JUNKER

Electric Furnaces

FOR ALL PURPOSES

Built in England of British Materials.

During the last five months of 1933 orders of 44 Junker Furnaces, totalling 3391 KW capacity, were executed; this success has been followed by the booking of orders, *during the first quarter of* 1934, for the following:

FOR THE NON-FERROUS TRADES:	
1 Rolling-feed Billet Heating Furnace, producing about 5 tons per hour	750 KW
1 Continuous Furnace for Annealing Sheets of Brass and Copper	150 KW
3 Complete Continuous Annealing, Pickling, and Drying Plants for Strip	120 KW
1 Rolling-feed Billet Heating Furnace for Aluminium	80 KW
2 Tube Annealing Furnaces for Brass and Aluminium	240 KW
1 Pot Furnace for Wire, 44″ Ø × 75″	90 KW
1 Bright Annealing Furnace for Copper Wire	30 KW
2 Hood Furnaces, 20″ Ø × 40″	100 KW
FOR THE STEEL INDUSTRY:	
1 Fork Heating Furnace	36 KW
1 Hardening Furnace for high-speed Steel	8 KW
1 Rim-type Muffle Furnace	15 KW
1 Rim-type Forging Furnace	15 KW
1 Rim-type Hardening Furnace	10 KW
1 Hardening Furnace, Muffle type	7 KW
1 Rim-type Hardening Furnace	15 KW
1 Salt-bath Furnace	15 KW
FOR THE CERAMIC INDUSTRY:	
1 Rim-type Hood Furnace for Glazing Tiles	90 KW
1 Continuous Furnace for Glazing Bricks	60 KW
1 Continuous Furnace for Baking Mosaic Tiles	30 KW
1 Enamelling Furnace, 44″ × 88″ × 12″	90 KW
MISCELLANEOUS:	
1 Casting-mould Heating Apparatus	50 KW
1 Furnace for Drying Lacquer	8 KW
TOTAL (3 months)	2009 KW

The Junker method of heat-insulation, dispensing with practically all interior masonry, ensures absolute minimum heat-loss and current consumption, combined with high efficiency and extreme reliability.

For further particulars apply to:

J. L. BROOKLAND
WATERLOO HOUSE, WATERLOO STREET,
BIRMINGHAM, 2

'Phone: Midland 4242.   *'Grams:* "Brookland, Birmingham."

Also Water-Cooled Moulds for Brass, Copper and Nickel Alloys.

PRINTED IN GREAT BRITAIN BY RICHARD CLAY AND SONS, LTD., BUNGAY, SUFFOLK.

Contains papers to be printed in the
half-yearly volume:
Journal of the Institute of Metals, 1934,
Vol. LV.

Vol. 1. **Part 5.**

The Monthly Journal of the
INSTITUTE OF METALS

and

METALLURGICAL ABSTRACTS

MAY, 1934

Fig. 1

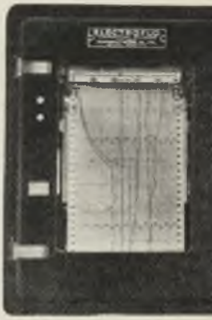
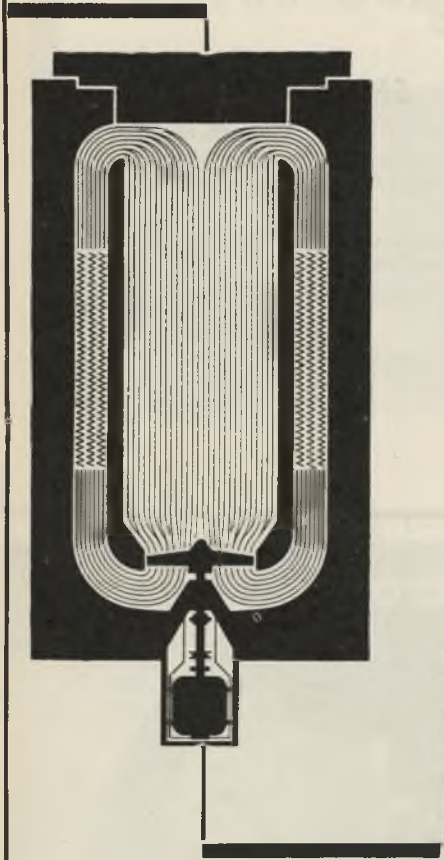
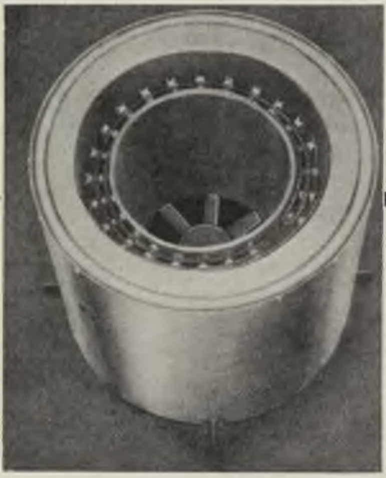
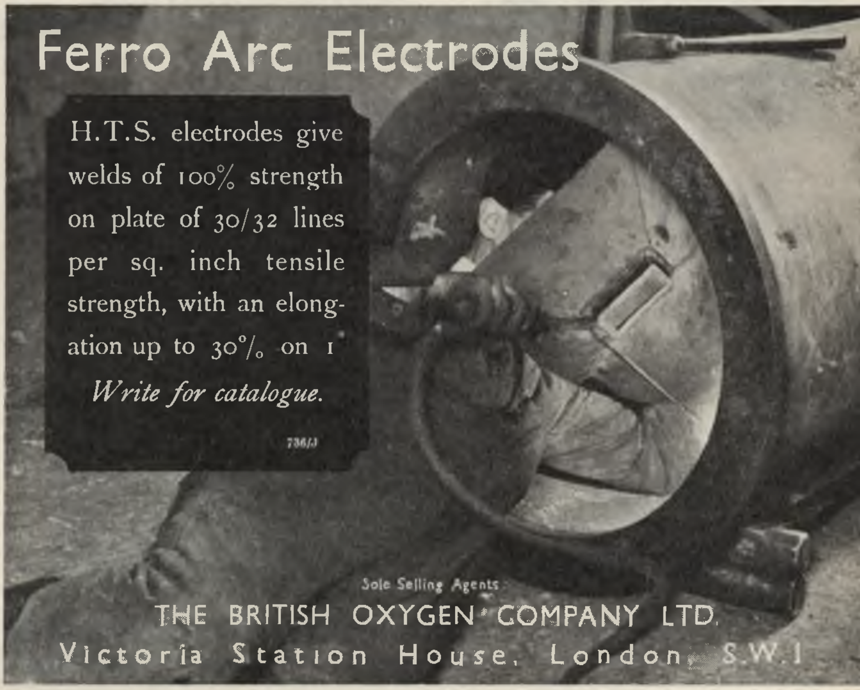


Fig. 2

“Perfecta” Regulator on Oil Tempering Pot





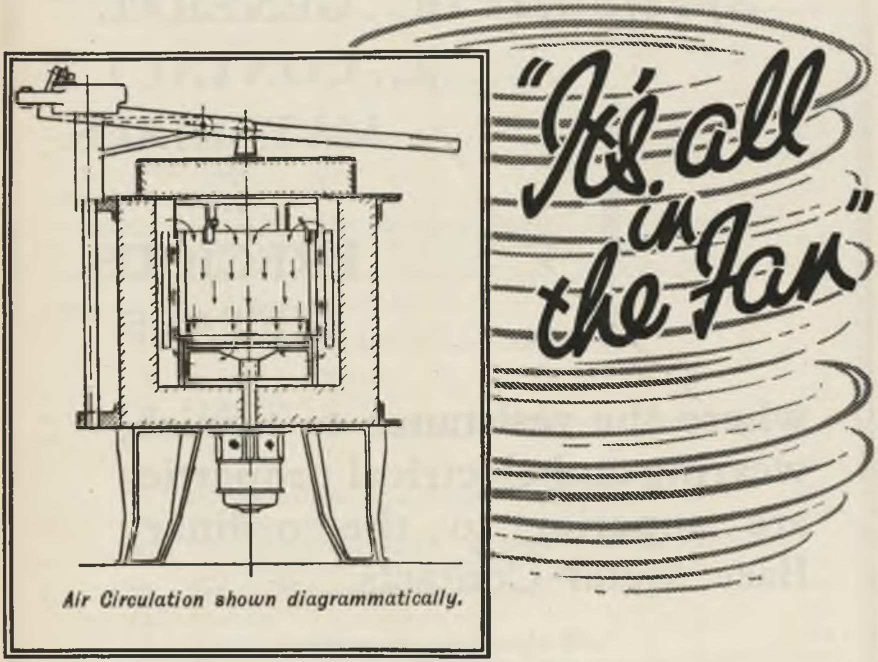


INDEX TO ADVERTISERS

MAY, 1934

PAGE
Advertising Association . . . . —
Aluminium Plant & Vessel Co., Ltd. . —
Amsler & Co., Alfred J. . . . —
Association Technique De Fonderie . ii
Appointments Required . . . —
Avery, Ltd., W. & T. . . . —
Birmingham Electric Furnaces, Ltd. . vi
Bolton & Sons, Ltd., Thomas . . —
Booth & Co. (1915), Ltd., James . v
British Aluminium Co., Ltd., The . iii
British Metal Corporation, Ltd., The . ii
British Oxygen Co., Ltd., The . . x
Brookland, J. L. xviii
Busch Optical Co., Ltd., Emil . . —
Calorizing Corporation of Great Britain, Ltd.. . . . . —
Chapman & Hall, Ltd. . . . —
Cooke, Troughton, & Simms, Ltd. . —
Ebonestos Insulators, Ltd. . . —
Electric Resistance Furnace Co., Ltd.. —
Electroflo Meters Co., Ltd. . . iv
Elliott Bros. (London), Ltd. . . —
Elton, Levy & Co., Ltd. . . . x
Erichsen, A. M. . . . . —
Fordath Engineering Co., Ltd. . . —
Foster Instrument Co. . . . —
General Electric Co., Ltd. . . —
Goodlass Wall & Lead Industries, Ltd. . . . . . . —

PAGE
High-Duty Alloys, Ltd. . . . —
Hilger, Ltd., Adam . . . —
I.C.I. Metals, Ltd. . . . . —
Johnson, Matthey & Co., Ltd. . . xiv
Krupp Grusonwerk, A.-G. . . —
Leitz (London), E. . . . . —
Locke, Lancaster & W. W. & R. Johnson & Sons, Ltd. . . . . —
McGraw-Hill Publishing Co., Ltd. . —
McKechnie Bros., Ltd. . . . xvii
Metropolitan-Vickers, Ltd. . . —
Mills, Ltd., Wm. . . . . —
National Alloys, Ltd. . . . xvi
Northern Aluminium Co., Ltd.. . xi
Pearson, E. J. & J., Ltd. . . —
Perfecta Gas Thermostats, Ltd. . vii
Pitman & Sons, Ltd., Sir Isaac . . xvii
"Prior" Oil Burners Ltd., The. . —
Ratcliff (Metals) Ltd., J. F. . . xii
Schloemann, A.-G. . . . . —
Siemens-Schuckert (Gt. Britain) Ltd.. ix
Stewarts and Lloyds, Ltd. . . —
Thermal Syndicate, Ltd. . . . viii
University College of Swansea . . —
Watson & Sons, Ltd., W. . . —
Wild-Barfield Electric Furnaces, Ltd. xiii
Wolfram Diamond Machine Manufacturers, The viii
Zeiss (London), Ltd., Carl . . —



Air Circulation shown diagrammatically.

EDITORIAL OFFICE:
36 Victoria Street,
London, S.W.1.

TELEPHONE:
Victoria 2320.

Editor:
G. SHAW SCOTT,
M.Sc., F.C.I.S.

THE
Monthly Journal of the
INSTITUTE OF METALS

ADVERTISING DEPARTMENT:
T. G. SCOTT & SON, Ltd.
63 Ludgate Hill,
London, E.C.4.
TELEPHONE:
CITY 4211 (2 lines).
Assistant Editor:
S. C. GUILLAN

Volume 1 MAY, 1934 **Part 5**

CONTENTS

PAGE
Institute News and Announcements 195
Letters to the Editor 199
Personal Notes 200
"The Corrosion of Tin and Its Alloys. Part I.—The Tin-Rich Tin-Antimony-Copper Alloys." By T. P. Hoar, M.A., Ph.D. . . . 201
"Some Properties of Heavily Cold-Worked Nickel." By H. Quinney, M.A. 215
Author Index to "Metallurgical Abstracts" 227

METALLURGICAL ABSTRACTS

I. Properties of Metals 225
II. Properties of Alloys 231
III. Structure (Metallography; Macrography; Crystal Structure) 237
IV. Corrosion 240
V. Protection (other than Electrodeposition) 245
VI. Electrodeposition 248
VII. Electrometallurgy and Electrochemistry (other than Electrodeposition and Electro-refining) 248
VIII. Refining (including Electro-refining) 249
IX. Analysis 250
X. Laboratory Apparatus, Instruments, &c. 252
XI. Physical and Mechanical Testing, Inspection, and Radiology 254
XII. Temperature Measurement and Control 256
XIII. Foundry Practice and Appliances 257
XIV. Secondary Metals: Scrap, Residues, &c. 260
XV. Furnaces and Fuels 260
XVI. Refractories and Furnace Materials 262
XVII. Heat-Treatment 263
XVIII. Working 265
XIX. Cleaning and Finishing 266
XX. Joining 266
XXI. Industrial Uses and Applications 269
XXII. Miscellaneous 274
XXIII. Bibliography 275
XXIV. Book Reviews 281

The monthly issue of *Metallurgical Abstracts* may be cut up for card indexes, as members will receive early in 1935 the year's abstracts in bound form.

INSTITUTE NEWS AND ANNOUNCEMENTS

May Lecture.

