of repetitions, where A, B, and n are constants.—W. D. J.

The Mechanism of the Creep of Metals. C. L. Clark and A. E. White (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 3-4).—[In English.] Certain theories of the mechanism of creep are discussed and considered justified by their ability to account for the influence on creep of chemical composition, grain-size, heat-treatment, lowest temperature of recrystallization, and previous deformation.—P. W. R.

Creep of Metals. A. Nadai (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 4-6).—[In English.] The usefulness of the various formulæ which have been suggested to express the laws of creep in metals are very briefly discussed, and the experience gained in the Westinghouse Laboratories is briefly summarized, with particular reference to the extrapolation over long periods of short duration tests.—P. W. R.

Creep and Engineering Design. R. W. Bailey (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 15–17).—[In English.] A very brief survey of certain important aspects of the subject only.—P. W. R.

The Rate of Oxidation of Molten Metals. A. Krupkowski (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 38-39).—[In French.] Two groups of metals may be distinguished. (1) Lead and zine, which absorb very small quantities of oxygen. In these cases the film of oxide formed in the surface impedes further oxidation, and the rate of oxidation is expressed by

$$w^2 = Kt$$
 and $w = c\sqrt{tc}^{-\frac{1}{2KT}}$

where w is the amount of oxygen absorbed per unit surface, t the time, A the energy of activation, and K and c are coefficients. For the oxidation of lead in air (with formation of PbO) in the range $470^{\circ}-625^{\circ}$ C, c = 3.39 grm./cm.² minute⁴, A = 31,800 cal./mol. In the case of zine allowance must be made for the minute amount of oxygen absorbed by the metal, so that $(w - w_0)^2 = Kt$. For the oxidation of zine in air in the range $600^{\circ}-700^{\circ}$ C, c = 0.3 grm./cm.² minute⁴, A = 35,100 cal./mol. (2) In silver and copper the equations

$$w = Kt$$
 and $1/K = ae^{RT}$

apply almost to the limit of saturation in oxygen. For copper a = 0.03 cm.² minute/grm., A = 21,000 cal./mol. For oxidation of these metals in air allowance must be made for the protective effect of the nitrogen-rich layer at the surface of the metal, so that

$$1/K = ae^{\frac{A}{RT}} + bhe^{\frac{B}{RT}},$$

where h represents the thickness of this layer and b depends on the experimental conditions.—P. W. R.

*On the Change of Magnetic Susceptibility in Metals During Melting and Allotropic Transformation. Yosomatu Shimizu (Sci. Rep. Tohoku Imp. Univ., 1937, [i], 25, (5), 921-938).—[In English.] An accurate measurement was made of the abrupt change of magnetic susceptibility in metals during melting and allotropic transformation. An attempt is made to explain quantitatively these abrupt changes of susceptibility in metals caused by cold-working. As is well known, tin changes the sign of its magnetic susceptibility twice as the temperature increases, *i.e.* at the transformation point and also at the melting point. These phenomena are satisfactorily explained by the above-mentioned theory. Good agreement has also been found between the observed change of susceptibility during melting and its theoretical value in the cases of copper, silver, gold, aluminium, mercury, sodium, potassium, rubidium, and cæsium.—S. G.

Crystal Diamagnetism as a Group Phenomenon. Alexander Goetz (*Sci. Rep. Tóhoku Imp. Univ.*, 1936, [i], **Honda Anniv. Vol.**, 235–247).—[In German.] A general review is given of the characteristics of crystal diamagnetism, discussing in particular the negative temperature coeff. of susceptibility and its dependence on crystal size. The existence of a critical size of crystal is inferred from measurements of Rao and of Gregory on graphite, and this is extended to show the existence of units or groups of the order of 10^{-4} cm. in size in other crystals. The property of crystal diamagnetism is shown to support G.'s theory of group phenomena.—B. C.

Paramagnetism which is Independent of Temperature. G. Foëx (Sci. Rep. Tôhoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 259-270).—[In French.] The cases in which paramagnetism occurs are divided into (1) constant paramagnetism (*i.e.* independent of temperature); (2) ordinary paramagnetism; and (3) constant paramagnetism superposed on ordinary paramagnetism. An account is given of the theoretical work, which explains the phenomena with fair accuracy.—B. C.

*Absorption of Infra-Red Light in [Lead and Tin] Supraconductors. J. G. Daunt, T. C. Keeley, and K. Mendelssohn (*Phil. Mag.*, 1937, [vii], 23, (153), 264-271).—The absorption of infra-red light by lead and tin at very low temperatures was studied by a calorimetric method. No change in the absorption could be observed when the metal was transformed from the supraconductive into the normal state by the application of a magnetic field. —W. H.-R.

Modern Theory of Solids .-- I-III. Frederick Seitz and R. P. Johnson (J. Applied Physics, 1937, 8, (2), 84-97; (3), 186-199; (4), 246-259).-(I.--) Wellknown classical theories of the solid state are reviewed and the modern theory of wave mechanics is outlined. On the basis of the quantum concept, the valence electrons of a solid are said to occupy an energy spectrum composed of zones of energy levels, the distribution and population of which may be correlated with many observed differences in properties among various solids. (II.--) An explanation is given of the outstanding peculiarities among different types of solids, based on the zone theory outlined in (I). An arbitrary classification of solids is made, but the general theory can be made to apply to any solid intermediate between the classified types. A brief review is then given of the advancement made in the theory for interpreting certain structure-insensitive volume properties, with particular reference to diamond, graphite, and the noble metals. Interpretation of published data is rendered difficult, as the theory as yet applies only to a perfect lattice, i.e. a pure solid. The theory is still in its infancy and S. and J. stress the necessity for further theoretical and experimental work, so that the theory may become generally applicable. (III.—) The application of the "zone theory" to explain properties of the solid surface is dealt with. In many cases, close agreement is found with earlier views. The influence of impurities and flaws on certain volume characteristics is also discussed. Any impurity atom will break the regularity of the lattice and induce changes in the energy spectrum just as a surface induces changes. The mechanical properties of single crystals are unexplained as yet, by the zone theory, but theoretical views are outlined and discussed. Much of the current theory is purely speculative, and necessitates further investigation.-I. J.

On the Characteristics of Changes of Solid Phases. G. Borclius (Sci. Rep. Tohoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 129–135).—[In German.] Discusses, in terms of thermodynamics, the two types of phase changes that can occur in the solid state, *i.e.* the discontinuous, occurring at a definite temperature, and the continuous, occurring over a range of temperatures, and

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the transitional cases between them. Hysteresis in phase change is also considered in connection with these types of change.—B. C.

II.—**PROPERTIES OF ALLOYS**

(Continued from pp. 230-238.)

*X-Ray Study of a New Aviation Alloy Under Mechanical Stress. Ph. Theodorides (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 71-74; and Aluminium and Non-Ferrous Rev., 1937, 2, (7), 241-242).—[In English.] Wires of Avional Sk. (aluminium 93.43, copper 4.28, magnesium 0.85, manganese 0.62, silicon 0.33, iron 0.26, and chromium 0.23%) were examined by X-ray diffraction at different stages during static tensile tests from below the yield-point to the breaking point. Fracture by torsion and by alternating stress in endurance bending tests was also investigated. After stressing statically below the yield-point or cyclically below the fatigue limit, the interference lines of the face-centred cubic structure consist of a large number of discrete spots. Stressing above the yield-point produces a diffuse, continuous appearance of the lines of higher indeces which spreads with increasing stress to the (111) line even below the fracture stress. During the work-hardening of the metal there is therefore a tangential spreading of the constituents of each interference line, which suggests that a certain disturbance of the lattice structure must be attributed to the internal stresses associated with plastic deformation. Alternating bending stresses well below the fatigue limit produced no effect on the lines even after several millions of cycles .--- P. W. R.

*Contribution to the Study of Aluminium-Magnesium Foundry Alloys. Georges Chaudron (Bull. Assoc. Tech. Fonderie, 1936, 10, (12), 442-445).— The determination of solution potentials has been used as a means of evaluating the homogeneity of solid solutions of magnesium in aluminium. A 6% magnesium chill-cast alloy developed a solution potential of 0.80 v. decreasing to 0.75 v. on homogenizing and, similarly, a 10% alloy gave figures of 1-05 and 0.82 v., respectively. Local couples therefore develop an e.m.f. of more than 0.1 v. and homogenization is therefore a necessary operation to obviate dangerous corrosion. Homogenization has little effect on the mechanical properties of alloys containing less than 6.5% magnesium. —W. D. J.

*A Metallographic Study of the Action of the Cementing Materials for Cemented Tungsten Carbide (Outline of Equilibrium Diagrams of Co-W-C and Ni-W-C Systems). Shuzō Takeda (Sci. Rep. Tóhoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 864-881).—[In English.] The equilibrium diagrams of the cobalt-tungsten, cobalt-carbon, and cobalt-tungsten-carbon, nickeltungsten, and nickel-tungsten-carbon and iron-tungsten-carbon systems are considered, and from a study of these diagrams the mechanism of sintering of tungsten carbide sintered with cobalt is explained, and the reasons are deduced for the superiority of cobalt over nickel and iron for this purpose. The phases discussed in the cobalt-tungsten system are (i) γ , face-centred, cubic Co solid solution, (ii) ζ W solid solution, (iii) ε , intermetallic compound corresponding to CoW, (iv) Co₇W₂, hexagonal close-packed, forming solid solutions β with hexagonal cobalt. ε is formed at 1630° C. by the peritectic, melt (61% W) + $\zeta \rightleftharpoons$ CoW. The cutectic melt $\rightleftharpoons \gamma + \varepsilon$ is at 1465° C. and 45% tungsten. Co₇W₂ is formed by the peritection $\gamma(27\% W) + \varepsilon \rightleftharpoons Co_7W_2$ at 1065° C. The change $\gamma \longrightarrow \beta$ is lowered by 16% W on cooling to below room temperatures. In the cobalt-carbon system no compounds are formed. There is an eutectic melt (2.6% C) $\rightleftharpoons \gamma(0.8\% C) +$ graphite at 1315° C. The tungsten-carbon system contains the phases (i) ζ ,

W solid solution (ii) W,C forming solid solutions δ , and (iii) WC. The principal phase in the ternary system is n, formed peritectically from the ternary melt, and δ . η is analogous to Fe₃W₃C₃ in the iron-tungsten-carbon system, and has a wide range of solid solution; it is more unstable than Fe₃W₃C₃ and decomposes with the formation of WC on slow cooling. The reason for the importance of η in the WC-Co industrial alloys is that its composition range leads to its taking part in the metastable ternary eutectic reaction melt \longrightarrow γ + graphite + η , thus preventing the formation of graphite in these alloys by the stable ternary eutcetic reaction melt $\longrightarrow \gamma + \text{graphite} + \text{WC}$. The nickel-tungsten system includes the compound Ni₈W forming at 1506° C. and having two modifications, γ stable above 943° C. and β stable below 943° C. The eutectic melt $\rightleftharpoons \zeta + \gamma$ forms at 1493° C. (47.5% tungsten) and the γ phase decomposes into β and ζ by an eutectoid change at 920° C. (46% tungsten). The nickel-tungsten-carbon system includes a similar phase n. but the alloys on the Ni-WC line are situated within the composition range in which both the metastable and the stable ternary reactions occur. When WC particles are sintered with 6% cobalt as a binder at temperatures between 1350° and 1400° C., a melt is gradually formed by the passage of WC into solid solution in cobalt. At the commencement of melting this solid solution y contains about 1.5% WC and the binder is completely molten when it contains 19% WC. On moderate rates of cooling, the stable phase WC is reformed and not the n phase. The precipitated WC crystallizes on the existing WC particles as nuclei, leaving behind a binder of y containing 4% WC in solid solution at solidification, and 1% at room, temperatures. Thus, the binder in the finished alloys is practically pure cobalt. The disadvantage of nickel as a binder in these alloys is that the temperature of the ternary eutectic reactions are higher, nickel has a higher solubility for WC, and these alloys include the stable ternary cutectic reaction; consequently higher sintering temperatures are necessary leading to an undue decrease in the amount of WC and the appearance of graphite. Whilst the ternary cutectic in the iron-tungsten-carbon system occurs at a low temperature, which is favourable to the use of iron as a binder, nevertheless the crystallization takes place mainly in the metastable system, leading to an undue formation in the amount of binder (white cast iron) and too large a decrease in the amount of WC. Co-Mo and Co-W binders are also suitable for these alloys because of the low solubility of WC in them.-W. D. J.

*On the Equilibrium Diagrams of the Alloys of Copper. W. Broniewski (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 88-90).—[In French.] A summary of the recent work of B. and his collaborators on the systems copper-zine, copper-tin, and copper-manganese.

-P. W. R.

*On the Mechanism of Age-Hardening in Copper-Beryllium Alloys. Koi Kawamura (Sci. Rep. Tohoku Imp. Univ., 1936, [1], Honda Anniv. Vol., 702-712).—[In English.] Tempered quenched specimens of copper containing 2.1% beryllium were examined for hardness, electrical resistance, lattice constants, total and differential dilation, and microscopic structure. It is concluded that, with some modifications, the mechanism of age-hardening of these alloys is satisfactorily explained by the theory of Kokubo and Honda. —W. D. J.

A New Material for Bearings of All Types [Carobronze]. — (Machines, 1937, (April), 2-5).—Carobronze, a phosphor-bronze containing about 0.3% phosphorus, derives its satisfactory mechanical properties from its availability in the "worked and annealed" state. Graphical summaries show the coeff. of friction for roller and for ball bearings of this type at various speeds and loads. Structural details of Carobronze bearings are illustrated.

-P. M. C. R.

*The Influence of the Initial Structure and Mechanical Properties of Brass Sheet (Cu-Zn 33) on the Mechanical Properties, Structure, and Recrystallization after a Further Cold-Rolling. Władysław Łoskiewicz, Zdzisław Hayto, and Brunon Podczaski (Prace nad Mosiadzami, 1936, [A], 2, 1-124).-[In Polish, with French summary. The experimental results are readily available from collected tables and diagrams.] Brass sheet, after cold-rolling to various known degrees of reduction in thickness, was cut into convenient pieces and annealed for 6 hrs. at various temperatures between 200° and 750° C. The hardness, tensile strength, and elongation of each specimen were then measured, and the specimens subjected to a second cold-rolling in 5% stages up to 50% reduction in thickness. After each 5% reduction the mechanical properties of the specimens were remeasured. The mechanical properties of the sheet after the second rolling depend on the same properties before the treatment. To establish the relation between the properties in the two states it is necessary to know two of the three factors : (a) degree of rolling before the anneal. (b) temperature and duration of the anneal. (c) the mechanical properties after the anneal, and it is probable that even these factors are not completely sufficient. The divergence between the results of different workers may be explained as being due to the variable past histories of the testspecimens. The following relationships were established : (1) The hardness, tensile strength, and elongation tend with increase in the degree of secondary rolling to a limiting value, independent both of the degree of primary rolling and of the temperature of the anneal between the two cold-workings. The elongation reaches this limit below 50% reduction in thickness, but the hardness and tensile strength do not reach their limiting values until further reduction has occurred. (2) The increases in hardness and tensile strength and the decrease in the elongation resulting from the second cold-working undergo an abrupt change when the intermediate annealing temperature reaches the temperature of recrystallization; below this temperature the changes are smaller than they are above it. The values of the increase in tensile strength pass through a maximum after passing the recrystallization temperature and then diminish with increase in the temperature of the anneal, while the changes in hardness and elongation increase indefinitely. (3) For a definite degree of cold-working, the effect on the mechanical properties is greater the further removed the annealing temperature from the recrystallization temperature. If this temperature is sufficiently high for a complete reanneal, the effect of the second rolling is independent of the first and depends only on the temperature of the intermediate anneal. The influence of grain-size on the properties studied is treated in Chapters V and VI.--P. W. R.

From Magnetite to Magnetic Alloys. C. W. A. Pasewaldt (Automobilitech. Zeit., 1937, 40, (7), 170-177).—An historical account is given of the use and study of magnetic materials, and magnetization phenomena and their nomenclature are briefly discussed. The properties of several permanently magnetic materials and of alloys suitable for cores are discussed, tabulated or graphical summaries being given in many cases. Magnetic materials which are mainly non-ferrous include some types of Oerstit, Permalloy, Megaperm (nickel-manganese-iron), Koerzit, and the nickel-aluminium group investigated by Mishima.—P. M. C. R.

*Studies on the Widmanstätten Structure. VIII.—The Gamma-Alpha Transformation in Iron-Nickel Alloys. (Mehl and Derge). See p. 290.

The Alloys of Iron and Zinc. W. D. Jones (Metallurgist (Suppt. to Engineer), 1937, 11, 3-5).—A discussion of recent work and of the conflicting results which have been obtained.—R. G.

Rates of Diffusion in Solid Alloys. Robert F. Mehl (J. Applied Physics, 1937, 8, (3), 174-185).—A review of data on solid diffusion in alloys, with

particular reference to binary systems and single-phase solid solutions. Apart from the effect of the chemical or electrovalent factor on the rate of diffusion, little by way of generalization has been observed. There appears to be a lack of correlation between melting points and rates of diffusion, but the rate of self-diffusion is shown to be inversely related to the melting point. In isomorphous systems, the rate of diffusion is more rapid in the lower melting point alloys. Generally, there is a lack of information concerning the variation in the rate of diffusion with concentration, but data are given illustrating its importance on the age-hardening properties of some copperaluminium alloys. Useful information is given of the rates of diffusion in lead alloys and those of the noble metals. 22 references are given.—I. J.

*Shearing Phenomena at High Pressures, Particularly in Inorganic Compounds [Including Metals and Intermetallic Compounds]. (Bridgman.) See p. 280.

The Solidification of Ingots. Cecil H. Desch (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 99-101).—[In English.] A summary of present knowledge.—P. W. R.

Transformations in Metals and Their Uses. Paul D. Merica (*Sci. Rep. Tóhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 636-651).—[In English.] The various types of transformations that occur in the solid metallic state are classified, and their industrial importance reviewed. Age-hardening in aluminium, copper, gold, silver, lead, iron, and nickel alloys is discussed, and it is suggested that the older simple theory of age-hardening may still adequately explain age-hardening processes.—W. D. J.

Theoretical Points of View on Age-Hardening. Carl Benedicks (Sci. Rep. Töhoku Imp. Univ., 1936, [i], Honda Anniv. Vol., 686-693).—[In English.] In a quenched solid solution no crystal nuclei need be present, but on ageing at a given temperature they are formed. It is considered that, once crystal nuclei have formed, a considerably stronger effective super-saturation exists than before; this manifests itself in increased hardness and electrical resistance. The influence of crystal nuclei in this manner will be more marked if the solubility is further reduced by the addition of more than two components.

-Ŵ. D. J.

Progress of Knowledge on Slag Inclusions. Helge Lofquist (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 95-99).... [In English.] A review of recent progress, with a full bibliography of some 200 references....P. W. R.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 238-242.)

Progress in Microscopy. Francis F. Lucas (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 60-61).—[In English.] A very brief resume of advances since 1931, with a brief note on the application of the very highest magnifications to the study of fatigue phenomena. Failure of a metal part subjected to reversed cycles of stress is governed by "internal stress raisers" as well as by the well-known "external stress raisers." Photomicrographs at extremely high magnifications (× 4000) of an iron casting which had been subjected to heavy reversed cycles of stress show fatigue eracks originating at the sharp tips of graphitic flakes or at notches in their walls.—P. W. R.

*The Value of the Microscopic Method for Studying the Structure of Electrodeposits. Pierre Jacquet (Compt. rend., 1937, 204, (18), 1320-1322).—Cf. Met. Abs., this vol., p. 188. According to G. L. Finch and A. L. Williams

(Met. Abs., this vol., p. 189), electrodeposits cannot be completely studied by microexamination. This view is contested by D. J. Macnaughtan and A. W. Hothersall (Met. Ind. (Lond.), 1937, 50, 468). Under suitable conditions, however, microexamination of the surface will show small variations of the structure of the deposits, and will further permit the total exploration of the cathode, which cannot be effectively done by electron diffraction. (1) When the thin deposit represents in all its details the internal structure of each of the crystals of support after polishing and anodic attack, the crystal continuity is perfect. (2) Copper, silver, and cadmium in evanide solutions and nickel in a sulphate solution, with current densities corresponding to a considerable evolution of hydrogen ions, never reproduce this internal structure; but with very thin deposits, the conservation of the general form of the grains is sometimes observable. (3) Copper (in cyanide solution) and nickel (in sulphate solution) deposited with a very weak discharge of hydrogen ions partly reproduce the internal structure of certain crystals of the cathode. (4) Whatever the current density, the copper and the nickel never reproduce the internal structure of the crystals of support if, during electrolysis, the

cathode has been removed many times from the solution.—J. H. W. The Electrolytic Polishing of Certain Metals and Its Applications. P. Jacquet (Bull. Soc. franç. Elect., 1937, [v], 7, (75), 323-324).—Discussion. See Met. Abs., 1936, 3, 202.—R. T.

The Preparation of Specimens for Macro- and Micro-Examination. W. H. Dearden (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 56-58; and Aluminium and Non-Ferrous Rev., 1937, 2, (7), 243).—[In English.] A report on the progress during the period 1931-1935, with a bibliography of 71 references.—P. W. R.

*Very Finely Divided Non-Metallic Inclusions, and the Action of Kindred and Foreign Nuclei. Roland Mitsche (Carnegie Schol. Mem. Iron Steel Inst., 1936, 25, 41-62).—M. discusses the effect of non-metallic inclusions on the properties of metals, with particular reference to cast-iron, steel, aluminium, and Silumin. A distinction is drawn between microscopic and sub-microscopic particles ("slag-clouds"), and means of identification of the latter are given. A "general theory of nuclei and clouds" is submitted. Transformation processes are explained by the combined effect of "kindred" and "foreign" nuclei, both of which must obey definite conditions to be operative, e.g. state of division, stability, &c. The effect of clouds is not specific. The influence of clouds and of their composition on the grain-size of steel is discussed, and the efficiency of deoxidizers is related to their ability to form clouds of this kind. The controlled flotation of non-metallic inclusions in metallic melts may be desirable when their elimination is difficult.—I. J.

The Beilby Layer. G. I. Finch (Sci. Progress, 1937, 31, (124), 609-625).-A general account is given of the nature of polished surfaces. There is an interesting historical introduction mentioning the improvements in the production of polish made by Newton and others. The conception of the polish layer as being the result of a flowing of the material, even in the cases of brittle materials, is due to Beilby, and the more important properties of this layer are considered. The application of electron diffraction methods to the study of polished surfaces has given rise to results of the utmost theoretical and practical importance, e.g. the recent work by G. I. Finch and his collaborators. The experiments dealing with the question of whether the layer is really amorphous or crystalline show that both types actually occur. In crystals such as calcite, recrystallization of the amorphous layer can take place, and this is most easily accomplished if the polished surface is a cleavage plane. The diffuse haloes obtained by Germer with some silicon carbide crystals have been shown to be due to a coating of amorphous silica formed by chemical action during the production of the carbide. Finally the importance of the nature of the surface films on such things as pistons made of aluminium alloys is discussed and alternative alloys producing less wear are suggested.—N. S.

*A New Phenomenon Observed in Cells One of Whose Electrodes is Polished. The Function of the Beilby Layer. Albert Grumbach and Félix Taboury (Compt. rend., 1937, 204, (16), 1178-1179).—(Cf. Compt. rend., 1931, 193, 1178 and 1932, 194, 84.) The asymmetry shown by elements whose electrodes are made of metals unaltered by the electrolyte was investigated. To obtain small and well-defined metallic surfaces, platinum wires soldered in glass were used, the sections being carefully polished. Electrometric experiments had shown that an electrode consisting of a small surface of polished gold or platinum has the effect of a condenser shunted by a large resistance. Cast gold has not this property. Every precaution was taken against the presence of oily material on the metal. The effect has been observed in different mineral and organic electrolytes. An asymmetry was always observed. It is clear that a relation exists between this phenomenon and the Beilby layer formed at the surface of a metal by polishing. There are no longer crystal boundaries and the atoms are distributed like those of a liquid. A current does not flow until a certain difference of potential is attained. Beyond this point, the anomaly disappears, but it is natural to attribute its origin to the particular state of the metallic surface .-- J. H. W.

*The Dynamical Theory of Electron Diffraction and Its Application to Some Surface Problems. J. W. Harding (*Phil. Mag.*, 1937, [vii], 23, (153), 271– 294).—Theoretical. A theory of electron diffraction based on that of Darwin (*Phil. Mag.*, 1914, [vi], 27, 315, 675; 1922, [vi], 43, 300) is developed, and Darwin's equations are generalized to allow for an arbitrary arrangement of planes near the crystal surface. The effect of a few planes with contracted spacing in the surface layer is discussed.—W. H.-R.

[†]The Study of Metal Films and Surfaces by Electron Diffraction. G. I. Finch (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 77-80).—[In English.] A brief, but very comprehensive, review of the subject.—P. W. R.

*Electron Interference in the Study of the Oxidation of Crystal Surfaces. G. Aminoff (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 80–82).—[In English.] Examination by electron diffraction of the oxide film formed by heating single crystals of zine blende shows a parallel orientation of the ZnO structure in the film. The orientation of the ZnO in relation to the underlying ZnS-structure is crystallographically determined, the C-axis of the hexagonal ZnO being parallel to a trigonal axis in ZnS and the α -axis of ZnO parallel to a tetrahedron edge in ZnS. Other oxidized single crystals, such as MoS₂, PbS, FeCO₃, &c., show effects similar to ZnS.

-P. W. R.

Electron-Optical Observation of Metal Surfaces. W. G. Burgers (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 82–84).— [In English.] A brief survey of the principles and possibilities of the method. —P. W. R.

*Principles of the Formation of Metals by Reactions in the Gaseous Phase. Experiments on the Reduction of Copper Halides by Hydrogen. Kurt Huber (Z. Krist., 1937, 96, (4), 287-310).—[In German.] Cuprous and cupric halides were reduced by hydrogen in a heated tube under different conditions, and the nature of the deposited copper was studied. Dendritic crystals of different kinds were obtained, as well as mirror deposits, and a fine hair-like (*Haar*kupfer) modification. Simple considerations of surface tension are insufficient to account for the production of crystals with round instead of plane faces. The form of the crystalline deposit is determined by the resultant action of a large number of factors, which are discussed.—W. H.-R. Quantitative Metallographic X-Ray Technique. A. J. Bradley (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 66-67).— [In English.] A brief account is given of the methods employed by B. and his collaborators for obtaining accurate lattice spacings. Some surprising results in certain systems are noted, such as the variation of lattice spacing of an alloy according to its previous heat-treatment, even when the composition remains the same. It is pointed out that such phenomena constitute an additional source of error in the X-ray method for determining phase boundaries. Some recent improvements in the measurement of X-ray intensities from powder photographs are also described.—P. W. R.

Characteristics of the Deformation and Fracture of Metals as Revealed by X-Rays. H. J. Gough (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 69–71).—[In English.] G. briefly summarizes the results of his systematic X-ray study of the changes produced in the crystalline structure of metallic single crystals and aggregates under various stressing actions and at various stages of these actions.—P. W. R. *The Crystal Structures of Cr_2Al and Cr_5Al_8 . A. J. Bradley and S. S. Lu (Z.

Krist., 1937, 96, (1), 20-37).-[In English.] The structures of the chromiumaluminium phases based on the compositions Cr. Al and Cr. Al, were determined from powder photographs. At high temperatures the body-centred cubic solid solution of aluminium in chromium extends from 0 to 30 weight-% aluminium, i.e. well beyond the composition Cr,Al, but on slow cooling at approximately 850° C., alloys containing about 25 weight-% aluminium change from the body-centred cubic α phase to a tetragonal β phase. The change is essentially an ordering process in which a superlattice is formed by stacking 3 bodycentred cubes one above the other so that two planes of chromium atoms alternate with one of aluminium. The space group is D_{4h}^{17} (14/mmm), and the dimensions of the unit cell are a = 2.9984 Å., c = 8.6303 Å., c/a = 2.878. The composition range of the B phase does not include the ideal composition Cr₂Al even after the most favourable heat-treatment. After slow cooling the phase range is considerable but there is always an excess of aluminium; this behaviour compares with that of the 0 phase (CuAl₂) of the copper-aluminium system where the structure is based on CuAl₂, but homogeneity is only found with excess of aluminium. The structure of Cr5Als somewhat resembles that of y-brass. There are the same clusters of 26 atoms grouped round points corresponding with cube corners and cube centres, but the cube is slightly distorted by clongation in the direction of a trigonal axis, and the symmetry is no longer cubic but rhombohedral. The space group is C_{**}^5 (R3m), and the lattice dimensions are a = 9.0327 A., $\alpha = 89^{\circ}$ 16.4'. The atomic positions of Cu₅Zn₆ and Cr₅Al₆ are very similar, but the distribution of aluminium and chromium atoms is quite different from that of copper and zinc, and the two are compared.-W. H.-R.

*X-Ray Investigation of the Lattice Distortion in Deformed Gold. W. Boas (Z. Krist., 1937, 96, (2/3), 214-224).—[In German.] The relative intensities of the lines of Debye-Scherrer X-ray diffraction patterns from gold filings before and after annealing were measured and compared. The results do not agree with the assumption that a statistical irregular displacement of the atoms from their mean position takes place on deformation. The broadening of the 422 line was also measured, and indicated an internal elastic stress of about 26 kg./mm.² in the worked filings. The bearing of these results on the mechanism of plastic deformation is discussed.—W. H.-R.

*The Space Lattice of Hg_5Tl_2 . E. Osswald and F. Sauerwald (*Sci. Rep. Tôhoku Imp. Univ.*, 1936, [i], Honda Anniv. Vol., 931-932).—[In German.] Debye photographs indicate a cubic face-centred lattice for Hg_5Tl_2 having a parameter of 4.67 A. No influence of a change point between 8° and 13.6° C. on the structure in lead-containing material was demonstrated.—W. D. J.

*Studies on the Widmanstatten Structure. VIII.-The Gamma-Alpha Transformation in Iron-Nickel Alloys. Robert F. Mehl and Gerhard Derge (Metals Technology, 1937, 4, (3), 15 pp.; A.I.M.M.E. Tech. Publ. No. 797) .-The relative orientations of the α and γ phases in Widmanstatten structures were investigated by X-ray methods for a metcorite containing 7% nickel, and for iron-nickel alloys containing from 27 to 34% nickel. When the trans-formation occurs above room temperature, the orientations can be described by the relation of Kurdjumow and Sachs (Z. Physik, 1930, 64, 325): (111) $\gamma //$ (110) α , and [110] γ // [111] α . In alloys containing from 28.5 to 34% nickel, in which the transformation has taken place at -190° C., the orientations are described by the relationship of Nishiyama (Sci. Rep. Tohoku Imp. Univ., 1934, 23, 637): (111) $\gamma //$ (110) α , and [211] $\gamma //$ [110] α . At intermediate temperatures the orientations range between the two, and the general conclusion is that the mechanism of K. and S. operates at high, and that of N. at low temperatures. This may be connected with the fact that the shear required by the mechanism of K. and S. is in the direction of easy slip, whilst the shear required by the mechanism of N. is that for twinning, and slip may be expected at high temperatures .--- W. H.-R.