On Wednesday, May 9, before a large gathering of members and visitors assembled in the Hall of the Institution of Mechanical Engineers, London, by the courtesy of the Council of that Institution, the Twenty-Fourth Annual May Lecture was delivered by Professor E. K. Rideal, F.R.S., on "Gases and Metal Surfaces." Prior to the lecture Professor Rideal was entertained to dinner by the Council; afterwards members met for light refreshments and conversation. The lecture will be reproduced in Volume LIV of the *Journal* that is due to be published next month.

Council Nominations for 1935–1936.

At the Autumn Meeting to be held in Manchester from September 3–6, the Council will present a list of names of persons nominated for office in 1935–1936. In accordance with the Rules, "*Any ten members may also, at or before such ordinary general meeting, nominate in writing, with the written consent to act if elected of the person nominated, any duly qualified person other than one of those nominated by the Council. . . .*"

Officers for 1934–1935.

At the recent Annual General Meeting of the Institute the following were declared to constitute the Council for the year 1934–1935.

President :

H. Moore, C.B.E., D.Sc., Ph.D.

Past-Presidents :

Professor Sir Harold Carpenter, F.R.S.
Sir John Dewrance, G.B.E.
Sir Henry Fowler, K.B.E., LL.D., D.Sc.
Richard Seligman, Ph.nat.D.
Leonard Sumner, O.B.E., M.Sc.
Professor T. Turner, M.Sc., A.R.S.M.

Vice-Presidents :

W. R. Barclay, O.B.E., London.
C. H. Desch, D.Sc., Ph.D., F.R.S., Teddington.
A. G. C. Gwyer, B.Sc., Ph.D., Warrington.
Professor D. Hanson, D.Sc., Birmingham.
H. C. Lancaster, London.
E. L. Morcom, M.A., Birmingham.

Honorary Treasurer :

John Fry, London.

Members of Council :

Professor J. H. Andrew, D.Sc., Sheffield.
Engineer Vice-Admiral H. A. Brown, C.B., London.
H. W. Brownsdon, M.Sc., Ph.D., Birmingham.
Engineer Vice-Admiral Sir Robert Dixon, K.C.B., D.Eng., London.
Maurice S. Gibb, C.B.E., J.P., West Hartlepool.
K. Gray, Sheffield.
H. H. A. Greer, J.P., Glasgow.
J. L. Haughton, D.Sc., Teddington.
Professor R. S. Hutton, D.Sc., M.A., Cambridge.
Wesley Lambert, C.B.E., A.K.C., London.
A. H. Mundey, London.
A. J. G. Smout, Birmingham.
James Steven, Glasgow.
F. Tomlinson, Manchester.
H. B. Weeks, London.

Committees of the Institute.

The following is a list of the Committees appointed by the Council for the year 1934–1935 :

Finance and General Purposes Committee.

Clarke, H. W.
Dixon, Engineer Vice-Admiral Sir Robert (*Chair*).
Lancaster, H. C.
Morcom, E. L.
Mundey, A. H.
Smout, A. J. G.
Turner, Professor T.

Ex-officio :

The President.
Ex-President.
Honorary Treasurer.
Chairman, Publication Committee.

Local Sections Committee.

Andrew, Professor J. H.
Barclay, W. R. (*Chair*).
Brownsdon, Dr. H. W.
Gray, K.
Griffiths, W. T.
Hanson, Professor D.
Haughton, Dr. J. L.
Mundey, A. H.
Thompson, Professor F. C.

Ex-officio :

The President.
Ex-President.
Honorary Treasurer.
Local Reception Committee's Representative.
Chairman and Secretary of:
  Birmingham Local Section.
  London Local Section.
  North-East Coast Local Section.
  Scottish Local Section.
  Sheffield Local Section.
  Swansea Local Section.

Meetings Committee.

Andrew, Professor J. H.
Barclay, W. R.
Brownsdon, Dr. H. W. (*Chair*).
Gwyer, Dr. A. G. C.
Hanson, Professor D.
Haughton, Dr. J. L.
Weeks, H. B.

Ex-officio :

The President.
Chairman, Publication Committee.

Membership Committee.

Andrew, Professor J. H.
Barclay, W. R. (*Chair*).
Brown, Engineer Vice-Admiral H. A.
Gray, K.
Lambert, W.
Lancaster, H. C.
Morcom, E. L.
Mundey, A. H.
Seligman, Dr. R.
Weeks, H. B.

Ex-officio :

The President.
Local Sections' Committee Representative.

Publication Committee.

Aitchison, Dr. L.
Brownsdon, Dr. H. W.
Desch, Dr. C. H.
Gwyer, Dr. A. G. C.
Hanson, Professor D.
Haughton, Dr. J. L.
Hutton, Professor R. S.
Seligman, Dr. R. (*Chair*).
Smith, Dr. S. W.
Smithells, Dr. C. J.
Turner, Professor T.

Ex-officio :

The President.
Chairman, Finance and General Purposes Committee.

Election of Members.

The next election of members is due to take place on Thursday, July 12. The Council trust that as this takes place at the beginning of a new financial year, there will be a large number of applications for membership to be considered at the July election. Membership application forms, literature regarding the Institute, and also specimens of the *Monthly Journal* for distribution to friends likely to be interested in the work of the Institute, may be obtained on application to the Secretary.

Local Sections.

At the annual meeting of the Local Sections Committee, held at the offices of the Institute on May 9, the reports of the several sections for the past session were presented and programmes for the coming session were submitted. The reports showed that the various sections had completed a very useful year's work and that there was every indication that a further period of activity was in prospect for next session. The following are the officers of the Local Sections for the session 1934–1935:

Birmingham Section.

Chairman: Maurice Cook, M.Sc., Ph.D.
Hon. Secretary: J. W. Jenkin, B.Sc., Ph.D.
Hon. Treasurer, G. Bill-Gozzard.

London Section.

Chairman: C. J. Smithells, M.C., D.Sc.
Hon. Secretary: J. McNeil, A.R.T.C.
Hon. Treasurer: H. J. Gough, M.B.E., D.Sc., F.R.S.

Institute News and Announcements

North-East Coast Section.

Chairman: W. Richardson, B.Sc.
Hon. Secretary: C. E. Pearson, M.Met.
Hon. Treasurer: H. Schofield.

Scottish Section.

Chairman: J. W. Donaldson, D.Sc.
Hon. Secretary: Harold Bull.
Hon. Treasurer: M. Brownlie.

Sheffield Section.

Chairman: Kenneth Gray.
Hon. Secretary: H. P. Gadsby, Assoc.Met.
Hon. Treasurer: Frank Mason.

Party at the Forges de la Providence, Charleroi.

Swansea Section.

Chairman: Professor L. Taverner, A.R.S.M.
Hon. Secretary: Roosevelt Griffiths, M.Sc.
Hon. Treasurer: A. E. W. Smith, B.Sc., Ph.D.

Educational Tour to Belgium.

Forty-five students took part in the Institute's first Educational Tour, which was made to Belgium last month. Arranged in co-operation with the National Union of Students, the tour was highly instructive and very enjoyable. It lasted from April 8 to April 14. Whilst the first four days were exceedingly strenuous, the last two days—spent in Brussels and Bruges respectively—came as a welcome relaxation from a long series of works' visits.

The party left Victoria Station, London, at 9.45 a.m. on April 8, and crossed from Dover to Ostend. Fine weather was experienced on the steamer, which, however, was considerably overcrowded owing to the return to Belgium of some 450 Belgian scholars who had been making a tour in England. On all trains accommodation had been reserved for the party, but owing to the large number of other travellers the reservations were not always respected.

The works' visits were both interesting and instructive, although in certain cases too few guides were allotted. As two large works were visited per day—each visit being of three hours' or more duration—and much time was occupied in getting to and from the works, the tour was somewhat strenuous. Members of the party would have appreciated more time in which to collect their thoughts and write up any notes on the various processes and plants inspected.

Works Visited.

John Cockerill, Liége.

The works occupy more than 300 acres, and the company employ some

10,000 workpeople. It is a most modern and up-to-date iron, steel, and engineering plant. The company manufacture their own coke for the blast furnaces, from their own coal. The coke is made in Semet–Solvay ovens with heat regenerators, and bye-products are recovered. The ovens are heated by blast-furnace or coke-oven gas. There are 150 ovens, and these produce 1300 tons of coke per day of 24 hours. The seven blast furnaces give a total output of some 1500 tons of pig iron per 24 hours. The necessary electric current for running the works is supplied by large gas engines, each of about 10,000 h.p.

The steel plant, which produces some 1400 tons of steel per day of 24 hours, consists of five Bessemer basic converters, each of 15 tons capacity, four small Siemens–Martin open-hearth furnaces of some 20 tons capacity each furnace, and two electric furnaces of 5 and 12 tons respectively. There are large up-to-date rolling mills and a smithy. In the latter are two large forging presses of some 2000–2500 tons. In the foundry, castings are produced up to 120 tons weight. In the engine shops, a large variety of engines are made, including locomotives, winding engines, gas engines, and turbines. After this visit, Professor Jamar of Liége University, escorted the party back to the Liége University Students' Hostel, where they were entertained to lunch. Mr. H. Harris proposed a vote of thanks to Professor Jamar, and this was carried with acclamation.

Société des Mines et Fonderies de Zinc de la Vieille Montagne, Flone.

In these works, the zinc concentrates (from Broken Hill, New South Wales) are first roasted in mechanical furnaces. Then the roasted concentrates are mixed with some 40 per cent. of coal, coke, or charcoal and the zinc distilled in retorts in the usual manner.

Société Anonyme d'Ougrée Marihaye, Liége.

An iron and steel works with 150 coke ovens recovering bye-products, seven blast furnaces with yearly output of 600,000 tons of pig iron, with the usual Bessemer basic converters, rolling mills, &c. An up-to-date plant with output of 600,000 tons annually of Bessemer basic mild steel, also open-hearth plant of some 100,000 tons annual output, rolling mills, axle and tyre plants, foundry, coal pulverizing plant (50 tons per hour) for feeding boilers, reheating and annealing furnaces.

Fabrique Nationale d'Armes de Guerre, Liége.

Manufacturing military and sporting arms, also ammunition, motor-cars, motor-cycles, bicycles, machine tools, &c.

Ateliers de Constructions Electriques de Charleroi, Charleroi.

A magnificent large works with tremendous well-lighted bays. The manufactures range from flex up to large cables and include large generators, pumps, &c. There are very good experimental laboratories. The whole works is run by electricity, and some of the electric cranes have a lifting capacity of 250 tons.

Forges de la Providence Marchienne-au-Pont, Charleroi.

A very large, modern, up-to-date steel plant. Large coke ovens recovering all bye-products, blast furnaces, Bessemer basic converters, rolling mills, &c.

Visit to Brussels University.

The party was entertained to lunch in the University of Brussels by Principal Grandmaître, and afterwards was shown over the various Departments. The University has first-class equipment in the various laboratories, including tensile testing machines, Charpy and Izod machines, Rockwell hardness and Brinell machines, and much more plant for carrying out various tests. The manufacture of liquid air was seen to be carried out in the short time of 20 minutes. Special thanks are due to the Principal for his kind reception and treatment of the party.

LETTERS TO THE EDITOR

Continuous Desilverizing of Lead Bullion.

In connection with the centenary of the discovery of the Pattinson process for the desilverizing of lead bullion and the remarks of your correspondents Messrs. Lancaster and Smith, it is interesting to note that this year sees the completion of the new continuous desilverizing process worked out by G. K. Williams (a graduate of the University of Melbourne), at the Broken Hill Associated Smelters Pty. at Port Pirie, South Australia.

This is one of the few cases where such a process has been developed as the result of a definite theory, as distinct from the old method of "practice anticipating theory by many years." The process depends on the formation of two conjugate liquid phases, one (lighter) rich in zinc and the other rich in lead. By establishing a continuous temperature gradient in the lead phase in a vertical "kettle," the solid (silver-rich phase) rises into the upper conjugate solution, whilst silver-free lead is withdrawn from the bottom by a syphon. The old intermittent time-wasting and arduous Parkes process is thus replaced by a continuous one. At the same time, continuous processes have also been developed for the removal of arsenic and antimony prior to desilverizing and zinc afterwards.

For a thesis based on his original work at Port Pirie, the University of Melbourne has conferred the degree of Doctor of Engineering on G. K. Williams, and has also honoured this Australian by bestowing the Kernot Memorial Medal awarded annually for high engineering achievement in Australia.

J. Neill Greenwood.

University of Melbourne.

March 20, 1934.

Origin of Rolled Gold.

Since writing my paper on rolled gold (*J. Inst. Metals*, 1930, **44**, 175), I have come across the following account of the production of gold-plated metal in "Divers Arts," by Theophilus, published early in the eleventh century, translated by R. Hendrie in 1847 (Murray : London). The reference is of interest as it proves that plated metal, the forerunner of rolled gold, was in use in the Middle Ages; a much earlier period than has hitherto been supposed. (Chapter 77, p. 335): "Silver of the weight of 12 minim, having been refined is beaten straightly to the length of half the little finger; refined gold of the weight of 1 minim is then beaten to the same breadth and length, and these two are united together with the prescribed gold solder (p. 327—Gold alloyed with one-third part of copper) until they perfectly adhere to each other, and they are thus beaten together until a very thin plate is made. This plate appears as if the silver were gilt on one side; nor can a thin sheet of such length be so brilliantly gilt with two or three minim of gold (*i.e.* by the mercurial process). From this thin sheet borders are made in the iron stamp (die). Fine strips are also cut from it, and are wreathed round in spun silk; gold fringes are made from it for the poor in the same manner as from pure gold for the rich."

This additional note will doubtless be of interest to those who use rolled gold.

Yours faithfully,

Ernest A. Smith.

Sheffield.

Annual Subscriptions.