*The Vibrations of a Face-Centred Cubic Lattice. C. Strachan (Phil. Mag., 1937, [vii], 23, (155), 590-597).—Theoretical.—W. H.-R.

*On the Scattering of Fast Electrons by Thin Material [Metal] Foils. Hikoo Sacgusa and Keiji Kikuchi (*Sci. Rep. Tóhoku Imp. Univ.*, 1937, [i], 25, (5), 817-828).—[In English.] The total angular distribution of the electrons scattered by some metallic foils (gold, platinum, silver, and nickel) was investigated. A study was also made of the velocity distribution of electrons scattered by gold and aluminium at an angle of 45°.—S. G.

*Crystal Polymorphism. M. J. Buerger and M. C. Bloom (Z. Krist., 1937, 96, (2/3), 182-200).—[In English.] The development of the concept of polymorphism is described, and the influence of the points of view of the chemist and crystallographer, and their adaptation to the results of thermodynamics and X-ray crystallography are indicated. The subject is further developed by considering the possible vibrational modes. For any given compound there is an infinite number of conceivable structures, each with its own potential energy of configuration. For static arrangements under negligible pressures, only one modification is stable—that with the lowest configuration energy. When temperature is taken into account, the most stable arrangement need not be that with the least configuration energy compatible with the ability to accommodate the thermal vibrations at that temperature.—W. H.-R.

IV.—CORROSION

(Continued from pp. 243-245.)

*The Corrosion of Beryllium Bronzes. Haldun N. Terem (Compt. rend., 1937, 204, (19), 1426–1428).—The corrosion of cast bronzes containing 0.5-10%of beryllium was studied by loss in weight and the examination of the surfaces after exposure by Thyssen and Bourdouxhe's method (*Rev. Univ. Mines*, 1928, [vii], 19, 63) to 1-10\% solutions of hydrochloric, sulphuric, nitric and acetic acids, sodium hydroxide, and ammonia. The results showed that: (1) The alloys are most resistant to the action of hydrochloric and acetic acids; an increase in the beryllium content has little effect. (2) Sulphuric acid has an appreciable attack with an oxidizing action but less so at higher beryllium contents. (3) The resistance to the attack of nitric acid is of the same order as that of copper, up to 2% beryllium, but diminishes enormously above 50%. (4) The resistance to caustic soda is about the same as that to sulphuric acid; oxidation and blackening of the specimens occurs. (5) The attack by ammonia is appreciable, but appears to diminish with increase in the beryllium content. (6) The alloys studied have good resistance to the action of artificial sea-water; they practically keep their polish, but small pinholes appear on the surface of the 10% alloy.—J. H. W.

*The Rate of Dissolution of Magnesium in Acids. Cecil V. King and William H. Cathcart (J. Amer. Chem. Soc., 1937, 59, (1), 63-67).—A comparison of diffusion coefficients of acids (alone and containing salts) with the constants of dissolution rate of magnesium showed that there was satisfactory correlation. It is necessary to modify the Nernst theory in that the evidence points to the probability that solution is controlled by rate of convection movement and of diffusion of the acid.—R. G.

*Methods of Testing the Corrosion of Unprotected Magnesium and Ultra-Light Alloys. Jean Cournot and (Mlle.) Louise Halm (Compt. rend., 1937, 204, (18), 1333-1334).-Under the direction of the Commission française de la Corrosion de l'Aéronautique, general tests of corrosion were studied for use with magnesium and ultra-light alloys, for which the usual laboratory attack is too severe. The methods tried were : total immersion, alternate immersion and removal, and mist; the measurements were the volume of gas evolved, the rise in temperature, the rate of initial attack, the diminution in the mechanical properties, and the loss in weight in the first case, and the last two measurements in the others. Great attention was given to the preparation of the surfaces. The two methods eventually adopted were: (1) Alternate immersion and removal; 30-minute periods with very dilute salt solution. Standard artificial sea-water was too active. From many solutions tried, a solution of 0.3% pure sodium chloride in distilled water was selected. The specimens consisted of 99.8% magnesium, cast magnesium alloys containing 0.4% manganese with 6, 4, 3, and 10% aluminium and 3, 3, 1, and 0% zinc, respectively, and rolled alloys containing 1.8% manganese, and 6 aluminium, 1 zinc, 0.4% manganese. The final weights were taken after pickling in an aqueous chromate solution. The attack was found to be regular, the variation in weight as a function of the time being virtually linear. (2) Total immersion, adopted to measure exactly the variation of the evolution of gas by pure magnesium with time. After an initial rapid attack, the evolution varied linearly with the time up to a certain limit of time and then slowed down.

-J. H. W.

The Reactivity of Zinc Amalgams. Herman A. Liebhafsky (J. Amer. Chem. Soc., 1937, 59, (3), 452-458).—Concentrated zine amalgams appear inert and dilute amalgams unstable. The oxidation process of amalgams is not understood. The experimental facts for zine amalgams show that, when concentrated, they only appear inert because the amount of zine which disappears is proportionately small. In the cleaning of mercury, the removal of zine by oxidation becomes easier as the concentration decreases.—R. G.

Corrosion Problems in Waterworks. J. Friedli (Schweiz. Verein Gas u. Wasserfach. Monats., 1937, 17, (1), 14-19; (2), 25-35).—The principal causes of corrosion in waterworks plant are reviewed. A final section, which deals with the internal corrosion of water-pipes, contains tabulated data regarding the stability of copper in stationary and flowing water of different types, and containing varying proportions of air or earbon dioxide. The influence of temperature on the corrosion of copper is discussed, as are the respective liabilities of tin, zinc, aluminium, and galvanized iron to corrosive attack.

-P. M. C. R.

[†]Corrosion as Influenced by Increased Temperature. U. R. Evans (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 34-35). [In English.] A short review of present knowledge of the effect of increased temperature on corrosion due to oxidation, condensed moisture, immersion in solutions, &c.—P. W. R. The Chemical Properties and Stability of Metals at High Temperatures. C. H. M. Jenkins (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 36-37).—[In English.] The factors determining the properties of metals at high temperatures are very briefly discussed.—P. W. R.

Regarding the Factors Influencing Corrosion at Increased Temperature. Carl Benedicks (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 40-41).—[In English.] An example of the hot-wall effect in promoting corrosion of boiler-tubes at local high-temperature regions is recorded, and the further influence of temperature on the electrolytic potential of metals, and therefore on corrosion, is discussed. If any point of a metal surface submerged in an electrolyte is at a higher temperature than the rest, electrolytic corrosion will occur, attacking the hotter metal.—P. W. R.

†Some Aspects of Metallic Corrosion. U. R. Evans (*Trans. Inst. Eng. Ship. Scotland*, 1937, **80**, (6), 276–300; discussion, 300–313; and (summary) *Machinery Market*, **1937**, (1902), 25–26; (1903), 21–23).—The aspects of metallic corrosion considered are direct oxidation, wet corrosion, electrochemical action, the production of oxide films, the effect of mill scale on corrosion intensity, and the influence of composition on corrosion. Special consideration is given to the corrosion of non-ferrous metals, when subjected to certain corroding media, and under certain conditions. Consideration is also given to the protection of ferrous metals by non-ferrous coatings applied by such processes as electroplating, hot-dipping, cementation, cladding, and spraying.—J. W. D.

Mechanism of the Corrosion of Metals. E. C. Rollason (Welder, 1937, 9, (39), 53-58, 61).—The electrolytic theory of corrosion is outlined and the influence of oxide films explained with typical examples of corrosion by natural waters, acids, and the atmosphere. The protection of steel by coatings of zinc, tin, lead, aluminium, and paints is briefly discussed.—H. H.

V.—**PROTECTION**

(Continued from pp. 245-247.)

*Measurement of the Hardness of Aluminium Oxide Films. André Hache (Bull. Assoc. Tech. Fonderie, 1936, 10, (12), 448-451).—The resistance to penetration and to wear of aluminium oxide films is measured by means of a tungsten carbide point in circuit with the test-piece and an indicating lamp. The resistance to penetration is influenced by the hardness of the basis metal and depends upon the energy in coulombs expended in anodizing. Wear resistance is independent of the basis metal hardness but is influenced by the compactness of the film which is governed by the homogeneity of the base. Accuracies within 10-15% are recorded on aluminium and aluminium-copper alloys.—W. D. J.

Rolls Used in Sheet Galvanizing. J. A. Succop (Amer. Zinc Inst. [Preprint], 1937, (April), 17 pp.).—Rolls are usually made of ingot iron or low to medium carbon basic steel. Phosphorus and sulphur should be at a minimum, silicon below 0.05%, and nickel and chromium absent. In general, low carbon steels are recommended for exit rolls, and medium carbon for bottom rolls. Failures are due to cracking or scaling of the protective layer of FeZn₇, which may be caused in numerous ways; commonly, by fatigue resulting from the deflection of the roll, and excessive temperature. It is recommended *inter alia*, that (1) the machining should provide a radius at the bottom of the grooves, (2) the roll should be preheated before installation, (3) exit rolls should be kept revolving during a shut-down, (4) after removal rolls should be uniformly cooled, (5) an inhibitor be used in pickling.—H. H.

Fluxes [in Galvanizing]. A. T. Baldwin (Amer. Zinc Inst. [Preprint], 1937, (Apr.), 13 pp.).—The use of the hydrochloric acid-sal ammoniac flux is regarded as the line of least resistance to overcome pickling and rinsing difficulties, and evidence is presented of the advantages to be gained by using zine ammonium chloride. It is emphasized that improvements in pickling, rinsing, and storage practice which are necessary for using zine ammonium chloride would themselves lead to a better product. The bad effects of increasing ferrous sulphate content in the pickle, and of chloride in the hydrochloric acid flux wash are discussed. Rinsing and scrubbing in running water, after the pickle, and the use of a zine ammonium chloride flux wash are recommended.—H. W. G. H.

Corrosion-Protection for Water Pipes. A. Violet (*Metallwirtschaft*, 1936, 15, (48), 1129–1130).—The use of tar and bitumen mixtures for protecting underground water pipes from corrosion by soil acids, water, and gases is briefly discussed chiefly with reference to iron pipes.—A. R. P.

VI.—ELECTRODEPOSITION

(Continued from pp. 247-251.)

Chromium Plating of Steel. I. Bogorad (Novosti Tekhniki (Tech. News), 1936, (50), 17–18; C. Abs., 1937, 31, 2522).—[In Russian.] An experimental investigation showed that chromium is firmly deposited on steel and that the destruction of the chromium surface under mechanical action is due to insufficient resistance of the chromium layer to a dynamic action, which is accompanied by a deformation of metal, but is not due to a loose chromium deposit on the steel.—S. G.

Control of Chromic Acid Mists from Plating Tanks. Edward C. Riley and F. H. Goldman (U.S. Public Health Rep., 1937, 52, 172-174; C. Abs., 1937, 31, 2521).—In large rooms with good general ventilation, the atmosphere near chromium plating tanks may contain concentrations of chromic acid greater than 1 mg. per 10 c.c., which has been taken as the safe limit. With a crossdraught local-exhaust system it is possible to keep the concentration down to less than this limit. The authors recommend for the standard type of plating tank, a cross-draught exhaust system satisfying the equation Q = $100 L \times W$. Previous recommendations by Bloomfield and Bloom (U.S. Public Health Rep., 1928, 43, 2330) are confirmed and again emphasized.—S. G.

Electrodeposition of Lead-Tin Alloys. P. P. Beliaev and Ya. N. Birman (Novosti Tekhniki (Tech. News), 1936, (42/43), 21; C. Abs., 1937, 31, 2935).---[In Russian.] A substitution of the tin underlayer in the steel body of bearings with a 50% lead-tin alloy, electrodeposited, improves the bearings. Electrolytic solutions can be used, of the composition: (1) 0.5N-PbSiF₆, 0.3N-SnSiF₆, 0.25N-H₂SiF₆, 0.5% H₃BO₃, and 1 grm./litre of glue; and (2) 0.5N-(C₆H₄(OH)SO₃)₂Pb, 0.3N-(C₆H₄(OH)SO₃)₂Sn, 0.25N-C₆H₄(OH)SO₃H, and 1.5 grm./litre of glue. The anode consists of lead 50 and tin 50%. The deposition was performed with a current density of 1.5-2 amp./in.², at room temperature, and a duration of 16 minutes. Before being covered with Babbitt, the layer was heated to 180° -200° C. and wetted with a flux consisting of a solution of 5% hydrochloric acid and 15% zinc chloride.-S. G.

Influence of Impurities in Nickel-Plating Baths. J. Salauze (Galvano, 1936, (56), 16-23).—The effects of copper, zinc, iron, chromic acid, hydrogen peroxide, and organic matter on the behaviour of nickel-plating baths are described and methods of overcoming them discussed with reference to recent articles in the literature.—A. R. P.

*Magnetic Method for Measuring the Thickness of Nickel Coatings on Non-Magnetic Base Metals. Abner Brenner (J. Research Nat. Bur. Stand., 1937, 18, (5), 565-583; and Research Paper No. 994).—The local thickness of an

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electroplated nickel coating on a non-magnetic base metal may be measured by the force of attraction of a small permanent magnet, the attractive force being determined with a simple spring balance. It was found that the attractive force between the magnet and coating is proportional to the thickness of the coating. The instrument is calibrated with nickel coatings of known thickness which have been deposited under about the same conditions as the coatings to be tested. Nickel coatings deposited under different conditions have somewhat different magnetic properties, which become uniform by heating the samples to 400° C. Specimens of unknown history should be annealed before testing. Measurements on coatings as deposited are correct within $\pm 15\%$, and on annealed coatings within $\pm 10\%$. The effect on magnetic measurements of factors such as curvature of surface, type of base metal, and superposed chromium coatings is discussed. The magnetic method was shown to be applicable to the testing of nickel-plated brass plumbing fixtures.—S. G.

*Metals Codeposited with Tungsten from the Alkaline Tungsten Plating Bath. M. L. Holt (*Electrochem. Soc. Preprint*, 1937, (April), 365-373).— See also Met. Abs., 1934, 1, 507). Alkaline tungsten plating baths gave no weighable deposits when specially purified materials were used. Traces of certain metal salts added to the electrolyte acted as depolarizers and codeposited with tungsten at the cathode. Various compounds of iron, with the exception of potassium ferri- and ferrocyanides, were found to be the most effective additives; nickel, cobalt, tin, and cadmium also codeposit with tungsten. Tungsten does not deposit on pure tungsten even in the presence of a depolarizer. H. is of the opinion that an entirely new approach is necessary for a successful solution of the tungsten plating problem.—C. E. R.

Continuous Deposition of Strip. Advantages of an Endless Cathode. — (Met. Ind. (Lond.), 1937, 50, (19), 542).—Describes a process developed by Heinrich Hampel, in which an endless cathode belt is used.—H. W. G. H.

Electro-Deposition. — (Metallurgist (Suppt. to Engineer), 1937, 11, 1-2).—A broad review of development referring to the International Conference of March, 1937, in London.—R. G.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from p. 251.)

*The Passivity of Chromium. Erich Müller and V. Čupr (Z. Elektrochem., 1937, 43, (1), 42-52).—Continues the discussion of the passivity of chromium (see Met. Abs., 1936, 3, 237). The apparatus and method used to determine the magnitude of the activating and passivating potentials in the activation of passive chromium by cathodic polarization and the passivation of active chromium by anodic polarization are described.—J. H. W.

*On the Anodic Potential of Chromium in Wave Current Electrolysis.—II. A. Geldbach and M. Schlötter (Z. Elektrochem., 1937, 43, (2), 91-103).—See Met. Abs., this vol., p. 53. The anodic potential of thermit chromium in relation to the direct current component, I_{g} , and the alternating current component, I_{W} , of a wave current of variable frequency in N-sulphuric acid and N-hydrochloric acid was measured. At constant I_{g} , the alternating current strength, I_{W} , required for activation increases with the frequency. The $e-I_{W}$ curves can be divided into 3 sub-groups, for which purpose the measured "critical instantaneous current strength," I_{kr} in anodic direct current polarization, is the decisive factor. The experimental results explain the shape of these curves, but leave important details, especially the frequency relationship, unexplained. The results can be satisfactorily interpreted by a consideration of the reaction velocity differences. The instantaneous current strength of the wave current does not follow the indicated instantaneous potential of the direct current-potential curve, but forms e-I loops, whose shape varies according to the composition and frequency of the wave current and the kind of electrolyte. Their form was shown by further alternating and wave current measurements, which indicated the determining character of I'_{kr} . —-I. H. W.

The Electrolytic Zinc Industry of Tasmania. H. P. Tuck (Electrotechnics, 1936, 9, 115-120).—S. G.

IX.—ANALYSIS

(Continued from pp. 253-254.)

*Methodical Notes on Quantitative Spectrographic Analysis. Heinrich Kaiser (*Metallwirtschaft*, 1937, 16, (13), 301-306).—The mean accuracy of results obtained by spectrographic analysis varies between 1 and 5%, according to the method used and provided that several exposures are made. Examples are given in the determination of Mg in Silumin.—v. G.

Micro-Analysis in the Chemical Laboratories. — (Bell Lab. Record, 1937, 15, (7), 232-233).—A very brief outline of the technique of microanalysis employed by the laboratories of the Bell Telephone Co. for detecting the presence of Au and Ag in electrical contacts of switches.—E. V. W.

*Systematic and Accurate Chemical Analysis of Aluminium and Its Light Alloys. E. Azzarello, A. Accardo, and F. Abramo (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 109-111; and Aluminium and Non-Ferrous Rev., 1937, 2, (6), 210-211).—[In English.] Two methods of analysis are given which, taken together, permit the accurate and systematic determination of Ag, Bi, Ca, Cd, Ce, Co, Cu, Fe, Mg, Mn, Ni, Pb, Sb, Si, Sn, Ti, Zn, Zr, and the routine determination of W in all known types of Al materials (except those containing Mo), in which Al itself is the chief constituent.—P. W. R.

Tannic Acid in Analysis. C. Franklin Miller (*Chemist-Analyst*, 1937, 26, (2), 38-39).—The reactions of tannin with Ti, Fe, Cb, Ta, Ag, Au, U, Hg, V, Mo, and W are described.—A. Ř. P.

*The Separation of Gallium and Its Colorimetric Determination by Means of Quinalizarin. H. H. Willard and H. C. Fogg (J. Amer. Chem. Soc., 1937, 59, (1), 40-45).—Ga gives a pink-coloured lake with quinalizarin, when in a solution normal in NH_4 : $C_2H_3O_2$, 0.5N in NH_4 Cl, of p_H 5.0 and containing 0.5 grm. NaCl per litre. With these conditions 0.02 mg, of Ga can be distinguished. The method is interfered with by other metals, notably Fe and Al; methods have been developed for removing them, except V and Mo.—R. G.

methods have been developed for removing them, except V and Mo.—R. G. *A Contribution to the Chemistry of Rhenium. G. E. F. Lundell and H. B. Knowles (J. Research Nat. Bur. Stand., 1937, 18, (5), 629–637; and Research Paper No. 999).—A study of the behaviour of Re when dilute solutions of KReO₄ are acidified with H_2SO_4 , cooled and passed through the Jones' reductor, indicates that Re forms a compound in which it has a valency of — 1, and that the Re in this compound is oxidized to a valency of + 1 if the diluted H_2SO_4 solution is protected from O_2 and warmed to approx. 50° C. In the course of the investigation it was also found that (1) Re can be electrodeposited from diluted (5 + 95) H_2SO_4 solution; (2) deposits are slightly contaminated; and (3) the deposited metal can be oxidized directly to perhenic acid by exposure to moist air, O_2 , or by making the deposit the anode in an aqueous solution.—S. G.

X.-LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from pp. 254-255.)

The Electron Microscope as an Aid in Metallographic Research. W. G. Burgers and J. J. A. Ploos van Amstel (Philips Tech. Rev., 1936, 1, (10), 312-316).-A description is given of how the crystal structure of a metal at high temperatures may be revealed by employing an electron beam to produce thermo-electronic emission of the metal under investigation. A suitable cathode-ray tube, and the method of preparation of the metal specimen are described. It is shown that crystal structure as revealed by the electron microscope substantially corresponds to that produced by etching. One exception cited is that the presence of twinned crystals is only very faintly shown up by this new technique.-E. V. W.

A New Method for the Determination of the Ferromagnetic Properties of Metals in the Region of Very High Frequencies [Wire Bridge Method]. G. Potapenko and R. Sanger (Z. Physik, 1937, 104, (11/12), 779-803) .--- Apparatus for the determination of the magnetic characteristics of small samples of ferromagnetic metals in the frequency region 10^8-10^{10} Hertz is described. The method employs a Lecher-wire system and the waves in the system are reflected at one end by a wire of the material being investigated. Data relating to measurements with copper and iron are given .-- J. S. G. T.

A Direct Reading Comparator for Spectra. L. G. Hoxton and D. W. Mann (J. Opt. Soc. Amer., 1937, 27, (4), 150-154).—An instrument is described which by the addition of two moving parts to the conventional form of comparator, enables the observer to read from the precision screw directly the values of the wave-lengths or wave numbers that would ordinarily be computed by the Hartmann formula. It is applicable to grating as well as to prismatic spectra.-R. G.

*Theory and Design of the Cam of an Oscillating Crystal X-Ray Spectro-

graph. S. H. Yū (Z. Krist., 1937, 96, (1), 1-6).—[In English.]—W. H.-R. *A Universal X-Ray Photogoniometer. Robert B. Hull and Victor Hicks (Z. Krist., 1937, 96, (4), 311-321).—[In English.] A compact apparatus for making Laue, rotation, and Schiebold-Sauter photograms, without the intermediate transfer of the crystal, is described .- W. H.-R.

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

(Continued from pp. 255-256.)

Physical Methods in Metallurgy. I .- Optical Interference. Bruce Chalmers (Met. Ind. (Lond.), 1937, 50, (22), 597-600) .- The phenomenon of diffraction is briefly explained, and interference methods are described for determining the shape and size of surface irregularities in tinplate, &c., and for delicate measurements such as are involved in determining coeffs. of thermal expansion, and in precision extensometry. A simple method for measuring the mesh of fine wire screens, depending on the action of the screen as a diffraction grating, is also described .-- H. W. G. H.

Testing High-Endurance Oxidation-Resistant Alloys. F. E. Bash (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 46-48).—[In English.] A brief description is given of the test methods employed by the Driver-Harris Co. for controlling production quality and the development of improved electric heating material, with particular reference to materials for high-temperature applications. Recent modifications of the older technique occasioned by the progressive improvement in these alloys are discussed.—P. W. R.

*Fatigue Fracture and Brittle Fracture. A. Smekal (Metallwirtschaft, 1937, 16, (8), 189-193; and (summary) Light Metals Research, 1937, 5, (15), 340-341).—The fracture of metals which have failed by fatigue under alternating stresses is remarkably like that of a broken glass rod. S. discusses the nature of the various similarities as well as the differences observed in the two fractures.—v. G.

*The Stiffness or Flexure Test. H. L. MacBride (Amer. Soc. Test. Mat. Preprint, 1937, (June), 10 pp.).—Discusses the test known as the cantilever bend, stiffness or flexure test for light wire, sheet, and strip of various materials. A description is given of a stiffness testing machine (the Tour-Marshall tester), and the method of testing is explained. Curves are given of typical tests on various materials—music wire; nickel wire; 67:33 and 70:30 brass strip, and 20-gauze auto-body sheet—and a brief interpretation is given, with a comparison of stiffness tests results with those given by other methods.—S. G.

Interpretation and Use of Creep Results. J. J. Kanter (Internat. Assoc. Test. Mat. Congr. London, 1937, Advance Proof, Group A, 26-27).—[In English.] A concise review of the present position.—P. W. R.

*Equipment for Routine Creep Tests on Zinc and Zinc-Base Alloys, and an Example of its Application. J. Ruzicka (Metals Technology, 1937, 4, (3), 16 pp.; A.I.M.M.E. Tech. Publ. No. 806).—(1) An apparatus is described for routine creep tests at temperatures up to 225° C. This consists essentially of a tank containing a constant-temperature oil-bath in which the creep of 14 specimens, loaded by means of levers, is measured by a single extensometer which is moved from one specimen to another. The extensometer has contactor points resembling those of inside calipers, and measures the distance between two measuring platforms firmly attached to the specimen. (2) Light zinc-base alloys were submitted to (a) ordinary tensile tests, and (b) beam tests, (c) spreading tests, and (d) creep tests, and the data are recorded. In general, the creep tests reveal differences in mechanical strength which are not shown by the ordinary tensile test. The differences in mechanical properties shown by the "practical" beam tests and spreading tests are usually shown in the results of the creep tests which can, however, be more accurately standardized. The alloys examined were ternary or more complex alloys containing more than 98.8% zinc; four contained from 1 to 1.1% copper.-W. H.-R.

Measuring Elastic Drift [Creep]. Robert W. Carson (Amer. Soc. Test. Mat. Preprint, 1937, (June), 10 pp.).—Spring elements in precision instruments may be subject to appreciable errors as a result of elastic drift, or deviations in elastic deflections occurring with continued time under a constant load. A recording electronic micrometer, sensitive to deviations as small as one millionth of an inch, was developed to measure deflections of spring members without disturbing the load deflection. Typical records show that drift continues indefinitely at a decreasing rate as long as the load remains. Test procedure is described for drift measurements on flat strip specimens (Isoelastic, beryllium-copper) and actual elastic elements used in instruments. A bibliography, with notes, is appended.—S. G.

*The Correlation of Impact Tests, and the Problem of Standardization. E. J. Warlow Davies and R. V. Southwell (*Proc. Inst. Mech. Eng.*, 1936, 134, 507-525; discussion, 525-545).—Twenty-one ferrous and non-ferrous alloys were submitted to impact tests on the "Oxford" impact machine (*Engineering*, 1935, 140, 54). The Izod and Oxford impact figures are closely proportional to one another over the whole range (from about 50 to 900 ft.-lb./in.²) of the tests; consequently the two tests measure essentially the same "impact property," and the Oxford specimen and method of loading could be standardized without fear of wasting experience previously gained from Izod tests. The low cost of preparation of the Oxford specimen, and the advantages of the test are emphasized. The paper is followed by a most interesting discussion on the practical and theoretical aspects of impact testing.—W. H.-R.

*Relations Between Stress and Reduction in Area for Tensile Tests of Metals. C. W. MacGregor (*Metals Technology*, 1937, 4, (3), 19 pp.; *A.I.M.M.E. Tech. Publ.* No. 805).—The different methods of plotting the data of tensile tests are discussed critically. A new method is suggested in which the average true stress $\frac{P}{T}$ is plotted as a function of the true reduction in area

average true stress \overline{A} is plotted as a function of the true reduction in area

 $q' = \log \frac{A_0}{A}$, where A_0 is the original area, and A the area at any load P. For all of the steels tested, and for most of the non-ferrous alloys, the above

type of eurve becomes a straight line from the point corresponding with the maximum load, up to fracture. This is in contrast to the usual eurve obtained by plotting $\frac{P}{A}$ as a function of $q = \frac{A_0 - A}{A_0}$. Copper and aluminium give anomalous results, which are probably connected with the formation of cracks inside the necked portion of the test-piece. Equations are deduced connecting (a) the average true stress and the true reduction in area within the necked portion, and (b) the tensile strength and the breaking strength. The application of the new method to data on wire-drawing is discussed. Tensile test data are given for $\frac{1}{2}$ -hard drawn brass (35% zine), cold-drawn commercial copper, and commercially pure aluminium.—W. H.-R. ***Dynamic Stress Measurements.** S. Berg (Z.V.d.I., 1937, 81, (10), 295-

*Dynamic Stress Measurements. S. Berg (Z.V.d.I., 1937, 81, (10), 295–298).—Apparatus for measuring elongations on specimens with a gauge-length of only 5 mm. is described. The apparatus can be fixed to machine parts to determine the stresses arising during use.—v. G.

*The Influence of the Testing Apparatus on the Load-Elongation Diagram of Metals. W. Späth (*Metallwirtschaft*, 1937, **16**, (8), 193-195).—The effect of the elastic deformation of the testing apparatus on the tensile diagram of metals was investigated. With a very strong design, the critical points in the tensile test are readily ascertained; the elastic limit (0.2% permanent clongation) is more or less affected by the springing of the apparatus.—v. G.

*The Application of Magnetic Tests to Metallurgical Problems. Heinrich Lange and Heinrich Hänsel (*Physikal. Z.*, 1937, 38, (10), 379-384).—A magnetic balance comprising electromagnet, microscope, furnaces, and quenching equipment for the investigation of thermomagnetic transformations is described. Examples are given of its application to the determination of transformation isotherms, the relation of velocity of transformation to temperature, the austenitic transformation of steel at various temperatures.

-J. S. G. T.

RADIOLOGY.

*On the Use of X-Ray Testing for the Evaluation of Lead-Bronze Bearings. Bernhard Garre (*Metallwirtschaft*, 1937, 16, (12), 281-283).—The faults which occur in lead-bronze bearing shells for automobiles are discussed on the basis of results obtained by X-ray examination. This procedure reveals uneven lead distribution (both in the casting and in the individual grains), fractures, pores, and oxide inclusions but not faults in the joint between bronze and steel backing.—v. G.

XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from pp. 256-257.)

A Review of Developments in Temperature Control Equipment. — (Indust. Heating, 1936, 3, (10), 645–666; (11), 755–762, 792; (12), 821–824, 842).—This is a series of concise descriptions of modern instruments for temperature measurement and control, supplemented by a section on safety devices. The apparatus is all for industrial use, and some of the examples are quite new. Controllers in which temperature changes are anticipated and corrections made for them before they are complete are coming into wider use. The control is operative on both increasing and decreasing temperatures. Safeguards against the failure of fuel or air supply in burners are very fully discussed, and numerous examples are given.—W. A. C. N.

Another Hour Glass Tradition Passes. Dial and Pointer Method for Accurate Temperature Readings. J. B. Dowden (*Inco.*, 1936, 14, (3), 10-11).—A short review of the development of modern thermometers actuated by bi-metallic coils of Invar and an alloy steel containing chromium and 20% nickel.—R. G.

*On the Construction and Sensitivities of Short-Period Platinum Thermometers. J. J. Manley (*Phil. Mag.*, 1937, [vii], 23, (156), 695-701).—Thirteen platinum resistance thermometers involving 9 different types of construction were tested at about 20° C., with special reference to the sensitivity and the time taken to indicate small changes in the temperature of the surrounding fluid (air or water). The original must be consulted for details of construction.—W. H.-R.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 257-260.)