Will members—particularly those residing Overseas—be good enough to note that the amount of their subscriptions—£3 3*s.*, *in the case of Members*, £1 1*s.* *in the case of Student Members*—should be remitted in time to be received *on or before July* 1, when subscriptions for the next financial year become due? Only by remitting their subscriptions promptly can members ensure the continued receipt of the *Monthly Journal*, "Proceedings" volumes, and other publications of the Institute. *Prompt payment of subscriptions means a substantial saving to the Institute in postage, bank charges, and discounts.*

PERSONAL NOTES

The Editor requests that his attention be directed to items of interest to members that might be included under the "Personal Notes" heading. All contributions for the June issue of the Monthly Journal *should reach the Editor not later than May 25.*

Sir Harold Carpenter, F.R.S., Past-President, will assume office as President of the Institution of Mining and Metallurgy at the Annual General Meeting of that Institution to be held in London on May 17.

Dr. Georg Lüttke has been appointed by the German Minister of Education as Commissioner for the Supervision of Base Metals. In taking up this post Dr. Lüttke, who was 50 years old on April 5, resigns his post as Editor of the *Zeitschrift für Metallkunde.*

Mr. R. Mather, B.Met., is now in England on leave from India. Communications may be addressed to him at 44 Alleyn Road, Dulwich, London, S.E.21.

Mr. P. W. Rolleston, B.A., is shortly moving to England from Canada. Correspondence may be sent to him at Windrush, Headington, Oxford.

Mr. E. van Someren, B.Sc., has left the service of the Nordiske Kabel og Traadfabrikker on account of the expiry of his permit to be employed in Denmark. He has now accepted a temporary post in the laboratories of the Norske Zinkkompagni at Odda, Hardanger. This electrolytic zinc company, which is one of the largest in Europe, is introducing in its laboratory spectrographic analysis, a subject in which Mr. van Someren is specially interested.

PAPER No. 666. This paper is not to be reprinted, wholly or in part, until presented (and then only with due acknowledgment) at a meeting to be held on September 3–6, 1934, in Manchester. The Institute as a body is not responsible for the statements or opinions expressed in this paper, on which **written discussion** may be sent to the Secretary not later than October 1. 1934.

666

This paper will not be reissued in the form of a separate "Advance Copy," a method of publication which has been discontinued.

THE CORROSION OF TIN AND ITS ALLOYS. PART I.—THE TIN-RICH TIN–ANTIMONY–COPPER ALLOYS.[*]

By T. P. HOAR,[†] M.A., Ph.D., MEMBER.

SYNOPSIS.

The tin-rich tin–antimony–copper alloys have been examined with regard to their resistance to corrosion by dilute hydrochloric and citric acids and by various tap-waters. The straight 5 per cent. antimony alloy containing no copper is found to be usually somewhat more resistant to these types of corrosion than alloys containing copper.

Soft water produces tarnishing; hard water gives no tarnish, but may give localized attack if there is much chalky deposit.

I. INTRODUCTION.

TIN is well known as a metal distinctly resistant to many types of corroding conditions. It is used in the pure form as a protective coating for steel and for copper, and, alloyed with other metals, it forms useful corrosion-resistant materials such as the bronzes and pewters. In this series of papers it is proposed to make a preliminary survey of the nature and extent of the corrosion which occurs when tin-rich alloys are exposed to various dilute acids, salt solutions, and tap-waters.

The present report deals with the tin–antimony–copper alloys, which are extensively used as pewter. The behaviour of alloys of three different compositions has been examined and compared with that of pure tin.

Two methods of investigation have been used: (*a*) a series of measurements of the change of electrode potential with time of the alloys exposed to corroding media, which gives information as to the state of repair of the oxide-film on the metal surface and hence of the likelihood of corrosion occurring;[‡] and (*b*) qualitative and weight-change experiments with specimens partly immersed in various corrod-

[*] Manuscript received January 30, 1934.

[†] University Metallurgical Laboratories, Cambridge.

[‡] May, *J. Inst. Metals*, 1928, **40**, 141; Hoar and Evans, *J. Iron Steel Inst.*, 1932, **126**, 379.

Note to Abstractors and Other Readers.—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LV, 1934. Reference should accordingly be as follows: *J. Inst. Metals*, 1934, **55** (Advance copy).

ing media, especially tap-waters, which is a state of affairs similar to practical conditions.

II. Materials.

Analyses of the alloys used are given in Table I. Micro-sections of certain cast and cold-rolled alloys are shown in Figs. 1–5 (Plate I).

Table I.—*Analyses of Materials.*

Alloy.	Reference.	Tin, Per Cent.	Antimony, Per Cent.	Copper, Per Cent.	Lead. Per Cent.	Bismuth, Per Cent.	Iron, Per Cent.	Sulphur, Per Cent.
Chempur tin	TP	99·989	0·005	0·0004	0·002	0·0007	0·002	0·001
Tin	TC	99·679	0·225	nil	0·039	0·021	0·010	0·014
Pewter alloys	P 0	95·00	5·00	trace	nil	...	nil	...
	P 1	93·96	5·05	0·98	nil	...	0·01	...
	P 3	91·89	5·12	2·98	nil	...	0·01	...

All the materials were used in the cold-rolled condition. Specimens were cut 6·5 × 2·5 cm., and, except where otherwise stated, were abraded with Hubert IF emery, degreased with carbon tetrachloride, and stored in dry air over calcium chloride for 24 hrs. before the corrosion test.

III. Potential–Time Measurements.

The technique described in a previous paper was adopted,* so that a rapid survey of the electrochemical behaviour of the alloys could be made. As has been pointed out, a fall of potential with time indicates penetration and/or breakdown of the oxide-film by the electrolyte, which will usually cause corrosion, whilst a rise of potential with time indicates repair of the film and protection of the metal from corrosion. Of course, no indication of corrosion *velocity*, which may be very small even with a film-free metal, can be obtained by the method.

Some of the more significant of the potential–time curves obtained are shown in Figs. 6 and 7, each curve being the average of three concordant experimental curves.

Fig. 6 shows the behaviour of the alloys tested in the cold-rolled condition without abrasion with Cambridge tap-water as corroding medium (*vide infra*, Table II, for analysis). It will be seen that in all cases there is initially a very rapid fall of potential to about — 0·2 to — 0·3 v. on the normal hydrogen scale, indicating film-penetration by the electrolyte; this rapid fall is followed by a slow rise, doubtless because an insoluble corrosion product is being formed so close to the

---

* Hoar and Evans, *J. Iron Steel Inst.*, 1932, **126**, 379.

PLATE I.

All specimens etched electrolytically.

ig. 1.—P 0. 95·00% Sn, 5·00% Sb. As cast. × 750.

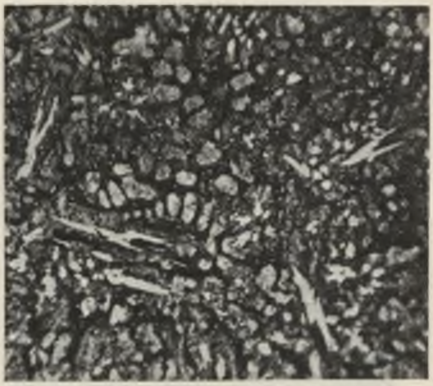


Fig. 2.—P 3. 91·89% Sn, 5·12% Sb, 2·98% Cu. As cast. × 750.

Fig. 3.—P 0. 95·00% Sn, 5·00% Sb. Cold-rolled; section. × 1000.

Fig. 4.—P 1. 93·96% Sn, 5·05% Sb, 0·98% Cu. Cold-rolled; section. × 1000.

Fig. 5.—P 3. 91·89% Sn, 5·12% Sb, 2·98% Cu. Cold-rolled; section. × 1000.

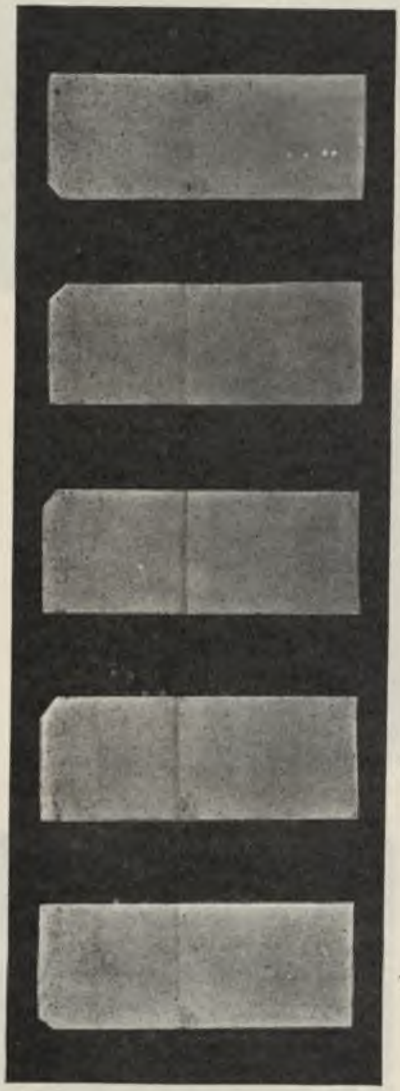


FIG. 9.—Corrosion in Cambridge Tap-Water.

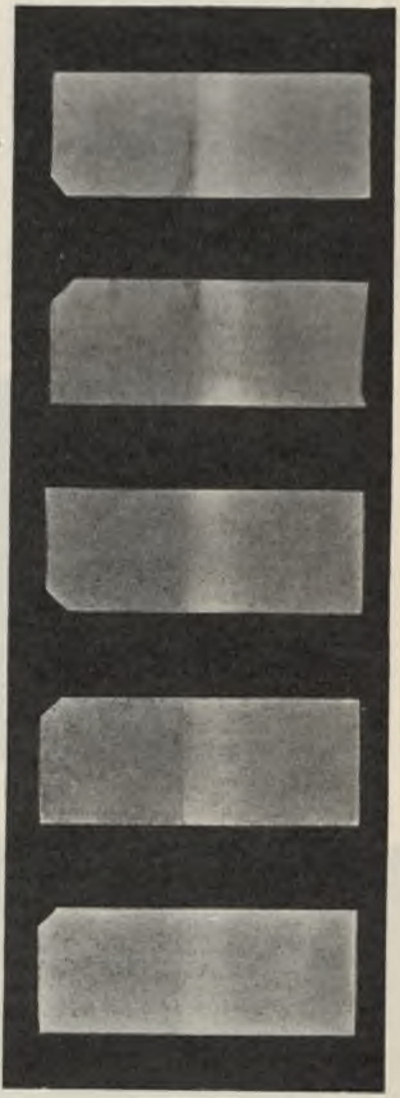


FIG. 10.—Corrosion in London Tap-Water.

metal as to be precipitated in optical contact with it and so lead to film-repair. The general inference is that extensive corrosion is unlikely, and that any which does occur will be of a localized nature at especially weak places in the film which refuse to heal up.

Fig. 7 shows the behaviour of the alloys tested with 0·1*M* citric acid, used as being typical of the organic acids to which tin is exposed in canned fruits. In all cases there is a rapid fall of potential to about — 0·25 v. and no subsequent rise; this, in so acid a solution, undoubtedly indicates the probability of considerable corrosion.

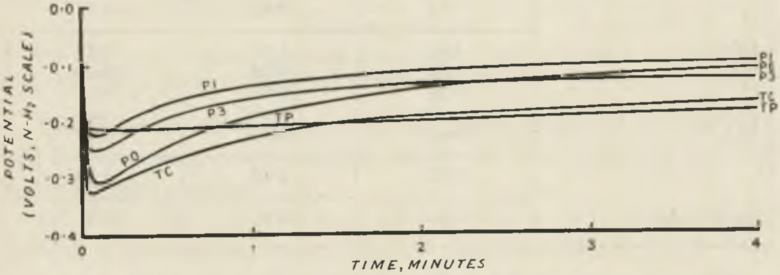


Fig. 6.—Potential–Time Curves in Cambridge Tap-Water.

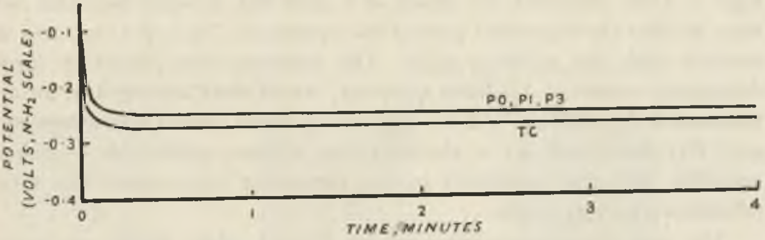


Fig. 7.—Potential–Time Curves in 0·1*M* Citric Acid.

It may be noted that there are no very significant differences between any of the potential–time curves of the alloys and the pure metal, except that P 0 shows a rise of potential rather more rapid than that of the other alloys. Much the same *probability* of corrosion may therefore be expected in all cases except that of P 0, which should be the least liable to attack. This conclusion has been borne out in further experiments which follow.

IV. Partly Immersed Corrosion Tests.

A series of weight-change corrosion experiments on materials TP, TC, P 0, P 1, and P 3 in 0·1*M* citric acid, 0·1*M* hydrochloric acid, and

Cambridge, London, and Birmingham tap-waters was carried out. The tap-waters were analysed with the following results:

Table II.—*Analysis of Tap-Waters.*

	Cambridge.	London.	Birmingham.
	mg. equiv./litre.	mg. equiv./litre.	mg. equiv./litre.
Ca^{++}	4·65	1·54	0·41
Mg^{++}	0·08	0·12	nil
Fe^{+++}	nil	nil	nil
Na^{+} (difference)	0·40	0·76	0·15
	5·13	2·42	0·56
HCO_3^{-}	4·42	1·21	0·37
SO_4^{--}	0·32	0·59	trace
Cl^{-}	0·39	0·62	0·19
NO_3^{-}	trace	trace	nil
SiO_2	trace	trace	nil
	5·13	2·42	0·56
p_H of water	7·4	8·6	7·2

Weighed specimens 6·5 × 2·5 cm., prepared as described, were fixed vertically and symmetrically in uniform straight-sided beakers 8 cm. high × 4 cm. diameter, by means of a glass rod, a paper-clip, and soft wax, so that the immersed part of the specimen, 3·5 × 2·5 cm., was in contact with the solution only. The beakers were placed in large desiccator vessels of 5·5 litres capacity, which were arranged in an air thermostat * at 25° ± 0·05 C. The air in these vessels was swept out each day with fresh air in the acid runs where considerable corrosion occurred, but was unaltered in the tap-water runs where the total corrosion was very slight.

The acid runs were continued for 6 days, after which specimens were removed, washed, and dried. There was very little adherent corrosion product and the weight loss of the specimen may be taken as a measure of the corrosion (Table III). The tap-water runs were continued for some 50 days, when visible attack had occurred; it was not possible in the Cambridge and London water runs either completely to remove the corrosion product or to leave it entirely untouched, and the weight change is therefore little guide as to the amount of corrosion. However, the loss or gain in weight of these specimens with all *loose* corrosion product removed is included in Table III for completeness, and should be considered conjointly with the qualitative description of the corrosion which follows.

---

* Evans, *Chem. and Ind.*, 1931, **40**, 66, 245.

TABLE III.—*Weight Change of Tin and Pewter Specimens Partly Immersed in Corroding Media*, 25·0° *C.*

Solution.	0·1*M* Citric Acid. 6 days.	0·1*M* Hydrochloric Acid. 6 days.	Cambridge Tap-Water. 50 days.	London Tap-Water. 63 days.	Birmingham Tap-Water. 50 days.
Metal.	mg.	mg.	mg.	mg.	mg.
TP . .	−29·3	−36·1	−0·4	−0·1	+0·2
TC . .	−22·5	−32·7	−0·3	+0·1	+0·3
P 0 . .	−25·5	−17·6	−0·3	±0·0	+0·3
P 1 . .	−27·1	−17·5	−0·3	−0·1	+0·6
P 3 . .	−28·3	−16·5	−0·4	−0·2	+0·6

Mean of duplicates.

The last three columns are semi-quantitative only, and must be considered with due regard to the qualitative description in the text.

Qualitatively, the corrosion showed many points of interest. It will be convenient to present the results for each corroding medium under separate headings.

(a) 0·1M *Citric Acid*, 6 *days*.—There was a very intense attack forming a rut parallel to and near to the water-line in every case, although a very narrow strip in the " meniscus " appeared to be unattacked (Fig. 8 (*a*)). Lower down, there was much less attack, but the whole surface was lightly etched. A small amount of loose black deposit appeared at the water-line.

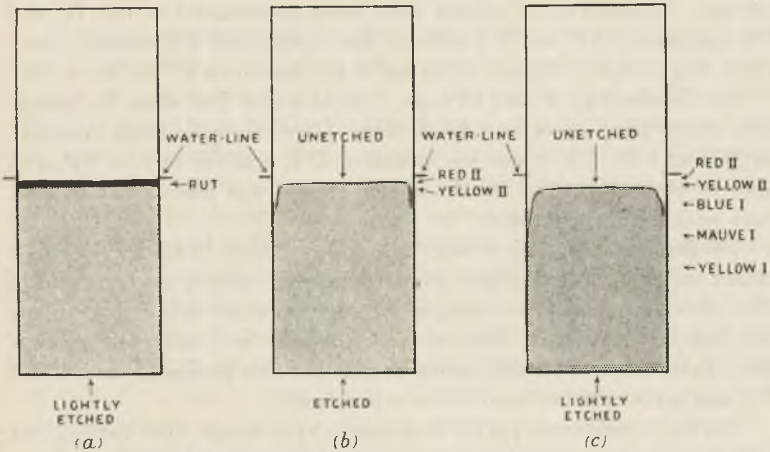


FIG. 8.—Distribution of Corrosion and Interference Tests.
(*a*) Tin and Pewter in 0·1*M* Citric Acid.
(*b*) Tin in 0·1*M* Hydrochloric Acid.
(*c*) Pewter in 0·1*M* Hydrochloric Acid.

(b) 0·1M *Hydrochloric Acid*, 6 *days*.—The whole specimen was evenly etched, except for the part near the water-line, where interference tints indicating a film growing thicker towards the water-line were observed.* This is clearly a secondary film of tin oxides or hydroxides, and it is significant that it is thickest near the surface of the liquid where the oxygen supply is the most plentiful. The interference tints formed a band some 1–2 mm. wide in the case of the tin specimens TP and TC, but were spread out over some 15 mm. in all three specimens P 0, P 1, and P 3, containing 5 per cent. antimony, which it may be noted suffered much less corrosion (Table III). The distribution of the tints is shown schematically in Fig. 8 (*b*, *c*). The main part of the tinted area appeared to be lightly etched, indicating a very porous secondary film formed on it during attack; but the metal beneath the film in the band within 1–2 mm. of the water-line appeared quite bright and unetched, indicating that here the primary air-formed film never entirely breaks down.

(c) *Cambridge Tap-Water*, 50 *days*.—All the alloys except one P 0 specimen showed localized attack just below the water-line (Fig. 9, Plate II), and usually a number of minute " pin-holes " over the entire surface. Both forms of attack were most pronounced in the TC and P 3 specimens; TP and P 1 suffered less attack and P 0 scarcely any : there was a chalky deposit adhering to the specimen at the water-line.

(d) *London Tap-Water*, 63 *days*.—Local attack just *above* the water-line, where creepage of liquid had taken place, occurred most intensely on TC and P 3. There was less attack on P 1, scarcely any on TP, and none at all on P 0 (Fig. 10, Plate II). There was less chalky deposit than with Cambridge water.

(e) *Birmingham Tap-Water*, 50 *days*.—There was no localized attack on any specimen, but all were covered with a nearly uniform film showing interference colours varying between first-order yellow and first-order mauve. The increase in weight was small but measurable (Table III, col. 6), and indicates that the film produced on P 1 and P 3 was rather thicker than in the other cases.

Further qualitative partly immersed experiments were carried out in hot water, with (*a*) Cambridge tap-water, (*b*) Cambridge tap-water which had been previously boiled and the precipitate filtered off, (*c*) distilled water. Specimens were stood in beakers with 4 cm. immersed,

---

* It is well established that a thin transparent oxide-film on a metal surface yields an interference tint depending on its thickness and refractive index, in accordance with optical principles. With any one material, increase of thickness gives successively the colours yellow, mauve, and blue (first order colours), followed by a silvery region (the " hiatus ") and then by yellow, red, and green (second order colours). After this the " overlapping " of the various orders produces results varying from one material to another.

and the beakers, covered with watch-glasses, were placed in a steam-oven which was run each day for 8 hrs. at about 95° C. for 20 days, being allowed to cool over-night. Evaporation was made good with distilled water each day.

The results with Cambridge tap-water were similar to those obtained in the cold, *viz.* local attack just below the water-line and "pin-holing," but, as expected, attack was considerably more rapid. In the boiled water, however, interference tints varying from first-order yellow to first-order mauve and blue, similar to those found with Birmingham water in the cold, were produced over the whole specimen, and very few points of local attack were noticed. Hot distilled water produced no local attack, but gave a similar although thinner film, which did not thicken above the first-order yellow in the case of TP and TC; such a film has also been observed on tin-plate exposed to hot distilled water for a few hours.* Except that all the pewters gave thicker films than TP and TC in the boiled and distilled water, no significant differences in the behaviour of all five materials was observed under hot-water conditions.

V. Discussion.

It will be seen from the foregoing results that the addition of 5 per cent. of antimony to tin (alloy P 0) is usually beneficial from the point of view of resistance to corrosion by the liquids used in this work. There is a slight reduction in the attack by citric acid in presence of air, and a marked reduction in the case of hydrochloric acid. The alloy containing 5 per cent. antimony was also much the least attacked of the series by cold Cambridge and London tap-waters.

The addition of 1–3 per cent. of copper to the 5 per cent. antimony alloy (P 1, P 3) proved detrimental in the conditions investigated. This is perhaps to be expected, since there is extremely little solid solubility of copper in the 95 per cent. tin–5 per cent. antimony alloy; † the copper phase can be seen in the photomicrograph of cast *P* 3 (2·98 per cent. Cu), Fig. 1, and being a "noble" heterogeneity, may well stimulate attack on the tin–antimony matrix under some conditions.

With regard to the mechanism of attack by the various media, only preliminary observations will be attempted here. It is well known that tin suffers practically no attack by cold dilute acids in the absence of air,‡ owing, no doubt, to its high hydrogen overpotential. The attack by 0·1*M* citric and hydrochloric acids in presence of air must therefore be associated with oxygen absorption.

---

* Macnaughtan, Clarke, and Prytherch, *Trans. Faraday Soc.*, 1932, **125**, 159.

† Tasaki, *Mem. Coll. Sci. Kyoto Imp. Univ.*, 1929, [A], **12**, 227.

‡ Mantell, *Amer. Inst. Min. Met. Eng. Tech. Publ.* No. **171**, 1929.

Some light is thrown on the corrosion mechanism in citric acid by the following measurements of electrode potential at various points on the corroding metal surface by the method previously developed during a study of the corrosion of iron.* In this technique, a capillary tube is arranged opening on to the metal surface at the point the electrode potential of which is required : through this capillary, liquid connection is made to a standard half-cell, and the e.m.f. of the cell

metal	corroding medium	standard half-cell

is then obtained on a valve electrometer. The potentials were measured against a quinhydrone half-cell made up in the same acid as the corroding medium : thus the potential against hydrogen in the same acid could be immediately found without any complication of liquid junction potential, and by a further measurement of the quinhydrone half-cell against a $N/10$ calomel half-cell through a saturated potassium chloride bridge, the potential of the corroding tin was obtained on the normal hydrogen scale. Readings were taken at several points near to the water-line and near to the lower edge of partly immersed specimens, at intervals for 48 hrs. Very concordant results were obtained, and average values are given in Table IV.

TABLE IV.—*Potentials Shown by Tin TC Corroding in Citric Acid Temperature* 18°–20° *C.*

Potentials in (*a*) volts against hydrogen in same acid are printed in italics.
(*b*) ,, ,, normal hydrogen electrode are printed in Roman.

Time, Hrs.	0·1*M* Citric Acid, p_H 2·14.				0·01*M* Citric Acid, p_H 2·78.			
	Water-line.		Lower edge.		Water-line.		Lower edge.	
1	*−0·172*	−0·296	*−0·182*	−0·306	*−0·126*	−0·287	*−0·133*	−0·294
2	*−0·168*	−0·292	*−0·176*	−0·300	*−0·127*	−0·288	*−0·136*	−0·297
24	*−0·165*	−0·289	*−0·172*	−0·296	*−0·129*	−0·290	*−0·138*	−0·299
48	*−0·157*	−0·281	*−0·163*	−0·287	*−0·126*	−0·287	*−0·135*	−0·296

Three points of major interest arise :

(1) The water-line potential is invariably some 5–10 mv. more noble than that at the lower edge. There must therefore be a small current of the differential aeration type flowing between the part of the specimen near the water-line and the part lower down. It is probable that most, if not all, of the mild corrosion of the lower part of the specimen can be accounted for in this way. It must, however, be remembered that citric

---

* Evans, Bannister, and Britton, *Proc. Roy. Soc.*, 1931, [A], **131**, 355; Evans and Hoar, *ibid.*, 1932, [A], **137**, 343.

acid causes a very intense corrosion at or near the water-line as well. It is not possible to measure the potential of the metal at the bottom of the " rut " formed by the water-line attack, so that information as to the possibility of a similar differential aeration mechanism applying here cannot be obtained.

(2) The potential of corroding tin in citric acid is considerably less noble than the hydrogen potential in the same acid. Were it not that tin has a particularly high hydrogen overpotential, hydrogen would be evolved; as it is, oxygen is necessary for the depolarization reaction and hence for corrosion.

(3) The potential of corroding tin, in both $0{\cdot}1M$ and $0{\cdot}01M$ citric acid, is about $-0{\cdot}3$ v. on the normal hydrogen scale, whereas the standard electrode potential of tin is given as $-0{\cdot}136$ v.* If therefore tin goes into solution as stannous ions according to the reaction $Sn \longrightarrow Sn^{++} + 2\varepsilon$ the concentration of Sn^{++} near to the metal surface must be very small, being on classical theory given by the equation :

$$-0{\cdot}3 + 0{\cdot}136 = \frac{RT}{2F} \log_e [Sn^{++}]$$
$$i.e.\ [Sn^{++}] = C\,.\,2 \times 10^{-6}\,N.$$

No doubt such calculations can give only qualitative results, but since after 48 hrs.' corrosion the total tin concentration in the solution is of the order of $3 \times 10^{-3}\,N$, there is a very significant discrepancy.

It is very probable that tin ions are removed by the citric acid with the formation of a citrato-complex. This hypothesis will be elaborated elsewhere; here it may be mentioned that an acid such as oxalic, which is known to form stable oxalato-complexes, corrodes tin much more rapidly and at a much lower potential than acids such as citric, and particularly sulphuric acid, where the complexes are considerably less stable. Riley † has recently directed attention to the effect of complex formation on the corrosion of copper and nickel by various acids, including citric acid; his conclusions have many points of similarity to the above views concerning tin.

It is proposed to make further potential experiments with hydrochloric acid. The formation of interference tints suggests that even in this strongly acid medium a certain amount of differential aeration occurs, under conditions of partial immersion.

The two quite different types of attack given by the tap-waters, *viz.* localized attack by the hard Cambridge and London waters, and film-thickening by the soft Birmingham water, are of great interest. Since

---

* Lewis and Randall, " Thermodynamics," p. 443. London : **1923.**

† *Proc. Roy. Soc.*, 1934, [A], **143,** 399.

the film-thickening is also produced by hot distilled water, those waters in which the film does not thicken to interference-tint thickness must contain an inhibitor of the process. It seemed possible that this might be soluble calcium bicarbonate, when present in sufficient quantity, since hot Cambridge water from which bicarbonate and carbonate had been removed by boiling and filtering readily gave the thickening, whereas hot untreated Cambridge water did not. The latter must always contain an appreciable amount of soluble bicarbonate; under the alternate hot and cold conditions of the experiment it is to be expected that absorption of carbon dioxide from the atmosphere would occur during the cold period with consequent re-dissolution of some of the precipitated carbonate.