Gates and Risers on Small Non-Ferrous Castings. J. M. Douglas (Found. Trade J., 1937, 56, (1077), 293-296; and (summary) Met. Ind. (Lond.), 1937, 50, (16), 461-462).—Read before the Scottish branch of the Institute of British Foundrymen. The principles governing the design of gates and risers for castings in gun-metal, brasses, and some nickel alloys are discussed. With gun-metal, large gates enable interdendritic shrinkage to be overcome at all casting temperatures and are recommended. Medium gates give sound castings with high pouring temperatures; small gates sometimes give sound castings with low pouring temperatures, when presumably the slow pouring enables progressive solidification to take place. Reference is made to the use of chills and the influence, in brasses and nickel brasses, of composition on gating methods.—J. C. C.

composition on gating methods.—J. C. C.
Non-Ferrous Foundry Problems. F. Dunleavy (Found. Trade J., 1936, 55, (1062), 489-490).—Abstract of a paper read before the East Midlands Branch of the Institute of British Foundrymen. Sand control, care in ramming, position and size of runners and risers, casting temperature, and melting practice are discussed.—H. W. G. H.

The Importance of the Melting and Casting Temperatures in the Production of Aluminium Castings. E. T. Richards (*Giesserei-Praxis*, 1937, 58, (5/6), 50-53).—The properties of practically all aluminium castings are dependent to a considerable extent on the melting and casting temperatures. The best casting temperature for binary alloys with zinc and magnesium is about $50^{\circ}-90^{\circ}$ C. above the melting point of the alloys, while in the case of binary alloys with nickel, manganese, and iron, it is $80^{\circ}-120^{\circ}$ C. higher. The rate of cooling is a very important factor, a lower casting temperature being necessary in sand- than in chill-castings. If the best casting temperature is exceeded, the tensile strength diminishes rapidly. The third important factor is the casting procedure which must take into account the temperature gradient in the furnace, the size and the shape of the casting, and segregation.

_J. H. W.

Practical Foundry Problems. I.—Soundness in Step Castings. E. Longden (Met. Ind. (Lond.), 1937, 50, (21), 579-583).—Details are given of moulding technique for small and large bearing eastings in phosphor bronze. Particular reference is made to gating and feeding arrangements to avoid porosity and blow-holes.—H. W. G. H.

Practical Foundry Problems. II.—A Large Leading Nut Casting. E. Longden (*Met. Ind.* (*Lond.*), 1937, 50, (22), 603–604).—A detailed account is given of the moulding methods used to obtain a sound casting in face of difficulties arising from the heavy and non-uniform section and the extensive machining required, involving deep cuts for an internal thread and external gear teeth.—H. W. G. H.

Practical Foundry Problems. III.—Inverse Segregation in Ring Castings. E. Longden (*Met. Ind.* (*Lond.*), 1937, 50, (23), 631-632).—An 8 ft. diam. lead-bronze ring, containing 5% lead, was poured from two tangential gates, on opposite sides. Segregation of lead and tin occurred immediately in front of these gates and on the upper face of the casting.—H. W. G. H.

The Production of Lead-Rich Copper Alloys for Bearing Purposes. —— (Giesserei-Praxis, 1937, 58, (7/8), 69–72).—Copper-lead bearing alloys often contain up to 60% lead, and, owing to the difficulty with which lead forms alloys and to its high density and strong tendency to segregation, these alloys have poor casting properties and involve considerable waste. A number of agents have been recommended from time to time to increase the alloying property. One of the most recent and important of these is sulphur or its compounds with copper or lead. The lead is heated to about 1000° C. and lead sulphide to the extent of 1-1.5% of the weight of lead is introduced. The use of fluxes, the beneficial effects of zinc and nickel, and the production of various copper-lead ternary bearing alloys are described. The composition of several typical lead-rich bearing bronzes is tabulated.—J. H. W.

Non-Ferrous Foundry Problems. R. J. Keeley (Found. Trade J., 1937, 56, (1084), 431-432; and Iron Age, 1937, 139, (17), 46-47, 126).—Abstracts from Paper presented to the Philadelphia Chapter of the American Foundrymen's Association. A pump, made of leaded-bronze, for use with mine-water, failed by corrosion. It was found to have been used for sea-water and the replacement, which was accordingly made in 88: 10:2 alloy, gave satisfactory service. High lead contents also gave trouble in contact with water containing carbon dioxide, a white deposit of lead carbonate being formed on the bronze. A passion for fluxes led one foundry to use as many as eight with each heat, resulting in castings containing slag inclusions. Oxidation during melting was found to be the cause of surface porosity in large impeller castings made in high-lead bronze.—H. W. G. H.

The Production of Dense Copper-Tin Bronzes. —— (Giesserei-Praxis, 1937, 58, (11/12), 118-120).—Owing to the difficulties in making compact copper-tin bronzes, virgin metals are usually employed in making up the charge. By taking suitable precautions as to the choice of the material for the charge, furnace conditions, prevention of overheating, use of a reducing

or at least a neutral atmosphere and correct deoxidation, however, 90:10 (acid-resisting), 84:16 (bearing alloy), and 80:20 (bell metal) copper-tin bronzes can be made successfully from secondary metal.—J. H. W.

The Practical Production of Special Bronzes. —— (Giesserei Praxis, 1937, 58, (17/18), 171-174).—Describes the selection of the raw material, the effect of different addition metals on the properties of the alloys, the preparation of the copper-aluminium pre-alloy, and the melting and casting practice for the production of special bronzes containing zinc, aluminium, manganese, iron, and nickel.—J. H. W.

*Defects in Wrought Brass. Is Melting or Pouring Practice Chiefly Responsible? L. Kroll and E. A. Anderson (*Metals and Alloys*, 1936, 7, (10), 261-262).—Tests with a scoop sampler indicate that melting conditions are not responsible for poor castings, but that these are due to turbulent pouring, splashing, a poor mould surface, or wrong mould dressings. Overheating of the melt or gassing with air or town gas causes no gas or other inclusions in yellow brass.—A. R. P.

Effect of Pouring Temperature on Structure of Bearing Metals. Owen W. Ellis (*Indust. Heating*, 1937, 4, (2), 117-120).—E. emphasizes the necessity for actually controlling the pouring temperatures of white metal anti-friction alloys and also the temperatures of the forms into which they are poured.

-W. A. C. N.

Suggestions for the Melting, Refining, and the Preparation for Melting of Magnesium and Its Alloys. —— (*Giesserei-Praxis*, 1937, 58, (9/10), 99–100). —Describes fully the details contained in British Patent No. 457,826 for the production of magnesium and its alloys.—J. H. W.

The Foundry as a Source of Raw Material. Arthur Schulze (Giesserei-Praxis, 1937, 58, (15/16), 153-157).—Describes the machines and methods of casting alloys which will utilize German-produced metals, and in particular the methods of die- and centrifugal-casting bearing metals, and the disposal of scrap and turnings.—J. H. W.

*Recent Developments in Testing Oil-Sands for Cores. N. D. Ridsdale (Found. Trade J., 1937, 56, (1066), 85–86).—Adaptors for making shear and tensile tests on baked oil-sand test-pieces with the Buchanan compression strength testing machine are illustrated, and reference is made to a new vertical hydraulie machine for the same tests. No fixed relationship seems to exist between these properties. Experiments showed that efficient air circulation during baking is necessary to produce maximum strength in oil-sand cores. Permeability and compression strength tests show the influence of various bonds on the green strength of cores before baking.—J. C. C.

*Heat Conductivity of Mould Materials. Development of Plastic Mould Compositions. F. Hudson (*Met. Ind.* (*Lond.*), 1937, 50, (21), 573-575).— Normal foundry moulding sands were tested together with experimental mixtures containing, respectively, flake graphite 85, steel grit 95, and carborundum 95%. The samples were made into flat discs which formed the bottom of a mould into which bronze was poured at a definite temperature. A thermocouple placed under the disc recorded the increase of temperature with time. Little difference in behaviour was found between the various commonly used moulding materials, but the graphite and steel-grit mixtures gave results of the same order as mild steel, and the carborundum composition gave similar results to copper. [*Note by abstractor*: The author appears to have confused thermal conductivity with thermal diffusivity in interpreting his results, which are themselves very valuable.]—H. W. G. H.

Factors Affecting the Ramming Density of Sand. J. Dearden (Found. Trade J., 1937, 56, (1085), 439-442).—Read before the Birmingham, Coventry, and West Midlands Branch of the Institute of British Foundrymen. The B.C.I.R.A. and A.F.A. methods of ramming a test-piece are compared, to the advantage of the latter. The product of the permeability and green

strength of a sand is suggested as a measure of quality.—H. W. G. H. Testing Foundry Sands. W. Y. Buchanan (Found. Trade J., 1937, 56, (1083), 406-408, 414; (1084), 423-425; correction, (1086), 463).—Read before the Falkirk Section of the Institute of British Foundrymen. The paper is divided into two sections, the first reviewing the apparatus described by B. in earlier papers in the light of some years' experience, and the second dealing with expansion phenomena in moulding sands. B. strongly criticizes the A.F.A. test-piece, on account of uneven ramming, and Dietert's hardness tester, on the ground that it measures only the skin hardness. The B.C.I.R.A. new type permeability apparatus is recommended, and B.'s design of drying oven is thought to be still the best. An "index of ramming" is suggested to define the hardness of a test-piece. Dilatometric tests on many samples are described and lead to the conclusions that the expansion is not materially affected by the degree of ramming or by additions to the sand, that it is not of serious consequence, and does not cause scabs .-- H. W. G. H.

Testing Foundry Sands. F. Hudson (Found. Trade J., 1937, 56, (1085), 438).-H. asks for particulars of the apparatus used for Buchanan's dilato-metric work (see preceding abstract).-H. W. G. H.

Why Must the Light Metal Caster Especially Consider Moulding Sand? M. Schied (Giesserei-Praxis, 1937, 58, (19/20), 190-193) .- Discusses the requirements of moulding sands suitable for light metal castings, and describes the properties of a number of German sands used for magnesium-containing and other light metal alloys .- J. H. W.

A New Clay Washer. ---- (Found. Trade J., 1937, 56, (1077), 296).---An automatic apparatus for determining the amount of elay substance in a moulding sand is briefly described. Clay particles less than 20 μ in diameter are washed from the sample (contained in a wash bottle with a removable bottom) by an upward current of water supplied through four rotating washing tubes. Four samples may be washed at one time. After washing, the bottom of the bottle, with the cleaned sand, is removed for drying in an oven.-J. C. C.

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

(Continued from p. 260.)

The Utilization of Iron and Metal Scrap. Kurt Nischke (Giesserei-Praxis, 1937, 58, (19/20), 187-190) .- Describes the briquetting of metal scrap, as practised in France and Germany during the War, and discusses German, British, Austrian, American, Swiss, and French patents for dealing with this material.-J. H. W.

XV.—FURNACES AND FUELS

(Continued from pp. 260-261.)

Annealing in Controlled Atmospheres. W. A. Darrah (Indust. Heating, 1936, 3, (10), 671-678, 701-702) .- A general description of the methods employed. Emphasis is laid on preliminary de-greasing. For annealing copper, a carbon monoxide content in the gas of 1.8% is preferable; richer gases have a tendency to cause the surface oils to crack. With brass the carbon monoxide may be increased to 4%. High-zinc brasses require more care than low-zinc brasses. Various types of furnaces are illustrated and described .--- W. A. C. N.

Special Atmospheres for Industrial Furnaces.-I,-I. W. A. Darrah (Indust. Heating, 1937, 4, (1), 26-30, 38; (2), 106-110).-In the section dealing with non-ferrous alloys, copper and brasses alone are mentioned. In the case of copper, sulphur in reduced form is very objectionable, but may be present in greater concentration in contact with zine alloys. General furnace design in connection with clean annealing is discussed.—W. A. C. N.

Recuperators for Industrial Furnaces. W. Trinks (Indust. Heating, 1936, 3, (10), 637-638).—To obviate the necessity for reversals as in the use of regenerators, recuperators are now receiving more attention. Few types have been found completely successful. Unless precautions are taken, preheated air quickens combustion and causes hot spots in the furnace. Air and fuel should be mixed slowly. Recuperators of refractory material are usually sufficiently robust to be placed under the furnaces. Cracking of the gas may occur in metallic recuperators so located unless they work at a temperature less than 870° C.—W. A. C. N.

A Review of Developments in Combustion Control Equipment.—I-IV. M. H. Mawhinney (Indust. Heating, 1937, 4, (1), 35-36; (2), 93-98; (3), 199-204, 208; (4), 273-276, 282).—The importance of atmosphere control is stressed, and descriptions are given of various types of burners. The principal factors affecting the atmosphere in a metallurgical furnace are the degree of mixing of the fuel and air, the ratio of air to fuel, and the pressure within the furnace. Schematic and pietorial diagrams of many types of burners for oil and gas are included. A table is given showing the principal methods of ratio control, and the actions employed in various types of controller are briefly explained. Pressure controllers are treated similarly.

-W. A. C. N.

Look Out for Secondary Combustion. W. Trinks (Indust. Heating, 1937, 4, (4), 279-280, 334).—A warning is issued against improperly situated recuperator tubes and similar material which are intended to be heated in the stream of flue gases. Where combustion in the main chamber is incomplete, in nearly every instance it is continued in the secondary chamber with the consequent increase of the temperature there above a safe point. The introduction of a screen may not be satisfactory, as any throttling of the gas flow may intensify the secondary combustion. Removal of the recuperator chambers to a point farther away from the point of principal combustion, and the by-passing of some of the flue gases are recommended. Return of part of the flue gases to the primary furnace is also suggested.

-W. A. C. N.

Report of Non-Ferrous Metals Committee [on the Use of Gas for Melting and Heat-Treating Non-Ferrous Metals]. W. Wirt Young (*Proc. Amer. Gas Assoc.*, 1936, 539-542).—About 15% of the copper melted in the U.S.A. is melted in gas-fired furnaces and about 20% of the annealing and about 50% of the hot-forging is also done with gas. Gas is used extensively for melting silver, lead, and tin, but oil is used for aluminium and zinc, and electricity for nickel. Nickel and silver are bright-annealed in a burnt-gas atmosphere.

—Â. R. P.

Modern Gas Burners for Foundry Work. —— (Found. Trade J., 1936, 55, (1062), 492).—Describes the "Gako" burner, which works at 2-4 in. water-gauge, has independent valve control of the gas and air supply, and gives a swirling motion to the gas, and, in some cases, the air, by means of spiral passages. Hot or cold gas, dirty or clean, may be burnt, whilst the air can be cold or preheated and at atmospheric pressure or under forced draught.—H. W. G. H.

Electric Melting Furnaces. Marcel Fourment (Bull. Assoc. Tech. Fonderie, 1936, 10, (11), 403-410; discussion, 410-412; and (summary) Usine, 1936, 45, (45), 29).—An outline of the evolution of electric furnaces and of recent tendencies. Resistance furnaces, composition of elements, molten metal resistance furnaces, induction furnaces, are furnaces, consumption of power and capacity for various metals are dealt with. In the discussion, the advantages of valve-operated high-frequency furnaces compared to other types are stressed.—W. D. J.

Furnaces for Aluminium Alloys. New Melting and Heat-Treatment Equipment. G. C. Castle (*Met. Ind. (Lond.)*, 1937, 50, (19), 527-531).— The advantages of electric furnaces for melting and heat-treatment of aluminium alloys are presented. The applications, current consumption, capacity and upkeep costs of crucible, large resistance, and induction furnaces for melting are given, the low melting losses of the last compared with oil-fired furnaces being emphasized. The uniformity of temperature attainable in air-circulation heat-treatment furnaces is pointed out and examples of different types are described.—H. W. G. H.