The hypothesis was verified by a series of 14-day tests with tin TC half-immersed in several mixtures of very dilute potassium chloride, to represent the " penetrating " type of ion present in tap-waters, and calcium bicarbonate, the supposed film-repairing agent. The results are summarized in Table V. It will be seen that increase of chloride concentration increases both the amount of film thickening and the tendency to break down at isolated points. Increase of calcium bicarbonate concentration decreases both the amount of film thickening and the local attack; at 0·005*N* the film remains below visible thickness, as in Cambridge tap-water containing about 0·0044*N*–HCO_3^- (Table II).

TABLE V.—*Effect of Calcium Bicarbonate on the Film-Thickening and Corrosion Produced by a Penetrating Anion* (Cl^-).

Conc. $Ca(HCO_3)_2$ → Conc. KCl ↓	0	0·001*M*	0·005*M*
0	Film : yellow I — mauve I * Attack : none	Film : yellow I Attack : none	Film : invisible Attack : none
0·001*N*	Film : mauve I — blue I Attack : 1 local point, at water-line	Film : yellow I Attack : none	Film : invisible Attack : none
0·005*N*	Film : mauve I — ' Hiatus ' Attack : 6 local points, all over surface.	Film : yellow I Attack : 3 local points, 1 at water-line.	Film : invisible Attack : 1 local point, at edge.

* See footnote to p. 208.

Precipitated carbonate is probably mainly responsible for the localized water-line attack found with hot and cold hard waters. Such attack did not occur except when precipitated carbonate was observed : thus a 14-day test of tin TC in Cambridge tap-water run concurrently with the tests of Table V gave only a minute trace of precipitate and no attack. The loosely adherent chalky deposit, found at the water-line of the specimen, might stimulate corrosion either by partly screening parts of the metal from oxygen access and so giving a differential aeration, or by assisting in the loosening of the otherwise protective film by surface tension effects. The " pin-hole " attack, found only in the very hard Cambridge water, may likewise be attributed to the precipitation of minute particles of carbonate all over the metal; the less hard London water gave much less precipitate and no pin-holing.

Finally, the creepage of the London water above the water-line is no doubt due to the high p_{H}, 8·6, of the water. The carbonate deposit, and the localized attack, was found in the creepage area.

VI. CONCLUSIONS.

This work indicates the desirability of incorporating about 5 per cent. antimony in tin from the corrosion-resisting standpoint, but suggests that the presence of 1–3 per cent. copper as well is deleterious.

Tin and its alloys with small amounts of antimony and copper are corroded by dilute citric and hydrochloric acids in the presence of air. The addition of 5 per cent. antimony effects a marked reduction of the corrosion in hydrochloric acid, but is without much effect in citric acid.

Two kinds of attack are found in hot and cold tap-waters. In soft water, tin and pewter tarnish with the production of a visible film of interference-tint thickness. In hard water there is no tarnishing, owing to the film-repairing properties of calcium bicarbonate, but localized attack at the water-line and sometimes elsewhere occurs if a chalky deposit is formed from the water. Nevertheless, if care is taken to remove chalky deposits from a pewter vessel, there should be no attack in hard waters; fortunately such cleaning is likely to be the rule in good domestic practice. The straight 5 per cent. antimony alloy containing no copper proved to be, under the conditions studied, somewhat more resistant to tap-waters than alloys containing copper.

VII. ACKNOWLEDGMENTS.

The above work forms part of a programme being carried out by the International Tin Research and Development Council. My great thanks

are due to the Director of Research, Mr. D. J. Macnaughtan, for many stimulating discussions and for permission to publish.

I am grateful also to my colleagues, Mrs. F. D. Heywood, B.Sc., for carrying out the difficult and tedious photomicrographic work; and Dr. W. D. Jones and Mr. W. E. Hoare, B.Sc., for the preparation of some of the rolled alloys.

UNIVERSITY METALLURGICAL LABORATORIES, CAMBRIDGE.
March, 1934.

PAPER No. 667. This paper is not to be reprinted, wholly or in part, until presented (and then only with due acknowledgment) at a meeting to be held on September 3–6, 1934, in Manchester. The Institute as a body is not responsible for the statements or opinions expressed in this paper, on which **written discussion** may be sent to the Secretary not later than October 1, 1934.

This paper will not be reissued in the form of a separate "Advance Copy," a method of publication which has been discontinued.

SOME PROPERTIES OF HEAVILY COLD-WORKED NICKEL.*

By H. QUINNEY,† M.A., MEMBER.

SYNOPSIS.

The Curie point of commercial nickel of 99·62 per cent. purity has been found to be 330° C., which is much lower than that generally accepted for pure nickel. After the metal has been subjected to torsional overstrain the Curie point on heating is raised considerably but returns to its original value on cooling. No such effect is observed with mild steel since the strain is relieved before the metal reaches the relatively high Curie point.

MANY physical properties of ferromagnetic materials change rather abruptly at temperatures near the so-called Curie point. Lacking a precise experimentally useful definition of the Curie point, we may perhaps be in uniformity with general usage by employing the expression to denote a small range of temperatures within which the various properties, especially the magnetic ones, change abruptly, these changes not being due to a change in lattice type.‡ It may be of interest in this respect to refer to the work of N. Michejew,|| Ray Chaduri, and S. Satô.§

In what follows an account is given of the temperatures of the Curie point for highly-strained nickel and mild steel as obtained from a study of: (1) the temperature–time curves on heating and cooling; (2) changes in magnetism on heating and cooling; (3) expansion and contraction of these metals on heating and cooling.

The nickel supplied by Messrs. Henry Wiggin and Co., Ltd., was alloyed with iron 0·15, magnesium 0·12, carbon 0·05, copper 0·04, and silicon 0·02; giving a nickel content of 99·62 per cent. The mild steel had the following composition: carbon 0·15, silicon 0·2, manganese

---

* Manuscript received December 27, 1934.

† University Engineering Laboratory, Cambridge.

‡ Bredig suggests, however, a possible change of lattice type between 357° and 363° C. for pure nickel.

|| N. Michejew, *Physikal. Z. Sowjetunion*, 1933, 3, 393.

§ S. Satô, "On the Thermal Measurement of the Latent Energy in Cold-Worked Metals and Alloys," *Sci. Rep. Tôhoku Imp. Univ.*, 1931, **20**, 140–177.

Note to Abstractors and Other Readers.—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LV, 1934. Reference should accordingly be as follows: *J. Inst. Metals*, 1934, **55** (Advance copy).

0·63, sulphur 0·043, phosphorus 0·027, nickel 0·08, and chromium 0·041 per cent.

The advantage of torsional overstrain as a means of giving a heavy degree of cold-working to metals has been made use of by the author in a long series of tests which has been made during the last few years.*

With ductile metals subjected to tension, the amount of cold-working which can be introduced is limited by the fact that a local weakening occurs, with the familiar necking and consequent fracture.

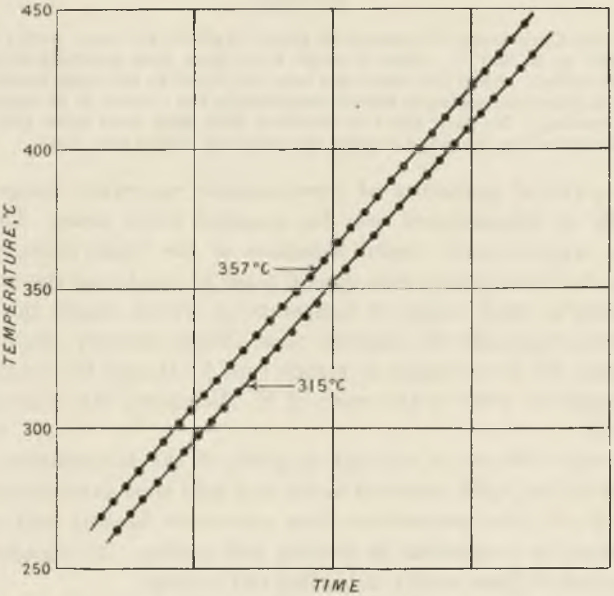


Fig. 1.—Nickel.

In torsion no neck is formed, and plastic deformation occurs throughout the whole length, with the result that the amount of cold-working which can be introduced before rupture is enormously increased. This is particularly marked in nickel as normally supplied by the manufacturer (Messrs. Henry Wiggin and Co., Ltd.). In two equal specimens of the same material it was found possible to do nearly 100 times as much work in torsion as was possible in tension.*

The difference, however, is much less in the case of mild steel.

When these torsion tests were first undertaken it was observed that in most cases there was an appreciable lengthening along the axis after the elastic limit was passed. The author,* accordingly, constructed the

---

* Taylor and Quinney, *Proc. Roy. Soc.*, 1934, [A], **143**, 310.

machines, on which such tests are made, to allow of axial expansion of the specimen and the consequent avoidance of any axial compression. Ductile specimens, tested in this way in pure torsion, preserve their original cylindrical form up to the point of rupture, and a specimen can be prepared for heat-treatment from the twisted bar, without the necessity of machining the surface other than facing two ends of the cylinder, and drilling the hole required to accommodate the thermocouple.

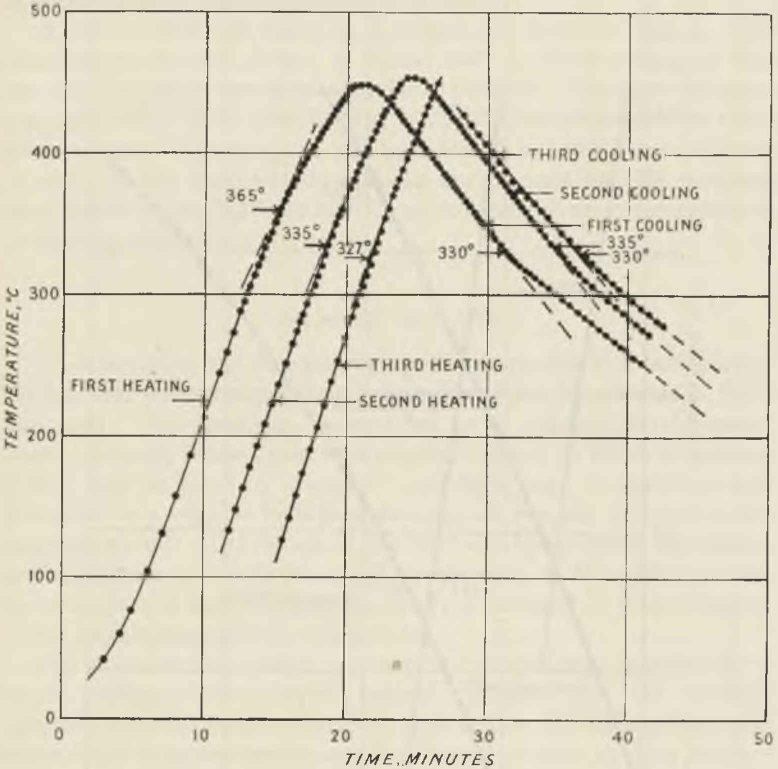


Fig. 2.—Nickel.

Two types of torsion specimens were used. In one, the part of the specimen to be twisted was initially $3\frac{1}{2}$ in. long, and its diameter was $\frac{5}{8}$ in., in the other the part to be twisted was 4 in. long and $\frac{5}{16}$ in. in diameter.

Temperature–Time Curves.

Considering first the temperature–time curves, Fig. 1 shows part of the temperature–time curve for a $\frac{5}{8}$-in. diameter specimen of nickel, heavily overstrained in torsion, tested in a vacuum up to a temperature of about 600° C., heat being supplied at an approximately uniform rate, and then reheated a second time through the Curie temperature. It will be seen that the Curie temperature is approximately 357° C. in the first case and about 315° C. in the second case, and that a fairly well-defined discontinuity of slope occurs at these temperatures.

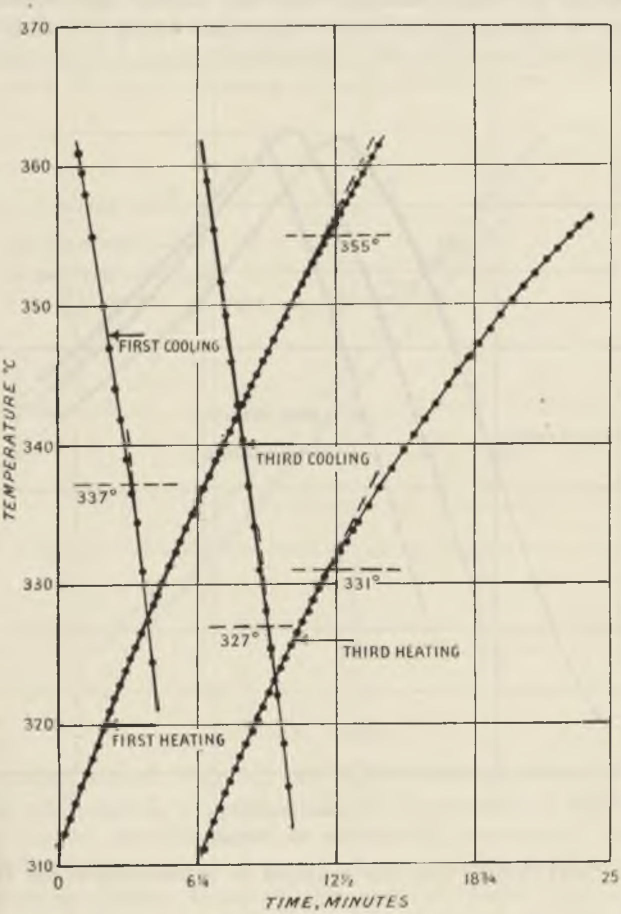


Fig. 3.—Nickel.

Fig. 2, shows the temperature–time curves obtained for a $\frac{3}{16}$-in. diameter nickel bar, twisted 25 complete turns before heating in an open furnace. (Between 30 and 40 turns are possible before fracture develops.) Again the Curie point on first heating is about 365° C. The temperature did not exceed 450° C. before cooling took place, and the Curie temperature on cooling is seen to be in the region of 330° C. On second heating the Curie point is reduced to about 335° C. and reappears at about this same temperature on cooling. The specimen was then heated to about 900° C. and the Curie points on heating and cooling appeared to be in the neighbourhood of 330° C.

A further test was made on a similar bar shown in Fig. 3. The temperature was not allowed to exceed 366° C. before cooling, so that the annealing effect was reduced so far as possible. The curve indicates a temperature of 355° C. on heating and 337° C. on cooling for the Curie temperatures. The specimen was next heated to 1000° C. and allowed to cool. It was then tested again for Curie points and the temperatures indicated are 331° and 327° C. approximately, these temperatures being very uncertain.

MAGNETIC CHANGES.

In determining the changes in magnetic properties with temperature the bar and yoke method, first invented by John Hopkinson in 1885, was used. The specimen, surrounded by a non-inductively-wound electric furnace, formed part of a magnetic circuit to which a constant M.M.F. was supplied by means of a primary coil. A secondary coil connected to a suitable ballistic galvanometer was also included in the magnetic circuit. The change of flux produced by reversing the current in the primary coil, was measured by the fling of the galvanometer. No attempt was made to estimate the true intensity of magnetization or the magnetizing force in the specimen.

Fig. 4 shows the relation between the temperature recorded by a rhodio–platinum thermocouple, suitably inserted into the strained specimen, and the magnetization as observed by the ballistic galvanometer fling, when the specimen is first heated steadily up to a temperature of about 800° C. The magnetization steadily increases with temperature to approximately twice its original value, until the point A is reached, then falls abruptly at a temperature of 341° C., and the specimen appears to have become nonmagnetic at point B about 360°–370° C.

The first heating is continued up to a temperature of about 800° C., *i.e.* considerably in excess of the Curie point, and the restoration of magnetization when the specimen again cools through the Curie temperature about 320° C. shows a considerable increase, being approximately three times as great as on commencement of first heating with

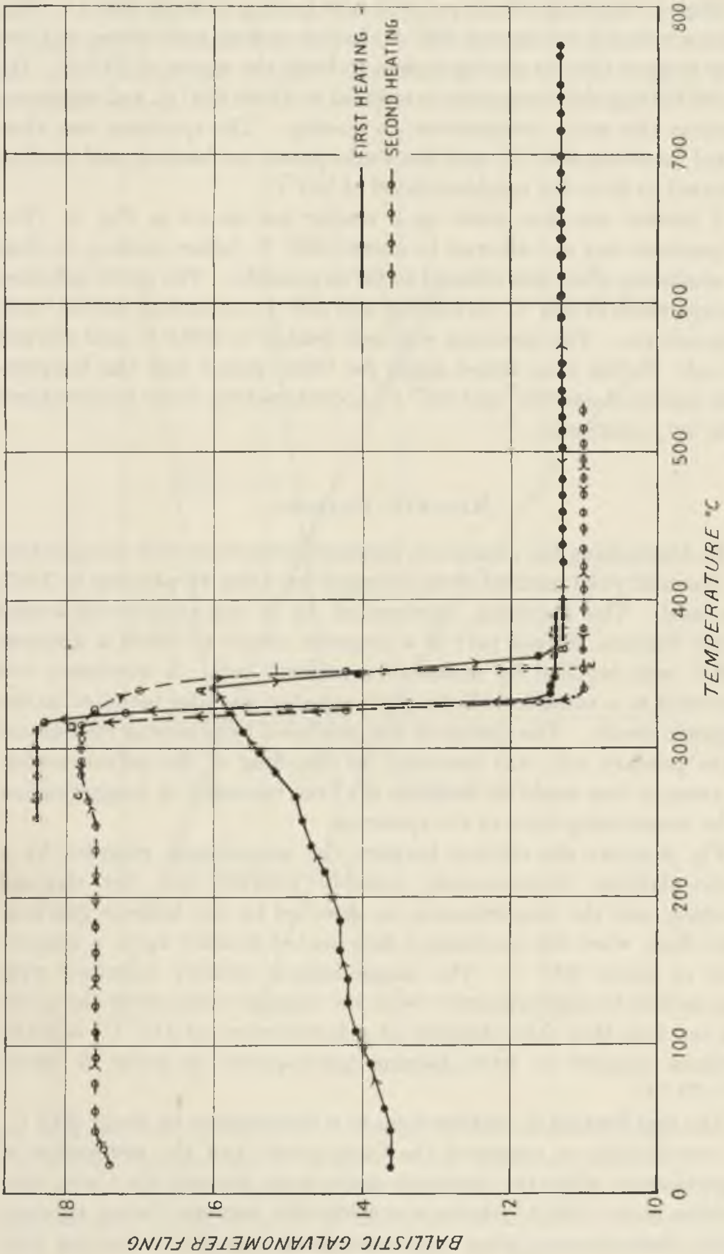

FIRST HEATING
SECOND HEATING
TEMPERATURE °C
BALLISTIC GALVANOMETER FLING
0
100
200
300
400
500
600
700
800
10
12
14
16
18
A
B
C
D
E

Fig. 4.—Nickel.

the specimen in the strained unheated condition. The heating and slow cooling of the originally overstrained nickel from a temperature of 800° C. undoubtedly removed almost completely the effects of overstrain.

The second heating curve shows that the magnetization remains practically constant except for the " hump " between the points *C* and *D*, which appears for low values of magnetizing force, for iron as well as nickel, at a temperature about 50° C. before reaching the Curie temperature.

The decrease in magnetization on second heating commences at *D*, 317° C., proceeding less abruptly than on first heating, and the specimen appears to have become nonmagnetic at *E*, 350° C. The Curie temperature interpreted from the curve obtained for second heating, in the same way as was done for first heating, would appear to be 330° C. The temperature for second heating was not taken above 530° C. and the curve obtained by cooling lies almost over that obtained after cooling when first heated.

Although approximately the same M.M.F. was applied in the first and second heatings, the flux produced when the specimen is nonmagnetic is less in the second heating than on the first heating. This is probably due to small changes in the air gaps in the two cases, which are unavoidable.

A considerable lag is shown between the Curie temperature determined in this manner on heating and cooling nickel, amounting to rather more than 20° C.

Fig. 5 shows the corresponding results obtained from a specimen of similarly overstrained commercial mild steel. As in the case of nickel, there is a general tendency for the magnetization to increase as the temperature approaches the Curie point. This increase in mild steel is, however, very much less than in the case of nickel, for the particular magnetizing on the force employed, although for other magnetizing forces the differences might not be so pronounced. The magnetizing force was the same as that used for nickel. It is proposed to carry out a series of tests using other values of *H*. The Curie temperature is, however, much higher, and the consequent recovery from overstrain due to heating to the Curie temperature is more complete than is the case for nickel.

The first and second heating curves shown in Fig. 5 do not indicate any appreciable difference between the Curie temperature obtained for strained, and unstrained mild steel. Moreover, the lag between the heating and cooling values of the Curie temperature is very considerably less than for nickel, being only about 5° C., as against 20° C. for nickel.

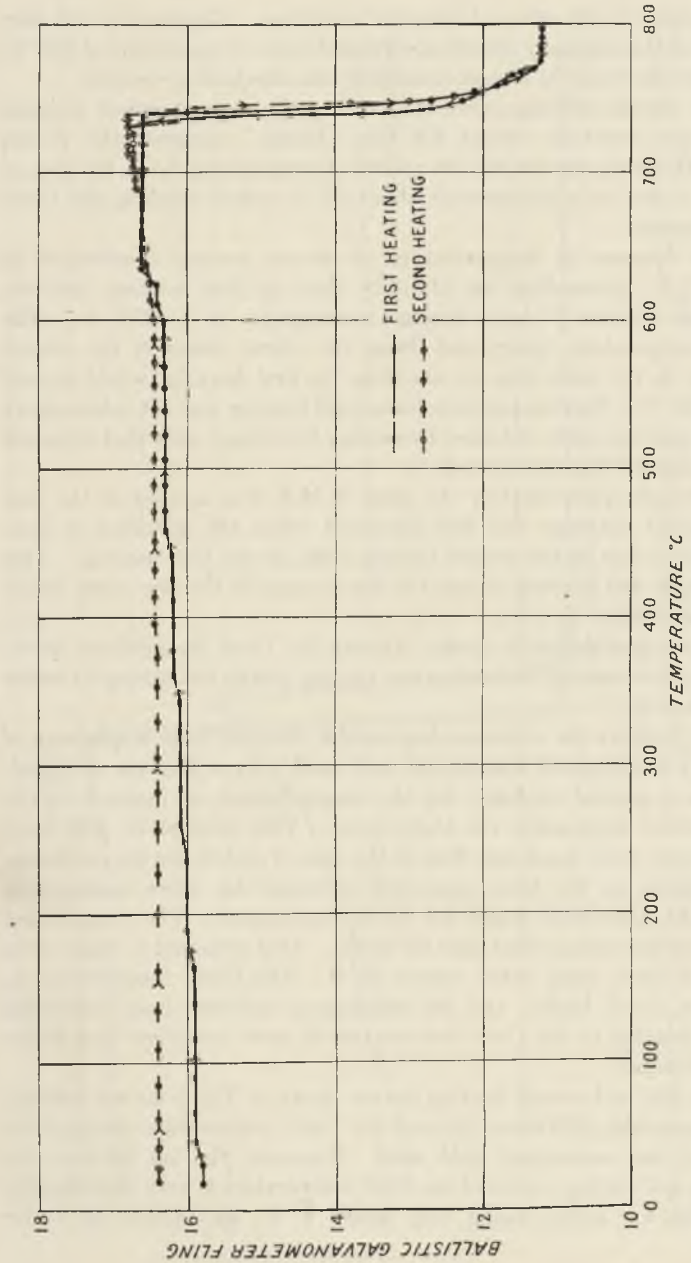


FIG. 5.—Mild Steel.

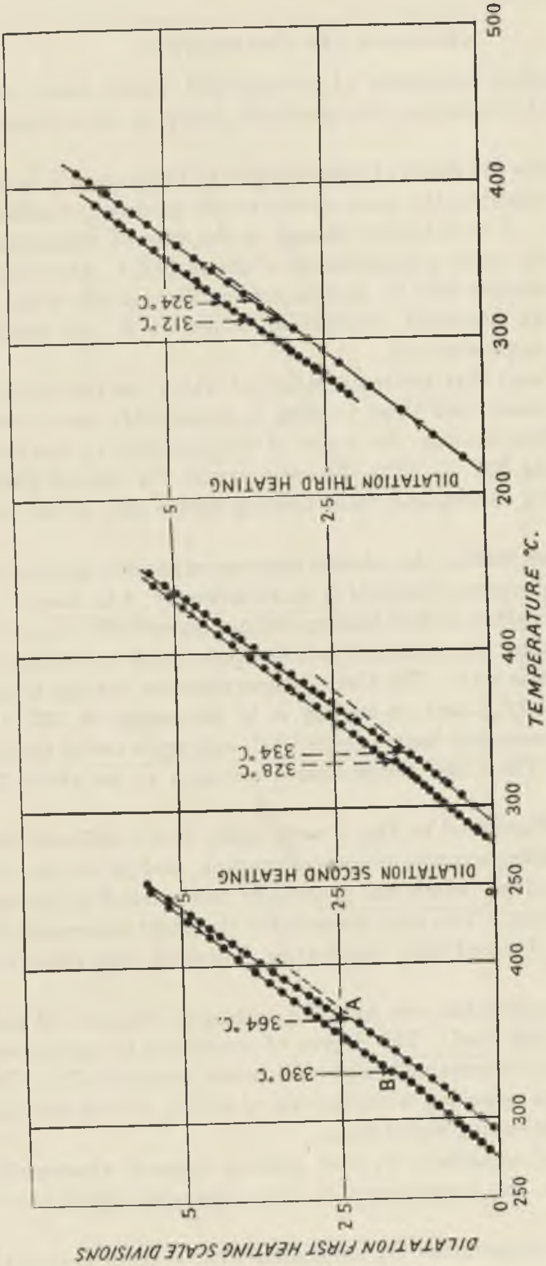

DILATATION FIRST HEATING SCALE DIVISIONS
DILATATION SECOND HEATING
DILATATION THIRD HEATING
TEMPERATURE °C.
0
2·5
5
250
300
400
500
200
330 °C.
364 °C.
A
B
328 °C.
334 °C.
312 °C.
324 °C.

FIG. 6.—Nickel.

EXPANSION AND CONTRACTION.

Corresponding specimens of overstrained nickel were tested for expansion and contraction, the specimens being $\frac{3}{16}$ in. in diameter and 4 in. long.

Fig. 6 shows the result of three successive heatings of a specimen of nickel overstrained to the same extent as the specimen of nickel tested magnetically. A well-defined change in the rate of expansion occurs at A on heating up to a temperature of about 460° C., the temperature being approximately 364° C., and on cooling through the same range of temperature an increased contraction occurs at B, the temperature being 330° C. approximately.

It will be seen that the temperature at which the rate of expansion changes on second and third heating is appreciably lower than that obtained on first heating, the point of discontinuity in the third case being as low as 324° C. The discontinuity in the rate of contraction on cooling after second and third heating occurs also in the region of 320° C.

Fig. 7 shows further the relation between expansion and contraction for a heated specimen of nickel ($\frac{3}{16}$ in. in diameter; 4 in. long). In this case the temperature on first heating did not exceed 365° C., so that the effect of annealing was restricted and the Curie point on cooling was not influenced in this way. The Curie temperature on heating is approximately 358° C. (P_1), and on cooling is in the region of 335° C. (P_2). The specimen was then heated to 1000° C. and again tested through the Curie range. The Curie temperatures are seen to be about 330° C. (P_3 and P_4).

The tests illustrated in Fig. 7 were made with a different arrangement for recording expansion and contraction, and an appreciable end thrust was involved, which was practically non-existent in the previous method of testing. This may account for the slight differences in form of the curves obtained from this test as compared with those given in Fig. 6.