Furnaces of High Thermal Efficiency or of Variable Power for the Manufacture of Aluminium and the Utilization of Energy. Louis Ferrand (Bull. Soc. france. Elect., 1937, [v], 7, (75), 293-322).—See Met. Abs., 1936, 3, 376. Additional notes examining theoretically the efficiency of a closed cell and the economics of its use. Means of avoiding irregular anode conditions are described. The different electrolytic processes—open cell (developed from Héroult), half-closed cell (Söderberg) and closed cell with oscillating anode are critically compared. In the discussion E. Vuigner observed that aluminium can be oxidized by carbon dioxide, especially when finely divided, and examined the cause of the formation of a fog of aluminium droplets in the electrolyte. P. Bunct mentioned the possible commercial use of methods other than electrolytic.—R. T.

*The Change in Electrical Resistance of Silicon Carbide Resistors During Service. Wilhelm Meyer (*Mitt. Forsch. Inst. Elektrowärmetech., Tech. Hockschule, Hannover*, 1937, (17); *C. Abs.*, 1937, 31, 2935).—Tests were carried out at 1400° C., the maximum recommended by the manufacturers of Globar and Silit resistor units. Operation in the open air resulted in the formation of SiO₂ on the surface of the crystals as well as at the interfaces. No recrystallization and grain-growth could be detected. Results of tests in argon were very much the same as those in air, *i.e.* vaporization of silicon, SiO₂, &c., with consequent increase in resistance. No two silicon carbide rods gave identical time-resistance curves. After 600 hrs. at 1400° C., the range of resistance was between 37 and 90% for one manufacturer's product. Tests were also carried out inside a resistor furnace : (a) with current, and (b) without current passing through the rod. Intermittent service resulted in shorter total operating life. The abrupt changes in resistance after cooling are attributed to the formation of β -cristobalite (transition temperature 200°-250° C.). If the rods are not allowed to cool below 350° C. no abrupt changes in resistance occur.—S. G.

XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from p. 261.)

Notes on the Action of Slags on Refractories, and Some Methods of Testing. A. E. Dodd (*Trans. Ceram. Soc.*, 1937, 36, (2), 63-71; discussion, 71-73).—A detailed account of the use of equilibrium diagrams in predicting the extent of slag attack, and of the limitations of this method of investigation. Laboratory tests cannot be applied to working conditions. D. urges the necessity for research work on the fundamental chemical and physical effects.—I. J.

Economic Importance of Insulating Refractories. J. G. Coutant (Indust. Heating, 1936, 3, (10), 695-698, 726).—Calculations showing the benefits to be derived from the use of insulating bricks in furnace linings. It is stated that, although the initial cost of manufacture is greater and the life is shorter for insulating than for firebricks, the ultimate saving is larger, owing to the economy of fuel used. With insulated brick linings, the heating-up time is reduced, it is stated, by 80%.-W. A. C. N. Properties and Uses of Mullite Refractories. Meyer L. Freed (Indust.

Properties and Uses of Mullite Refractories. Meyer L. Freed (Indust. Heating, 1937, 4, (1), 57-62).—Mullite belongs to the alumina-silicate group of refractories and is obtained by firing one of the sillimanite group—kyanite, and alusite or sillimanite. Of the three, kyanite is considered to be the best, especially when devoid of free quartz. The melting point of mullite is approximately 1800° C.—W. A. C. N.

XVII.—HEAT-TREATMENT

(Continued from pp. 261-262.)

Fabrication and Heat-Treatment of Beryllium-Copper.-I-III. ----- (Indust. Heating, 1937, 4, (2), 112–116; (3), 206–208; (4), 281–282).—Alloys containing less than 1% beryllium do not respond to heat-treatment; those with 1-1.6% are slightly heat-treatable; those having 1.6-2.75% beryllium can be heat-treated readily. "Anaconda" beryllium-copper has the nominal composition: beryllium 2-2.5; nickel 0.25-0.50; iron, less than 0.10%; copper the remainder. Annealing at 800° C. develops full heat-treating characteristics but yields a coarse structure, which may be reduced, however, by the addition of 0.25-0.50% nickel; the latter also increases the percentage elongation and modulus of elasticity. The alloys may be obtained in various forms. In cold-working, hardening rapidly occurs and frequent annealing is therefore necessary. Hot-working is done within the range 575°-775° C. The reductions in forging should be considerably less than those used for steel. Quenching should be done immediately after annealing. Controllable atmospheres in the furnaces are advisable. Subsequent heattreatment consists generally in reheating the material at 275° C. for a predetermined time; for soft-annealed material 300° C. is better, while for severely cold-worked articles 250° C. is preferred. Pickling can be effected in dilute sulphuric acid, and any red re-deposit of copper can be removed by immersion in another bath containing the acid and sodium dichromate. Oil and grease should be removed before heat-treatment, or pickling may be retarded. In silver soldering, the work must be handled carefully to keep all parts between 780° and 864° C. The article should then be quenched, or reheated to 780° C. and quenched. Afterwards re-heating to 300° C. completes the hardening. The mechanical properties may be varied over a wide range by heat-treatment. The alloys have good wear-resistance, which is independent of heat-treatment. The corrosion-resistance is about equal to that of deoxidized copper.-W. A. C. N.

XVIII.-WORKING

(Continued from pp. 262-263.)

On the Internal Changes Which Occur in the Mechanical Working of Metals. Georg Buchner (*Kalt-Walz-Welt*, 1936, (12), 92–93).—Brief explanations are given of age-hardening, grain-refinement, corrosion limits, rolling stresses, recrystallization, &c.—A. R. P.

Welded Alloys Rolled to Six Millionths of an Inch. — (Inco), 1936, 14, (3), 13).—An experimental development. Welded strips of "Copnic" (nickel 45; copper 55%) and "Chromel" (nickel 90; chromium 10%) were placed between pieces of steel and successfully rolled to a thickness of the same order as that of gold leaf.—R. G. Sleeve-Rolls. W. Trinks (Blast-Fur. & Steel Plant, 1937, 25, (5), 496-498).—Discusses some mechanical problems which arise with backing rolls of four-high cold mills. Sleeve-rolls are discussed in particular.—R. Gr.

Roll Flatting Machines. L. Reichert (Z.V.d.I., 1937, 81, (13), 385-387). --A description of new types of German machines.--v. G.

Manufacture of Monel Metal Wire Gauze. Rudolf Müller (*Draht-Welt*, 1936, 29, (41), 575-577).—The various steps in the conversion of Monel metal ingots into wires down to 0.035 mm. diameter are briefly described, and some mechanical properties and uses of the wires are given.—A. R. P.

Extrusion of Metals. D. K. Crampton (Trans. Amer. Soc. Met., 1937, 25, 55-79; discussion, 80-84; and (summary) Met. Ind. (Lond.), 1937, 50, (8), 235-236).—A review, covering both hot and cold extrusion methods and low and high melting point metals. Compositions and properties of the alloys used in commercial extrusion are given. The Hooker process of cold extrusion used for cartridge case manufacture and impact extrusion are described.—R. G.

Hot Press and Upset Forging. J. H. Friedman (Trans. Amer. Soc. Met., 1937, 25, 28-49; discussion, 49-54; and Heat-Treat. and Forging, 1936, 22, (12), 610-613).—A practical review, with illustrations of typical products.

-R. G.

Factors Relating to the Production of Drop and Hammer Forgings. Adam M. Steever (*Trans. Amer. Soc. Met.*, 1937, 25, 1-22; discussion, 22-27).—A practical review dealing with the history of the process, types of hammers used, construction and life of dies, heating material for forging, elimination of forging defects, grain flow, &c.—R. G.

Some Problems in the Cutting of Non-Ferrous Metals. Alf Schroeder (*Metallwirtschaft*, 1936, 15, (51), 1200–1202).—Types of saws, rasps, drills, and screw-cutting tools for working light metals are described and their performance discussed.—A. R. P.

Machining Properties of Light Metals. A. Wallichs (Z. V.d. I., 1937, 81, (16), 457-458).—See A. Wallichs and F. Hunger (Met. Abs., this vol., p. 206).—v. G.

XX.—JOINING

(Continued from pp. 264-267.)

Fluxes for Soft Soldering. C. C. Miller (*Met. Ind.* (*Lond.*), 1937, 50, (18), 503-505).—The requirements of a soldering flux are said to be: (1) to clean the metal surfaces; (2) to remove the skin of oxide from the solder and so reduce its surface tension; (3) to protect against further oxidation, and (4) to leave a protective and non-corrosive residue. The extent to which these requirements are satisfied is examined in the cases of inorganic fluxes—such as zine chloride, hydrochlorie acid, orthophosphorie acid, zine ammonium chloride, and special pastes, and of organic fluxes—such as resin and aniline hydrochloride (see also following abstract).—H. W. G. H.

Fluxes for Soft Soldering. Bruce Chalmers and W. D. Jones. C. C. Miller. V. B. Douglas (*Met. Ind. (Lond.)*, 1937, 50, (19), 537; (20), 560; (21), 577).— C. and J. criticize Miller's statement (preceding abstract) that removal of the oxide skin from the solder reduces the surface tension. M. suggests that the flux enables the true surface tension of the metal to be revealed, and C. and J. point out that addition of flux to a drop of molten solder causes it to become more spherical, indicating an increase in surface tension, and state that the effect of a flux is to lower the surface tension of a clean metal but to a value above that of the oxidized surface. D. agrees with C. and J.

-H. W. G. H.

The Hard Soldering of Galvanized Iron Sheet and the Welding of Zinc Sheet. K. Werner (*Illust. Zeit. Blechindustrie*, 1937, 66, (18), 526-527).— Both processes are discussed with reference to plumbers' work. The use of a soldering pistol applying zine and operated by acetylene is recommended for galvanized sheet, and a somewhat similar instrument may be used in the welding of zine : alternatively an oxy-acetylene burner may be used, especially on thin sheet. Precautions and equipment are described, with illustrations.

-P. M. C. R.

Modern Practices in Cable Splicing. Ray Blain (*Telephone Eng.*, 1936, 40, (7), 15-16, 26).—B. asserts that the prime requisites for producing nonporous wiped solder joints in telephone cables are, a good solder, a method for accurately measuring the temperature of the solder and a pressure-testing outfit. This last item is described in some detail.—E. V. W.

Soldered and Welded Joints in Aluminium Cables. L. Rostosky and K. Heinemann (*Metallwirtschaft*, 1936, 15, (49), 1152-1153).—Fusion welding, resistance welding, and various methods of soldering aluminium cables are briefly described.—A. R. P.

Electric Welding of Aluminium. Hans Groebler (*Elektroschweissung*, 1937, **8**, (3), 49–53).—The physical properties of aluminium are compared with those of iron, the low melting point, refractory oxide, high specific heat and thermal conductivity of the former being emphasized. The requirements of a suitable electrode core and coating are reviewed. It is claimed that with modern electrodes 3–10 mm. sheet can be butt-welded without chamfering of the edges and with a minimum of preheating. Metallic are welding is stated to offer metallurgical, thermal, and economic advantages over gas-welding for light alloys.—H. W. G. H.

*Examination of Welded Aluminium Sheets of Great Thickness. H. Buchholz (Z.V.d.I., 1937, **81**, (15), 433–437).—The structure, resistance to corrosion, and mechanical properties of are and oxy-acetylene welds in pure aluminium were examined, and the quality of the weld tested by X-rays. The results show that welds can be produced by either method which are as good as the sheet, but this is more difficult to do by the arc method than by the gas method. Welds made with rods containing silicon or titanium are less corrosion-resistant than those made with pure aluminium rods.—v. G.

The Welding of Copper and Its Alloys. A Review of the Literature to Jan. 1, 1936. Ira T. Hook (J. Amer. Weld. Soc., 1937, 16, (2), suppt., 7-32; (3), suppt., 33-46).—This review, carried out for the Welding Research Committee, is divided into eight sections: (1) metallurgy of copper, effect of addition elements on welding properties; (2) welding processes applied to copper; (3) brass, nickel silver, Tobin bronze, manganese bronze, &e.; (4) phosphor bronze, gun-metal, bell metal, bearing bronzes, &c.; (5) Copper-silicon alloys; (6) cupro-nickels; (7) alloys with cadmium, aluminium, and beryllium; (8) brazing, copper-brazing, and bronze-welding. A bibliography of 210 references is given.—H. W. G. H.

*The Weldability of the Binary Aluminium Bronzes. H. Szepanik (*Elektroschweissung*, 1937, 8, (2), 28-32; (4), 69-74; (5), 93-94).—Welding tests were carried out on material of composition 96% copper and 4% aluminium, and of 3 mm., 6 mm., and 10 mm. thickness. Preliminary work on the thin sheet showed that the formation of tenacious alumina films made a flux essential, and the usual types of flux used for welding copper or aluminium were found to be useless. A flux was developed, containing a borofluoride and silico-fluoride, which gave good results with both oxy-acetylene and metallic are processes, being applied to the filler rod or electrode as a suspension in a 5% solution of a cellulose compound in alcohol. By either process, strengths over 70% of that of the sheet could be obtained. Detailed figures and micrographs of typical welds are given.—H. W. G. H.

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Practical Experiences and Recommendations for the Welding of Zinc, Zinc-Coated, and Lead-Coated Sheets. W. Anders (Autogene Metallbearbeitung, 1937, 30, (3), 33-36; also (condensed) Welding Ind., 1937, 5, (2), 49-50; and Met. Ind. (Lond.), 1937, 50, (7), 213).—A special flux is used, with a neutral flame for welding zine. Experiences in welding sheet of 0.7, 1, and 3 mm. thickness are described. The strengths of the welds obtained in the thick material are considerably less than that of the parent metal, but are higher than that of a normal soldered joint. Better values are obtained on the thin sheet. Zinc-coated sheet can be welded by overlapping the edges, using the special flux and a zine filler rod. The same practice is recommended for lead-coated sheet, the lead being removed at the edges and a joint made, with the zine rod, between lead coating and steel sheet.—H. W. G. H.

Visual Inspection of Welding. E. W. P. Smith (Welding Eng., 1937, 22, (2), 37-39).—The inside of a welded joint can be seen while it is being made. Four points should be observed: (1) the "burn-off" of the electrode; (2) the fusion and penetration; (3) the form of the bead; and (4) the sound of the arc. The influence on these of various factors, such as the type of electrode, current, voltage, and speed of welding, is illustrated and described.

-H. W. G. H.

Double Bead Welding and Its Industrial Applications. —— (Soudeur-Coupeur, 1937, 16, (2), 1–48).—A series of articles describing the technique, advantages, and applications of the double-welding methods developed by the Institut de Soudure Autogène.—H. W. G. H.

Electric Spot-Welding Appliances. Friedrich Hoch (*Elektroschweissung*, 1937), 8, (2), 21–27.—Various specially developed portable welders are described, *e.g.* gun, pincer, pinch-bar, and twin-spot welders.—H. W. G. H.

Recent Improvements in Automatic and Semi-Automatic Machines for Arc Welding. R. Sarazin (*Welding Ind.*, 1937, 5, (2), 53-58).—Refers entirely to steel, but gives a useful picture of modern French practice.—H. W. G. H.

The Philips Twin Current Welding Unit. H. A. W. Klinkhamer (*Philips Tech. Rev.*, 1936, 1, (11), 338-345).—A detailed description is given of a unit for are welding with d.e. and a.e. The transformer feeding the rectifier for d.e. welding is used as a welding transformer during a.e. welding.—E. W.

Concerning the Acetone Content of Dissolved Acetylene. Otto Mics (Autogene Metallbearbeitung, 1937, 30, (2), 17-20).—It is concluded that the loss of acetone is not due to mechanical entrainment but to its vapour pressure in the cylinder. It follows that cylinders should be kept as cool as possible.—H. W. G. H.

On Anti-Freezing Mixtures Suitable for Acetylene Generators. A. Leroy (*Rev. Soudure Autogène*, 1937, 29, (276), 64).—Glycerine, calcium chloride, and ethylene glycol are discussed, and the last is recommended.—H. H.