The same apparatus was used for testing a specimen of similarly overstrained mild steel. The degree of overstrain in torsion was the same as for the overstrained mild steel tested magnetically. The axis of the specimen coincided with the axis of rolling, as was also the case with the corresponding nickel tests.

The rate of expansion on first heating appears abnormally low, which may be the counterpart to the expansion which occurs on twisting.

The Curie temperature A_2 associated with a small contraction at

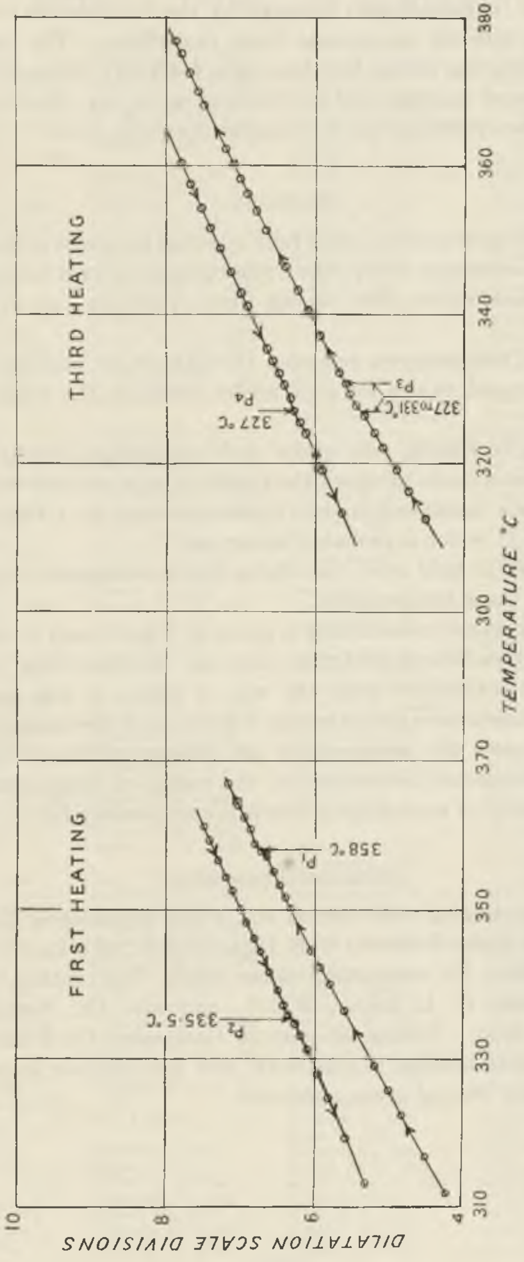

THIRD HEATING
FIRST HEATING
327°C
P_4
327 to 331°C
P_3
358°C
P_1
335·5°C
P_2
380
360
340
320
300
370
350
330
310
TEMPERATURE °C
10
8
6
4
DILATATION SCALE DIVISIONS

Fig. 7.—Nickel.

about 740° C., is immediately followed by the considerable contraction A_3, and it is difficult to separate these two effects. The form of the curve on contracting during first heating is markedly different from that shown on second heating, and no evidence as to any effect on the expansion due to overstrain can be found at the Curie point.

SUMMARY.

The results indicate that, after fully allowing for errors in the methods of recording, overstrain delays the Curie temperature for nickel on heating, but no measurable effect arising from overstrain can be observed on cooling.

The Curie temperatures recorded throughout on heating are lower than the accepted values for pure nickel, being in the neighbourhood of 330° C.

According to Bredig, pure nickel does not change directly from the ferro-magnetic α state, in which the lattice is body-centred cubic to the β paramagnetic modification, but apparently has an α form between 357° and 362° C. which is probably hexagonal.

In the case of mild steel, no effects due to overstrain could be observed at the Curie temperature.

The temperature measurements given in Figs. 2 and 6 were taken with a gold–palladium/platinum–rhodium thermocouple using an ionization potentiometer with the aid of which it was possible to determine temperatures accurately to 0·25° C., over the range employed. In all other cases the temperatures are interpreted from observation of the galvanometer deflection for the range of temperatures used and the accuracy of such measurements is considerably lower.

ACKNOWLEDGMENTS.

These experiments were carried out in the Engineering Laboratory at Cambridge under Professor C. E. Inglis, F.R.S., who kindly provided all the facilities for conducting these tests. The author wishes to thank Professor G. I. Taylor, F.R.S., and also Dr. Francis Bitter for valuable help. During his stay in Cambridge Dr. Francis Bitter has taken a keen interest in this work, and his extensive knowledge of the subject has been of great assistance.

AUTHOR INDEX TO ABSTRACTS

ABEGG, R., 275.
Abramo, F., 252.
Abramson, M. B., 231.
Acken, J. S., 236.
Adami, O., 251.
Aizawa, T., 233, 275.
Akent, M., 270.
Alexandrov, N. V., 245.
Allen, —, 254.
Alten, F., 252.
Anastasiadis, L., 267.
Anderson, J. S., 278.
Andrieux, L., 248.
d'Ardigny, G., 259.
Arend, A. G., 261.
Aristov, V., 265.
Aristow, N. P., 276.
Arndt, H., 283.
Atkinson, —, 248.
Audrieth, L. F., 235.
Auerbach, F., 275.
Austin, R. G., 276.
Azzarello, E., 252.

Bach, H., 272.
Bader, —, 266.
Bailey, G. L., 257.
Bailey, N. P., 256.
Bally, J., 270.
Bamford, T. G., 254.
Banks, F. R., 244.
Barbers, J., 279.
Barnett, S. J., 226.
Barrett, C. S., 255.
Bartel, —, 246.
Bastien, P., 226, 233.
Batty, G., 257.
Bauer, H., 274.
Bauer, O., 228, 231, 233, 236, 250, 283.
Beck, F., 228.
Becker, E., 257, 283.
Becker, K., 273.
Behrens, O., 227.
Belaiew, N. T., 276.
Bellia, C., 230.
Belov, A. F., 263.
Benedicks, C., 230, 255.
Bennett, H., 276.
Benton, —, 254.
Berkó, J., 242.
Berl, E., 276.
Berman, S. I., 265.
Bernstein, G. D., 276.
Berthold, R., 255.
Biran, A. de, 225.
Blake, F. C., 240.
Blazey, C., 275.
Blewitt, W. E., 271.
Blohinzev, D., 239.
Blomberg, H., 269.
Blumenthal, B., 231.
Blumenthal, H., 250, 252.
Boas, W., 239.
Bodforss, S., 249.
Bogomolow, A. E., 279.
Bolchovitinov, N. F., 225, 227, 236.
Bornhak, R., 234.
Botchvar, A., 273.
Bradbury, E. E. G., 228.
Bradley, R. S., 227.
Bragg, W. L., 240.
Brenner, A., 248.
Briscoe, H. V. A., 276.
Broniewski, W., 264.
Brunnckow, W., 276.
Bumm, H., 234, 238.
Burger, M. M., 248.
Burmeister, W., 248.
Burton, E. F., 276.

Cagliotti, V., 239.
Campbell, A. N., 235.
Carpentier, H., 270.
Carter, H. D., 235.
Cazaud, R., 277.
Chaffee, W. J., 268.
Challansonnet, J., 225.
Chamberlain, —, 254.
Chapman, C. M., 275.
Chaussain, M., 240, 242.
Childs, W. H. J., 283.
Cone, E. F., 258, 264.
Cournot, J., 233.
Crampton, D. K., 271.
Crepaz, E., 232.

Daiger, G. P., 253.
Dehlinger, U., 238.
Deiss, E., 250.
Delbart, G. R., 276.
Detourmignies, —, 258.
Dickinson, E. C., 274.
Dodero, M., 248.
Donike, W., 232.
Downie, C. C., 260.
Duckworth, E. H., 277.
Dumas, A., 235.
Dunlap, W. M., 267.
Dunn, C. L., 252.
Dunoyer, L., 254.
Durrer, R., 277.
Dusold, T., 236.

Edmonds, S. M., 252.
Ehret, W. F., 231.
Eisenkolb, F., 252.
Elbourne, E. T., 277.
Englefield, E., 277.
Esmarch, W., 261.
Evans, D. O., 250.
Evans, G., 265.
Evans, U. R., 244.
Eyles, A. J. T., 268.

Fano, E. da, 241.
Faulkner, V. C., 259.
Field, J. H., 266.
Filippow, K. W., 277.
Fisher, G. E., 258.
Focke, A. B., 226, 239.
Fournier, H., 240, 242.
Fowle, F. E., 277.
Fox, J., 264.
Frankenberg, H., 231.
Freitag, —, 248.
Fröhlich, K. W., 248, 258, 266.
Fröhlich, W., 257, 258, 260.
Fry, A., 254.

Gaertner, —, 277.
Gajew, I. S., 277.
Galibourg, J., 272.
Ganswindt, S., 273.
Garner, W., 277.
Garrison, A. D., 249.
Gerlach, W., 228.
Gibson, W., 268.
Gilchrist, R., 251.
Gill, S., 247.
Glasstone, S., 277.
Goetz, A., 226, 239.
v. Göler, (Frhr.), 237.
Granjon, R., 268.
Green, V. E., 254.
Gregg, J. L., 278, 283.
Grevel, A., 250.
Gropius, W., 271.
Grube, G., 234.
Grunert, A., 231.
Grüss, H., 262.
Guerin, R., 259.
Guidi, G., 263.
Guljev, A. P., 265.
Günther, —, 246.
Guzzoni, G., 240.

Haase, L. W., 274.
Haehnel, O., 241.
Hägg, G., 253.
Hammet, L. P., 252.
Härsel, G.. 250.
Hansen, M., 231, 233, 236.
Hanson, A. W., 228.
Harries, R., 277.
Hartmann, F., 262.
Hay, R., 256.
Heaps, C. W., 227.
Hengstenberg, T. F., 237.
Hermann, F., 269.
Hess, R. E., 275.
Hessenbruch, W., 231, 236.
Hidnert, P., 232.
Hiltbold, F., 233.
Hoglund, G. O., 267.
Hopkins, B. S., 235.
Höpp, W., 273.
Horioka, M., 243.
Hosaka, T., 266.
Hosford, H. H., 235.
Hulburt, E. O., 229.
Hull, C., 280.
Hunt, L. B., 248.

Imhoff, W. G., 246.
Ingleson, H., 241.
Irmann, —, 258.
Isenburger, H. R., 279.
Iveronova, V. I., 237.

Jaeger, F. M., 225, 227.
Jewett, F. B., 275.
Jones, E., 254.
Jones, H., 230, 237.
Jones, J. H., 276.
Jones, O. C., 269.
Jong, W. F. de, 238.
Jukola, E. E., 235.

Kachenov, I. I., 268.
Kalkner, B., 269.
Kase, T., 247.
Keinath, G., 256.
Kelley, K. K., 253.
Kendrick, J. A., 266.
King, A., 278.
King, B. T., 278.
King, C. V., 248.
Kinzel, A. B., 231.
Kistjkovskiy, V. A., 244.
Klewe, H., 241.
v. Klitzing, K. H., 227.
Knowles, D. C., Jr., 251.
Koppel, J., 275.
Kornfeld, M. O., 228.
Kostron, H., 255.
Kouwenhoven, W. B., 253.
Krapiwin, S. G., 278.
Krause, E. F., 279.
Krause, H., 266, 278.
Krause, W., 283.
Krishnan, K. S., 239.
Krohnke, O., 278.
Kroll, W., 258.
Kunze, —, 246.
Kurmeis, B., 252.

Laer, M. H. Van, 240.
Laing, J., 281.
Laporte, M., 256.
Lawson, T. R., 275.
Le Thomas, A., 274.
Leighton, W. G., 250.
Lenher, V., 251.
Lewis, K. G., 244.
Lieneweg, F., 262.
Lilly, J. F., 249.
Limmer, G., 250.
Livermore, F. A. W., 259.
Lloyd, D. S., 269.
Lloyd, P., 278.
Logan, A., 257.
Logan, K. H., 242.
Lohausen, K. A., 261.
Lowe, F., 278.
Lunge, G., 276.
Lyst, J. O., 231.

McClain, H. K., 249.
McGregor, G. H., 244.
McKinnon, H. L., 259.
McLennan, J. C., 230.
McNeill, J., 268.
McPhail, G., 278.
Mahul, J., 272.
Mainelli, A., 271.
Malkov, L., 236.
Mamykin, P., 262.
Mandl, K., 243.
Marson, C. B., 276.
Mathewson, C. H., 271.
Mathieu, M., 269.
Matthies, K., 273.
Meerbold, R., 246.
Mehrtens, J., 266.
Meier, E., 272.
Mellor, J. W., 278.
Mets, C. F., 255.
Metzger, T., 260.
Meyer auf der Heyde, H., 246.
Mikhailov, N. I., 271.
Miles, H. M., 253.
Milner, R. T., 228.
Mohr, L., 234.
Möller, F., 226.
Möller, H., 279.
Moore, E. S., 272.
Moore, H. F., 275.
Moriya, I., 266.

Author Index to Abstracts

Mueller, G. J., 227.
Müller, W. J., 249.

Nathanson, J. B., 229.
Naumann, E., 274.
Nawo, L., 261.
Nesterovskiy, M., 273.
Newman, Q. B., 244.

Oakley, C. A., 269.
Obinata, I., 227, 238.
O'Bryan, H. M., 253.
O'Connor, F., 268.
O'Leary, W. J., 251.
Onnis, G., 270.
Oram, J. E., 261.
Orowan, E., 228.
Osanai, K., 233.
Osanai, T., 275.
Oschatz, H., 254.
Osenberg, E., 279.

Panseri, C., 282.
Papish, J., 251.
Partington, E. B., Jr., 268.
Partington, J. R., 279.
Payne, R. J. M., 252.
Pelczynski, T., 264.
Percival, L. C., 268.
Peredelsky, K. V., 259.
Petrov, D. A., 257.
Pfeiffer, A., 250.
Pilon, H., 255.
Piwowarsky, E., 282.
Portevin, A., 268.
Potter, H. H., 253.
Preiswerk, M., 270.
Prideaux, E. B. R., 279.
Prujinina, V. I., 245.
Pullen, N. D., 245.