Resistance Welding Problems—A Plea for Training and Research. Jas. L. Miller (*Welding Ind.*, 1937, 5, (2), 51-52).—Points out the scanty attention paid to spot-welding problems, and gives many examples which require solution.—H. W. G. H.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 267-269.)

Aluminium and Its Alloys. Wm. L. Fink (Indust. and Eng. Chem., 1936, 28, (12), 1402-1406).—The chemical and physical properties of aluminium are described; these fit it admirably for service in contact with many chemicals. Higher efficiency, higher quality of product and lower operating or transportation costs are among the advantages of the intelligent use of aluminium. Its suitability should be carefully determined for each new type of application; approved cleaners and sterilizers should be used, to assure long service. The mechanical properties of 31 aluminium alloys are tabulated, but only the numbers (e.g. 28-0) are given, not the compositions. The care of aluminium apparatus is discussed.—I^{*}. J.

On Advances in the Use of Aluminium for [Collapsible] Tubes. E. J. Kohlmeyer (*Metallwirtschaft*, 1936, **15**, (48), 1128-1129).—Aluminium tubes are gradually replacing tin and lead tubes in Germany for packing cosmetics and medicinal pastes. When the pastes are alkaline, protective materials such as sodium silicate or chromato may be added to the paste, or the inside of the tube may be coated with a protective varnish.—A. R. P.

The Use of Aluminium in the Nitric Acid Industry. R. Chevillotte (*Rev. Aluminium*, 1937, 14, (88), 559–566).—Aluminium of at least 99.5% purity has special application in the nitric acid industry. The attack of the acid is so weak that it shows up uniformly over the whole surface without any trace of pin-holes or corrosion. Porous soldering, lack of homogeneity in the soldering and inclusions of aluminium oxide and the pickling agents tend to cause corrosion of the metal.—J. H. W.

On the Development, Construction and Use of Light Metal Bearings. H. Wiechell (*Automobiltech. Zeit.*, 1937, 40, (9), 235–240; discussion, 240).—Tests on aluminium-copper and aluminium-silicon alloy bearings are described. Suitably controlled admixtures and carefully adjusted solidification conditions have produced a modified microstructure which enables the hard constituent to fulfil its function without fracture or tearing. Tests included running under service conditions, together with determinations of wear resistance, tensile and compressive strength, melting point, expansion coeff., and hardness. In the discussion, the importance of load and lubrication conditions is emphasized.—P. M. C. R.

The Evolution of Weight-Saving in Aeroplane Motors. J. Bally (*Rev. Aluminium*, 1937, 14, (88), 567-578).—B. describes the gradual decrease in weight per horse-power in aeroplane motors by the use of light alloys from 1904 to 1930, and the increasing applications of these alloys in such motors.—J. H. W.

Material for Photographic and Cinematographic Manipulations. J. Bally (*Rev. Aluminium*, 1937, 14, (88), 579-590).—The behaviour of high purity aluminium after various treatments, Duralinox H-7 (7% magnesium), and Almasilium, when in contact with five developing, fixing, and washing baths used in photography was studied. Alumilized (chemically oxidized) 99.6% aluminium was found to give the best results. The application of aluminium and its alloys to the construction of photographic and cinematographic apparatus is described.—J. H. W.

Material for Photography and Photographic and Cinematographic Projection. J. Bally (*Rev. Aluminium*, 1937, 14, (89), 621-634).—Describes the application of light alloys in the construction of photographic and cinematographic apparatus.—J. H. W.

German Standards Committee [Specifications for Aluminium Alloys and Brasses]. — (Giesserei-Praxis, 1937, 58, (11/12), 117-118).— The specifications and the variations permitted in the DIN 1713 aluminium alloys and DIN 1709 brasses Bl 1 and Bl 2 are set out.—J. H. W.

Use of Copper Pipe for Gas Services, Drip, &c. A Progress Report Based on an Inquiry Sent to Ten Operating Companies. H. L. Gaidry (*Proc. Amcr. Gas Assoc.*, 1936, 601-602).—Copper pipe in diameters from $\frac{3}{4}$ to 3 in. has proved satisfactory for underground gas conduits where steel pipe corrodes rapidly. The cost for a 3 in. pipe is about 50% greater than that of steel, but only 1-2% greater than that of cast iron. Copper pipe is readily jointed with Sil-Fos solder. One company in America uses copper pipe to replace corroded steel pipe, the copper being pulled through the steel. Another company reports satisfactory service of copper pipe for drip connection to gas mains and as suction lines out of drip pots. Several companies advance reasons against the use of copper pipes, but these are apparently not based on experience.—A. R. P.

Wrought Copper Base Alloys. D. K. Crampton (Indust. and Eng. Chem., 1936, 28, (12), 1397-1400; discussion, 1400-1401; and (summary) Waste Trade World, 1937, 50, (18), 9-11) .- Copper tubes are being used increasingly for all water supplies, for pulp lines in the paper industry, air lines, oil supply lines, vapour lines, &c. For gas lines, where the sulphur content of the gas is high, the tubes are tinned. Red brass (copper 85, zinc 15%) is preferred for resistance to corrosive waters, showing immunity to dezincification type of attack and being superior to copper in resisting pitting attack. Coppernickel alloys are gaining ground in the condenser tube field. Silicon-bronzes are diversely applied, e.g. tanks, kettles, evaporators, bolts, springs, agitators, Fourdrinier wire, &c. Aluminium-brass and tin-aluminium-brass are used in condensers. Antimony is being added to many brasses to prevent dezincification. Alloys of great promise are the aluminium-nickel-copper alloys (1.5: 7.5: 91.0 and 3.0: 150: 820, respectively). The former is worked hot or cold, the latter is only hot-worked; both are improved by precipitationhardening. The addition of beryllium or silicon to brazing rod of the Muntz metal type confers non-fuming properties .- F. J.

Beryllium-Copper Alloys. Horace F. Silliman (Indust. and Eng. Chem., 1936, 28, (12), 1424–1425).—The chemical and physical properties of beryllium-copper alloys are described and illustrated by Masing's equilibrium diagram, as modified by Borchers and by Tanimura and Wassermann. Fatigue and wear resistance, cold-working, hot-working, annealing, heat-treatment, pickling, welding, soldering, and uses of the alloy containing 2·15% beryllium are well discussed.—F. J.

New Metals and Alloys from Lead, Tin, Zinc, and Antimony. George O. Hiers (Indust. and Eng. Chem., 1936, 28, (12), 1406–1408; discussion, 1409– 1411; and Dutch Boy Quarterly, 1936, 14, (3), 23–24).—Lead is prominently used in the heavy chemical industry and in other lines. When alloyed with a few hundredths of 1% tellurium, it meets drastic conditions successfully, this material of construction being superior to ordinary lead on account of its good corrosion-resistance supplemented by improved mechanical properties. Lead alloyed with antimony up to 28% (commonly with about 6%) is used in appreciable quantities on account of its physical properties. A lead alloy containing 1% silver and another containing 7% tin are used for special purposes. Pure tin is used with chemicals because of its corrosionresistance and non-toxie nature. Zine-coated metals and die-casting zine alloys are used in spite of somewhat limited corrosion-resistance.—F. J.

Development of the Magnesium Industry. James Rubinfield (Chem. Eng. Min. Rev., 1937, 29, (340), 153–154).—Statistics of production are given, and the applications of magnesium and its alloys are briefly described.—J. H. W.

On the Advantages and Economy of Monel Wire Mesh Products in the Working of Raw Materials. Rud. Müller (*Draht-Welt*, 1936, 29, (47), 647–649).—Monel metal wire sieves have a much longer life than sieves of brass, bronze, or tinned iron in the wood pulp and paper-bleaching processes, for filtering alkaline liquors, for use with various salts and alkali products, and in the clarification of mineral oils. In addition to a high resistance to corrosion it has also a good resistance to erosion.—A. R. P.

Nickel and Corrosion-Resisting Nickel Alloys. Robert J. McKay (Indust. and Eng. Chem., 1936, 28, (12), 1391-1397).—The most useful developments in nickel alloys during the past few years are outlined. A general survey of the properties and corrosion-resistance of commercially-pure nickel is given, with reference to detailed figures. These properties serve as a basis for discussion of the newer alloys of nickel. The service properties of the Monel metals, the copper-nickel alloys and nickel-silvers, Inconel, nickel-clad steel, nickel electroplate, nickel and alloy welding-rods, and nickel cast-iron are outlined. The variation in physical properties and the degrees of corrosion resistance of these alloys are discussed in general terms.—F. J.

Silver, Gold, Tantalum, and the Platinum Metals. James A. Lee (Indust. and Eng. Chem., 1936, 28, (12), 1412-1415; discussion, 1415-1416; and (summary) Waste Trade World, 1937, 50, (19), 5-7).—Silver has been used to a limited extent for chemical equipment for many years, but recent economic changes have extended its use in chemical industry. Fine silver is preferred, sterling and coinage silver not being so chemically resistant, although being stronger; other silver alloys are seldom used. The initial cost is high, but much of the metal is salvaged when the vessel is scrapped. Platinum, gold, palladium, and tantalum are utilized, but only in relatively small quantities and only in vital spots and for extreme conditions under which no other material would be satisfactory. The success of failure of the operation of equipment or process generally depends on their successful performance.

-F. J.

The Uses of Tungsten : Its Manufacture. Julius L. F. Vogel (Alloy Metals Rev., 1937, 1, (3), 25-29; and Metallurgia, 1937, 15, (89), 149-150).—Abridged from a paper read before the 'Tavoy Chamber of Mines, Burma. A brief history is given of the use of tungsten in alloy steels, and of their manufacture. Attention is directed to the variation in composition of the crude tungsten with the source of raw material and the effect of this on the properties of tungsten alloy steels.—I. J.

Advances in the Field of Hard Alloys. K. Becker (*Metallwirtschaft*, 1937, 16, (8), 196–197).—Reviews German and foreign patents dealing with sintered hard metals issued since July 1936.—v. G.

Metals from Powders. Charles Hardy (Inco, 1936, 14, (3), 15, 28-29).—A description of some examples of the applications of metal powders in manufacture.—R. G.

Evolution of New Metals. B. D. Saklatwalla (Indust. and Eng. Chem., 1936, 28, (12), 1366-1373; discussion, 1373-1374; and (summary) Waste Trade World, 1936, 43, (185), 6, 8).—Recent developments in metals and alloys are discussed. In the case of pure metals, improvement seems to have been achieved by two diametrically opposite paths; the one by obtaining the metals in a super-pure state, the other by adding to pure metals very small traces of impurities. In spite of the advance in the art of alloying, a strong tendency exists towards composite metal articles where two different metals are united by some process of adherence, such as sintering, welding, electroplating, &c. Similarly, there are possibilities of composite articles of metals and non-metals. The importance of corrosion and high-temperature resistance is stressed. For the chemical engineer, suitable metals are just as necessary for handling waste effluents and for shipping containers as for process equipment.—F. J.

[†]Thermionic Vacuum Tube Electrode Materials. Fred P. Peters (*Electrochem. Soc. Preprint*, 1937, (Apr.), 339–363).—A critical review of the functions and necessary properties of the various metals now used in thermionic valve construction. The importance of the closest control is stressed throughout the paper. Particular attention is given to the effect of impurities on the electrical and mechanical properties of nickel cathodes, and useful new data on the properties of special alloys, which have recently been developed as core metals, are presented. The specific advantages of carbonized nickel, molybdenum, and iron for use as anodes are discussed. Grids, formerly made of molybdenum wire, are now being constructed of cheaper materials, such as alloys of nickel-chromium, manganesc-nickel, or nickel-iron-molybdenum.

and tables are given of the mechanical properties of these alloys at both normal and elevated temperatures. 50 *references* are given in the text.—C. E. R.

Metal in Vacuum Tubes. J. Delmonte (*Metal Progress*, 1937, 31, (5), 518–523).—Metals commonly used in the cathodes, grids, anodes, sheaths, and "getters" of vacuum tubes are reviewed. The work-function and (where known) the melting point of 21 non-ferrous metals are tabulated in comparison with iron and calcium oxide; important properties of tantalum, tungsten, molybdenum, nickel, copper, and platinum are summarized, and the emission-temperature properties of tungsten filaments are shown graphically. The requirements for anode materials are enumerated and discussed in connection with the substances in common use for the purpose.—P. R.

Materials for Fine Mechanical Constructions. U. von Moellendorff (Ma-schinenbau, 1937, 16, (9/10), 247-250).—The uses of bronzes for bearings and springs, of bimetals for contacts and temperature regulators, and of aluminium alloys for moving parts are briefly discussed.—v. G.

Discussion of New Metals in the Pulp and Paper Industry. J. D. Miller (Indust. and Eng. Chem., 1936, 28, (12), 1389-1390) .- Particularly severe service conditions and the most recent applications of new materials to old processes and of both old and new materials to new processes and equipment are discussed. Galvanic corrosion has been experienced where stainless steels have been used with bronzes, both materials having prematurely failed. Stainless steels, Monel metal, nickel, and Inconel are used for valve trim and for tubes in "black liquor" evaporators used in the alkali recovery process. The introduction of new bleaching processes involves direct treatment of the pulp with chlorine, and has resulted in severe corrosion problems in pulp-washing equipment. Inter alia, Monel metal is being tested for wire cloth and winding wire on pulp-washers. Stock lines and white-water lines, formerly of wood or cast iron are being replaced by copper. There has been considerable increase in the use of chromium-plating. Chromium-plated bronze screens maintain the desired slot width longer than unplated screens. Brass and phosphor bronze remain the favoured material for wire-cloth for the Fourdrinier machines. Monel metal finds favour in several specifically mentioned applications .- F. J.

Effect of Substitution in Power Vehicle Construction on the Metal Industry. —— (Metallwirtschaft, 1937, 16, (8), 176–180).—The substitution of German for imported raw materials in automobile construction is discussed, with especial reference to the alloying elements in steels, to bearing metals, to coolers, and to the use of magnesium and zine alloys in various parts.—v. G.

Native [German] Materials for Water Heating Units Operated by Coal, Gas, or Electricity. —— (Illust. Zeit. Blechindustrie, 1937, 66, (18), 528-530; (19), 562-564).—The use of copper in water-heaters in Germany is now restricted to high-pressure units. The amount of copper used may be diminished either by the substitution of entirely different materials (aluminium or its alloys, zinc, enamelled or copper-plated sheet, &c.) or by employing copper alloys of high strength. Both methods, with the relevant modifications in practice, especially in regard to joining, are discussed in detail, and a tabulated summary reviews the practicability of a variety of materials for different purposes.—P. M. C. R.

When Specifying Alloys for Equipment. —— (Eng. and Min. J., 1937, 138, (5), 239–240).—Outlines the applications of alloy steels for mining equipment. Tables of analysis of alloys for resistance to oxidation and corrosion, impact and abrasion, and strength, toughness, and ductility are included.

-R. Gr.

Restrictions Bring Improved Materials. Reorganization in the German Metal Industry. Hansheinvich Pontani (Met. Ind. (Lond.), 1937, 50, (23), 621-624).—Describes the work of the technical department of the Metallgesellschaft A.G. in developing new materials to replace those withdrawn from the market by the German Government. New Zamak zine alloys, improved lead-base bearing metals (Bahnmetall), Bonderizing, Sigal aluminium-silicon pigments for rust-proofing, and the new light alloy "Pantal 5," are mentioned.—H. W. G. H.

XXII.---MISCELLANEOUS

(Continued from p. 269.)

Albert Sauveur. Lionel S. Marks (J. Applied Physics, 1937, 8, (3), 160–162).—An outline of the metallurgical career of Albert Sauveur, and an appreciation of his invaluable contribution to metallography.—I. J.

Non-Ferrous Alloys in Germany. Their Development Since 1933, and Their Present Status. Willi Claus (Bull. Assoc. Tech. Fonderie, 1936, 10, (12), 452-461).—A discussion concerning aluminium, magnesium, copper, nickel, tin, lead, zinc, and alloys. Data are tabulated for the mechanical properties of cast aluminium and magnesium alloys, aluminium bronzes, tinand lead-base white metals, and lead- and zinc-base pressure die-casting alloys.—W. D. J.

The Early Production of Copper and Copper Alloys. I; II.—Bronze; III.—The Brasses. Maurice Cook (Met. Ind. (Lond.), 1937, 50, (18), 511– 515; (19), 534-537; (20), 557-559).—A fascinating story begins before 4000 B.C., tracing the development of copper metallurgy from the First Dynasty to the Middle Ages—a clearly-presented picture of an immense subject.—H. W. G. H.

The Nickel Industry. Robert C. Stanley (*Found. Trade J.*, 1937, 56, (1066), 50-53).—A survey of the progress of the nickel industry in 1936, with particular reference to the uses of the metal and its alloys in various branches of engineering.—J. C. C.

Metallurgical Development and Engineering Progress. (Sir) William Larke (J. Record Trans. Junior Inst. Eng., 1937, 47, (4), 125-146; also Mech. World, 1936, 100, (2677), 611-612, 619, 626; (2608), 641, 650-651; 1937, 101, (2609), 6, 13; and (summarics) Engineering, 1936, 142, (3702). 695-696; Machinery Market, 1937, (1887), 23-25; (1888), 19-20.—Presidential Address to the Junior Institution of Engineers.—S. G.

Dangerous Dust and Fumes Cause of Industrial Diseases. F. M. R. Bulmer (Canad. Mach., 1937, 48, (5), 27-29).—From an address delivered before the Toronto-York Division of the Industrial Accident Prevention Association. The principal types of industrial dust are considered : harmful metallic dusts, characteristic effects of which are given, include lead, cadmium and arsenic compounds, whilst siliceous dust is associated with numerous finishing processes.—P. M. C. R.

XXIV.—BOOK REVIEWS

(Continued from pp. 273-276.)

S.A.E. Handbook, 1936 Edition. $5\frac{1}{2} \times 8\frac{1}{2}$ in. Pp. xxviii + 776, 1936. New York : Society of Automotive Engineers, 29 West 39th St. (Members, \$2.50; non-members, \$5.00.)

This useful publication, which includes all current standards and recommended practice adopted by the Society of Automotive Engineers, has just been published. It contains the new and revised specifications as well as the usual engineering tables common to such handbooks. In addition to the chapters of special interest to automobile engineers dealing with details of upholstery, leather, reflectors, lamp tests, lubrication data, &c., there are valuable chapters concerned with composition, treatment, and properties of steels and non-ferrous alloys. An indication of present-day American practice is to be found in the inclusion of grain-size charts. The publication is well printed and of a convenient size.—J. H. ANDREW.

Metals Handbook, 1936 Edition. Med. 8vo. Pp. xvi + 1392, illustrated. 1936. Cleveland, O.: American Society for Metals, 7016 Euclid Ave. (Non-members, \$10.00; future editions \$5.00 if previous issue returned.)

This handbook, which is composed of over 1350 pages of matter, is virtually a Metallurgical Encyclopedia, possessing that detailed finish so often associated with American technical books. Its great asset is that each chapter is compiled either by a committee especially chosen for the purpose or else by individuals who have distinguished themselves in the realms of metallurgical science. To detail its contents would occupy too much space, but it may be said that, compared with the 1935 edition, the size of the volume and the subject-matter covered has almost doubled.

The arrangement of the text is systematic. After twenty pages or so of general data, there follows a special chapter on testing, mechanical, spectrographical, and radiographical. Chapters on welding and eutling of metals, processes, methods, and equipment are exceedingly well done.

The constitution, treatment, and testing of ferrous alloys occupies a large part of the volume, and is followed by a non-ferrous section in which the important industrial metals and their alloys are dealt with. Naturally, a book covering such a wide field cannot be expected to deal exhaustively with any one factor, and one has to accept the views of the particular authority concerned with the writing of the chapters. Even so, however, the data put forward have been well considered, and the conclusions reached in general are logical and complete.

As a reference book the handbook will serve an extremely useful purpose, and metallurgists requiring an accurate and concise account of any particular metallurgical feature will be wise to consult this volume. The printing and illustrations are particularly good.—J. II. ANDERW.

Bearing Metals and Alloys. By Henry Norman Bassett. With a Foreword by Sir Henry Fowler. Demy 8vo. Pp. xiv + 428, with 9 plates, 9 illustrations in the text. 1937. London: Edward Arnold and Co. (25s. net.)

The literature devoted to bearing materials is now so extensive that any attempt to consolidate it must be welcomed. Corse's " Bearing Metals and Bearings," although a valuable reference book, does not attempt to do so: the present book does. Its origin was a card index system kept by the author. This he found so useful that he has put it together in summarized form in this volume, which is intended (see preface) for the works manager and designer, and the engineering user generally, rather than for the "research worker." Any book so con-structed must inevitably reflect the method adopted. The woods tend to be lost in the trees. Again, card indices accumulate a good deal of extraneous matter, and some of that included does not appear to fulfil any need of the user specified. The crystal structure of metals and alloys (pp. 72-80), the effect of various impurities on the properties of pure copper (pp. 234-238), inverse segregation (pp. 255-265), the micro-examination of bearing metals (pp. 389-403), &c., are important to the manufacturer of bearing metals, and to the metallurgist, but do not interest the user in question. He does want to know, for example, the relative advantages of the-base and lead-base alloys, but I do not think that he will study some 19 pages detailing the individual effects of 10 different metals (incidentally, not treated in alphabetical order) on the lead-base alloys (pp. 88-107). The uses of tin-base alloys arc indexed, but not those of lead-base alloys, and there is not very much information as to the purposes for which each should be employed. The uses of bearing alloys as a whole are again dealt with in Appendix II (pp. 404-405), which seems rather an afterthought, because no reference to it appears in the index. It is thus difficult to find one's way about this book; sometimes, also, to find the information required, this being not always a criticism of the book itself, but merely disclosing gaps in existing knowledge.

Despite these criticisms, the book has naturally much to commend it. It brings together an enormous mass of data, including much of specific value to the user, such as the sections on lubrication and operating conditions in bearings, the quality of oiliness, suce of colloidal graphite, lubrication of gears, hot bearings, seizing, effects of lubricants on bearing metals, &c. The theory of bearing metals is discussed in detail, and there is much information covering mechanical properties, joint adhesion, wear-resistance, properties at elevated temperatures, and so forth. Chapters are devoted to copper alloys, zine-bronzes, lead-bronzes, and phosphorbronzes, and the lead-alkali metal, cadmium-base and other special bearing alloys are adequately treated.

On the whole, this book will be found of considerable value, and, in view of the present diffused state of the information on bearing materials, should appeal particularly to the metallurgist. It is well produced, and represents a good investment to anyone interested.

-R. T. ROLFE.

Metallic Corrosion, Passivity, and Protection. By U. R. Evans. Med. 8vo. Pp. xxiii + 720, with 93 illustrations. 1937. London: Edward Arnold and Co. (45s. net.)

To read and digest this work thoroughly would take so long that any adequate review would be out of date; the author's great reputation is sufficient guarantee of an authoritative treatment, and it remains, therefore, but to indicate the plan and scope of the book.

In the first place, it should be emphasized that all who encounter corrosion—" the Practical Men and the Pure Scientists "—will find full consideration given to their points of view. Each chapter is divided into three sections: the (A) sections deal with The Scientific Basis, the (B) sections discuss Practical Problems, and the (C) sections provide a Quantitative Discussion for the mathematical reader. A typical example is given by Chapter 8—" influence of Constituents of the Liquid "—which is subdivided as follows:

(A) Substances acting both as Stimulators and Inhibitors. Restraining action of Absorbed Substances. Influence of Oxidizing Agents and Oxygen-Carriers. Influence of Substances which remove Metallic Cations. Other Influences.

(B) Control of Corrosion by Additions to the Corrosive Liquid. Control of Corrosion by Chemical or Electrochemical Pre-treatment. Boiler Problems.

(C) Theoretical Conclusions from Statistical Researches.

Although a knowledge of the (A) sections is necessary for a full understanding of the (B)'s, many will be relieved to find that the (C)'s can be omitted completely without destroying the continuity of the argument. On the other hand, these (C) sections provide, *inter alia*, an explanation of statistical methods, as applied to research problems, which is clearer, more concise, and more free from ambiguity than any mathematical treatise we have seen.

Concise, and more free from ambiguity than any mathematical treatise we have seen. The scope of the book is immense, ranging from the theory of contact potentials to the enamelling of saucepans. The chapter headings are: (1) Simple Examples of Corrosion and Passivity; (2) Thin Films; (3) Oxidation at High Temperatures; (4) Atmospheric Corrosion and Tarnishing at Ordinary Temperatures; (5) Corrosion by Stagnant Liquids; (6) Corrosion by Moving Liquids; (7) Hydrogen Evolution; (8) Influence of Constituents of the Liquid; (9) Influence of the Major Constituents of the Metallle Phase; (10) Influence of the Minor Constituents of the Metallic Phase; (11) Influence of Stress and Strain; (12) Influence of Contacts and Crevices; (13) Protection by Metallic Contings; (14) Protection by Paints and Enamels; (15) Testing. Some idea of the thoroughness of the treatment is given by the list of over 300 periodicals, to which reference is made, and the Author Index, which contains nearly 1700 names.

Brilliant scientists, like politicians, pass through a stage of vigorous controversialism before attaining the judicial calm which accurate weighing of evidence requires. This book is written by an "elder statesman," who presents the most controversial aspects of his subject in a way which provides both a dispassionate account of the various theories involved, and, at the same time, a clear indication of his own opinion. In order to preserve complete impartiality on the vexed question of differential acration, for example, the author includes the views of the Teddington school as an additional section to Chapter 5, written by Dr. Bengough and Dr. Wormwell.

The publishers have unfortunately failed to realize that it is a privilege to publish a work of this eminence. The binding should be considerably stronger in view of the continual handling to which this book will be submitted, and should permit the pages to lie flat without the ald of paper-weights. Table 15, pp. 148 and 140, is a disgraceful example of careless printing. "Birmabright" is spelt correctly in the text, but incorrectly in the index.

These are but quibbles; there is no doubt that this is the book on corrosion, and no chemist, metallurgist, or engineer can afford to be out of reach of it.-H. W. G. HIGNETT.

Löten und Lote. Von E. Lüder. 2., verbesserte und erweiterte Auflage. Herausgegeben vom Ausschuss für wirtschaftliche Fertigung (AWF) beim Reichskuratorium für Wirtschaftlichkeit. 15×21 cm. Pp. 66, with 33 illustrations. 1936. Berlin : Beuth-Verlag G.m.b.H. (R.M. 1.75.)

The technique of soft soldering, brazing, and silver soldering is described in this booklet. Sufficient of the theory underlying the various alloy compositions, fluxes, and methods of treatment is included to make clear the descriptions, and excellent diagrams are an additional advantage. This is a most useful booklet at a very reasonable price.—H. W. G. HIGNETT.

Nouveau Barême de Soudure Autogène Oxy-acétylénique. 10.5×13 cm. Pp. 32. 1936. Paris : Institut de Soudure Autogène. (2 francs.)

The subject-matter of the booklet appeared in *Rev. Soudure Autogene*, 1936, 28, (264), 2-9 (see *Met. Abs.*, 1936, 3, 221). In its present form, it is a handy little pocket-book crammed with data of importance to welders.—H. W. G. HIGNETT.

Documents sur les nouvelles méthodes de Soudure Autogène oxy-acétylénique. Par R. Meslier. 13 × 21 cm. Pp. 72, illustrated. [1936.] Paris : Office central de l'acétylène et de la soudure autogène. (10 francs.)

This booklet consists of the reprints of four papers, of which the last is the "Nouveau Barême" reviewed on p. 315. The other three refer entirely to ferrous welding and present the responsible, in comparison with arc-welding and riveting.—II. W. G. HIGNETT.

Copper and Bronze Welding of Tube and Sheet Copper for Piping Installations and Roof Work. By W. L. Kilburn. Demy 8vo. Pp. 157, with 143 illus-trations. [1936.] London : The British Oxygen Co., Ltd., Thames House, Millbank, S.W.I. (5s. net.)

In addition to the ordinary tools of his craft, the modern plumber has a complete welding equipment to leave behind. The rapid development of copper piping for water services and sanitary installations is largely due to the improved methods of jointing made possible by the welding blowpipe. This eminently practical book is written by an authority on modern plumbing whose pioneer work has done much to further the use of welding, and particularly bronzewelding, in this field. The book describes the equipment required and gives detailed instructions for its safe manipulation. The principles of welding and bronze-welding copper are explained, and full instructions are given in the technique to be adopted for various types of joint in pipe-work. The last chapter deals with the use of copper in roof-work and the methods of welding.

An important feature of the book is the comparison of alternative jointing methods, e.g. Sub joints, bell joints, and the use of weldable fittings, for different types of installation. One must object to the term "flash-weld," as used for welding the tirred-up edges of sheet, since it has a well-established meaning as a form of resistance welding; and one suspects that the author is far from clear in his own mind with regard to the principles underlying the hammering and annealing of copper welds. This is a useful book, well printed and illustrated, which can be recommended to all those for whom it is written .- H. W. G. HIGNETT,

Materials of Industry. Their Distribution and Production. By Samuel Foster Mersercau. With an Introduction by Albert J. Colston. Revised Edition. Pp. 541. 1936. New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd. (12s.)

This book is based on the requirements of a course developed in the Brooklyn Technical High School over a period of several years, designed to give first-year students systematic instruction in the materials and processes of industry, and running parallel with the practical courses. There are live chapters, dealing with forest products, non-metallic minerals, iron and steel, non-ferrous metals, and miscellaneous materials, such as rubber, paint, &c. The treatment is almost free from theoretical considerations and yet is remarkably clear, although at times one wonders whether the little knowledge imparted may not be dangerous. The very brief discussion of non-ferrous metals is insufficient to be really informative : for example, the sentence (p. 482)-" Duralumin is the name often applied to a class of light alloys that are susceptible to heat-treatment and ageing phenomenon," would require considerable explanation to those for whom this book is intended. This criticism is to some extent answered by the provision of a bibliography at the end of each chapter, where there is also a series of carefully graded questions.—II. W. G. HIGNETT.

Dictionary of Terms Used in the Theory and Practice of Mechanical Engineering. Comprising approximately 8000 Definitions. Originally Compiled by J. G. Horner. Sixth Edition, with Appendix. Revised and Enlarged by E. H. Sprague. Demy 8vo. Pp. iv + 508. 1936. London : The Technical Press, 1.td. (12s. 6d. net.)

Unacknowledged references to Horner's Dictionary have probably enabled many young engineers and metallurgists to parade a knowledge of practical engineering terms incompatible with their years and experience, and for sentimental reasons alone it is good to see that the present revision of an old acquaintance has left the main body of definitions intact. It is true that some of the original definitions now seem rather quaint and old-fashloned, and some of the additions will certainly give rise to arguments; but those who have endeavoured to draw up a few exact scientific or technical definitions for subsequent discussion by experts will realize very fully the difficulties involved in producing the present 8000 definitions. It is enough to say that some are better than others. Members of the Institute may smile at some of the theoretical definitions, but they should feel grateful for the explanations of many words which by long workshop usage have acquired meanings somewhat different from those commonly understood in more high-brow literary circles .- G. A. HANKINS.