Quincy, L., 259.

Rae, W. N., 279.
Raistrick, A., 232.
Rakovski, W. S., 260.
Rakowski, A. W., 279.
Ramsauer, C., 253.
Raper, —, 248.
Raub, E., 265.
Read, T. T., 275.
Reece, E. J., 271.
Rees, G. W. M., 263.
Reilly, J., 279.
Reinhart, R. E., 236.
Reininger, H., 258.
Reiter, K., 269.
Reyerson, L. H., 229.
Richards, E. T., 233.
Richter, G., 273.
Roches, C., 279.
Roessler, —, 255.
Rogers, W. F., 245, 273.
Rohn, W., 236.
Rolfe, R. T., 281.
Rollason, —, 254.
Roller, D., 229.
Rolshtikov, B. P., 265.
Romanow, V., 265.
Röntgen, P., 226, 232.
Rosenbohm, E., 225.
Roshin, P., 265.
Rossi, A., 238.
Rowe, F. W., 259.
Ruf, K., 231.
Ruppin, K., 269.
Rusetsky, G. K., 256.
Rusterholz, A., 229.
Ryan, A. R., 263.

Sabin, A. H., 248.
Sachs, G., 237, 254.
Safir, H., 274.
St. John, A., 255, 279.
Sanderson, L., 273.
Sänger, R., 230.
Schikorr, G., 240, 244.
Schlippe, O., 253.
Schloetter, M., 248.
Schlumberger, C., 243.
Schlumberger, M., 243.
Schmid, E., 227, 234, 235, 238.
Schmid, W. E., 255.
Schmidmer, E., 279.
Schnegg, H., 270.
Schneider, K., 250.
Schulz, E. H., 262.
Schulz, H., 267.
Schwartze, E. W., 269.
v. Schwarz, (Frhr.) M., 279.
Schwarz, R., 271.
Scott, L. G., 279.
Seliger, H., 234.
Seltz, H., 237.
Shtanko, D. A., 257.
Siebel, E., 279.
Siebel, G., 235.
Siljeholm, G., 230.
Simonds, H. R., 246.
Skerry, E., 254.
Smakula, A., 229.
Smith, G. B. L., 251.
Smith, G. W., 229.
Smout, A. J. G., 249.
Smythe, J. A., 232.
Sokolov, N. N., 245.
Southard, J. C., 228.
Spirin, D. T., 267.
Starck, H. P., 280.
Steen, P., 272.
Steewen, O. P. Van, 272.
Stek, H. J., 238.
Stenzel, W., 231, 236, 239.
Stevens, J. W., 244.
Stiegler, L., 278
Stirrat, A. Y., 268.
Stockdale, D., 236.
Summa, O., 279.
Sutton, H., 254.

Tanimura, H., 232.
Tararykin, V. S., 247.
Tareev, B. M., 245, 271.
Tarshish, L., 253.
Tartar, H. V., 249, 252.
Taylor, R. H., 242.
Thain, W. A., 260.
Thomas, J. L., 229.
Thum, A., 254.
Titov, V. Y., 249.
Tshitaev, A. V., 265.
Turner, D., 262.

Underhill, C. R., 230.
Usow, W., 267.

v. Vargha, G., 237.
Vargunin, P. A., 263.
Veenstra, W. A., 227.
Velten, A., 281.
Vitkin, A. I., 247.
Vollenbruck, O., 236.
Volovik, B. E., 253.

Walden, G. H., Jr., 252.
Warner, W. E., 268.
Warwick, C. L., 275.
Wassermann, G., 232, 237, 238, 239.
Weerts, J., 228, 231, 232, 236, 239.
Weiland, H., 252.
Welty, G. D., 271.
West, C. J., 280.
Westgren, A., 238.
Whitby, L., 241.
Wieghardt, P., 265.
Wiersma, E. C., 280.
Wiest, P., 232.
Wittmann, C., 275.
Woolridge, D., 229.
Worden, E. C., 280.
Wright, M., 280.

Yampolsky, S. M., 274.

Zarubin, N., 236.
v. Zeerleder, A., 271, 282.
Zener, C., 230.
v. Zeppelin, H., 234.
Zhdanov, G. S., 237.
Zipurdeev, S. D., 235.

METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 1 MAY 1934 Part 5

I.—PROPERTIES OF METALS

(Continued from pp. 161–167.)

***The Thermal Properties of Aluminium and Their Application.—II.** A. de Biran (*Rev. Aluminium*, 1934, **11**, 2311–2332).—Thermal problems are of 2 different types: heat insulation and heat transmission. The use of aluminium in the former type has already been discussed (*J. Inst. Metals*, 1932, **50**, 209). Its applications in the latter type are now discussed, with illustrative examples, under the following headings: reflecting and insulating properties of aluminium; conducting properties, with which are tabulated the compositions and physical and mechanical properties of the principal aluminium alloys used for pistons; applications where the thermal qualities are secondary. A *bibliography* containing 43 references is appended.—J. H. W.

†Aluminium and Its Alloys. N. F. Bolchovitinov (*Vestnik Ingenerov i Tehnikov* (*Messenger of Engineers and Technologists*), **1933**, (5), 207–209).—[In Russian.] A review covering pure aluminium, basic characteristics of the microstructure of aluminium alloys, and the most important types of the latter.—N. A.

***The Exact Measurement of the Specific Heats of Solid Substances at Higher Temperatures. XIV.—The Specific Heats and Thermal Retardation Phenomena of Beryllium.** F. M. Jaeger and E. Rosenbohm (*Proc. K. Akad. Wet. Amsterdam*, 1934, **37**, 67–76).—[In English.] The duration of heating and cooling has a considerable influence on the apparent specific heat of beryllium in the compact form. Constant values are obtained, however, for finely-powdered beryllium. With this material the true specific heat between 99·80° and 1064·97° C. can be represented by $0{\cdot}414032 + 0{\cdot}719894 \times 10^{-3}t - 0{\cdot}2221422 \times 10^{-6}t^2 - 0{\cdot}1436704 \times 10^{-8}t^3 + 0{\cdot}156547 + 10^{-11}t^4$ and the atomic heat by $3{\cdot}73457 + 0{\cdot}64935 \times 10^{-2}t - 0{\cdot}20037 \times 10^{-5}t^2 - 0{\cdot}12959 \times 10^{-7}t^3 + 0{\cdot}14122 \times 10^{-10}t^4$. The phenomena are believed to indicate the existence of 2 states of beryllium in inner equilibrium, but the nature of the constituents is unexplained.—E. S. H.

Beryllium and Its Alloys (concluded). Jean Challansonnet (*Aciers spéciaux*, 1933, **8**, 363–370).—Cf. *J. Inst. Metals*, 1933, **53**, 545. In the copper–beryllium alloys, the copper-rich α crystals have the copper lattice and the γ crystals are face-centred cubes. Radiometric examination confirms the equilibrium diagram that the hard γ constituent is precipitated by quenching and annealing. The addition of phosphorus accelerates ageing and lowers the temperature at which this treatment is most efficacious. The properties and heat-treatment of ternary alloys of beryllium and copper with tin, zinc, and aluminium, of copper–beryllium alloys containing 2–3% of beryllium, and of nickel–beryllium alloys containing 1·5–3·0% of beryllium are described. The elastic limit and hardness of the nickel alloys can be quadrupled and the breaking stress doubled by suitable heat-treatment, but beryllium reduces the resistance of nickel to corrosion by nitric acid. The iron–beryllium and the iron–nickel–beryllium alloys, and the effect of beryllium on the hardness and corrosion-resistance of special (nickel–chromium) steels are described.—J. H. W.

---

* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

***The Crystal-Diamagnetism of Bismuth Crystals.** Alexander Goetz and Alfred B. Focke (*Phys. Rev.*, 1934, [ii], **45**, (3), 170–199).—Previous work on crystal-diamagnetism is reviewed with special reference to bismuth and its alloys with elements of the B sub-groups. Single crystals of bismuth and its alloys with silver, tin, lead, tellurium, selenium, antimony, and germanium were prepared by the method of Goetz (see *J. Inst. Metals*, 1930, **43**, 397); two-phase specimens were also prepared by this method in cases where the solid solubility limit was restricted. The diamagnetic properties were studied from − 185° to + 271° C. For pure bismuth the susceptibility varies with the crystal orientation according to the Voigt–Thomson law. In contrast with some previous results for polycrystalline metal, the magnetic properties of single crystals grown *in vacuo* are identical with those grown in an inert atmosphere, showing that a single crystal is not affected by absorption of gases. When a solid solution is formed, elements of lower valency (germanium, tin, and lead) increase the magnetic anisotropy, whilst those of higher valency (selenium and tellurium) decrease it. The results are complex, and with tin in solution it is possible to obtain crystals which are paramagnetic parallel to the principal axis, and diamagnetic at right angles to it; this shows the danger of using magnetic properties of polycrystalline material for the determination of solubility limits. The specific effect of a dissolved atom is greater the smaller the solubility limit. A transformation point at 75° C. is shown by all alloys of low concentration of the added element. The results are discussed and a theory is proposed according to which the solute atoms are not distributed at random, but in certain crystallographic planes which occur periodically, the periodicity being connected with the secondary structure proposed by Zwicky.—W. H.-R.

***On the Existence of Three Allotropic Forms of Calcium.** P. Bastien (*Compt. rend.*, 1934, **198**, 831–833).—By means of differential thermal and thermoelectric analysis and dilatometric measurements in an atmosphere of argon on a large quantity (2 kg.) of sublimed calcium, it is shown that there are 3 allotropic forms of calcium, the transformations occurring at about 260° C. and between 430° and 440° C., respectively.—J. H. W.

***The Rotation of Cobalt and Nickel by Magnetization and the Gyromagnetic Ratios of Their Magnetic Elements.** S. J. Barnett (*Proc. Amer. Acad. Arts. Sci.*, 1934, **69**, 119–135).—If μ_0 is the magnetic moment in a ferromagnetic substance, and M_0 its angular momentum, the gyromagnetic ratio is defined as $\rho = M_0/\mu_0$. B.'s previous methods (see *J. Inst. Metals*, 1932, **50**, 19) have been extended to avoid systematic disturbances, and the values of ρ for nickel and cobalt were determined as $1{\cdot}059 \times m/e$, and $1{\cdot}077 \times m/e$, respectively, and are probably correct to within 1%.—W. H.-R.

***On the Solubility of Gases in Copper and Aluminium.** P. Röntgen and F. Möller (*Metallwirtschaft*, 1934, **13**, 81–83, 97–100; and (partial translation) *Light Metals Research*, 1934, **2**, (46), 2–4).—By the method of Röntgen and Braun (see *J. Inst. Metals*, 1932, **50**, 721) it has been shown that nitrogen, carbon dioxide, and carbon monoxide are insoluble in copper at 600°–1400° C. and that the two first-named gases are insoluble in copper containing 0·5% cuprous oxide, 0·5% cuprous sulphide, or 0·1 or 0·3% aluminium. Sievert's and Krumbhaar's values for the solubility of hydrogen in pure copper (cf. *Z. physikal. Chem.*, 1910, **74**, 277) have been confirmed; the solubility at the melting point jumps from 2 to 5·3 c.c. per 100 grm. of copper, irrespective of the presence or absence of moisture. On exposing molten copper containing sulphur to an atmosphere of hydrogen, a certain amount of the latter is absorbed chemically, and remains in the metal on cooling, rendering it porous; part of this is evolved as hydrogen sulphide on prolonged annealing. The solubility of hydrogen in copper containing aluminium decreases linearly with the aluminium content within the solid solution range, the extrapolated curve showing zero solubility at 16% aluminium. Hydrogen is insoluble in solid aluminium, but at the melting point 0·22 c.c. of gas is absorbed by 100 grm. of metal; addition of copper reduces the solubility in a similar way to that recorded above for the addition of aluminium to copper.—v. G.

†**Manganese.** N. F. Bolchovitinov (*Vestnik Ingenerov i Tehnikov* (*Messenger of Engineers and Technologists*), **1933**, (9), 408–409).—[In Russian.] A brief review of the physical properties of manganese and its alloys, and its use in steels, copper, and aluminium alloys.—N. A.

***The Surface Tension of Mercury in a Vacuum and in the Presence of Hydrogen.** R. Stevenson Bradley (*J. Phys. Chem.*, 1934, **38**, 231–241).—The surface tension of mercury, determined by measurements on a flat drop, is found to be 500·3 dynes/cm. at 16·5° C. A slow fall in the value of the surface tension of mercury occurred in an atmosphere of hydrogen. The surface tension fell more rapidly when the drop, in hydrogen, was illumined by radiation from a mercury vapour lamp.—J. S. G. T.

***The Influence of Corrosion on the Endurance Strength of Steels and Pure Nickel.** O. Behrens (*Metallwirtschaft*, 1934, **13**, 44–46).—Compression of the surface of pure nickel increases the endurance limit by 20–30% in air or in water. Corrosion by water then has only a very slightly deleterious action. —v. G.

***An Experimental Contribution to the Knowledge of the Magneto-Optical Rotation of Nickel.** Kurt Hans v. Klitzing (*Z. Physik*, 1933, **85**, 240–252).—Measurements of the Kerr effect exhibited by nickel for various wavelengths, field strengths, and temperatures, and of the Faraday effect for various wavelengths and field strengths are detailed. The rotatory dispersion in the Faraday effect resembles that characterizing the Kerr effect, but the direction of rotation is opposite in the respective cases.—J. S. G. T.

***Discontinuities of Resistance Associated with the Barkhausen Effect** [**for Nickel**]. C. W. Heaps (*Phys. Rev.*, 1934, [ii], **45**, 320–323).—A nickel wire under bending stress showed a large Barkhausen discontinuity of magnetization. Examination with a sensitive Kelvin double bridge showed that a jump in magneto-resistance accompanied the magnetization jump. This is in contrast to the work of Steinberg and Miroschnischenko (*Physikal. Z. Sowjetunion*, 1933, **3**, 602), whose apparatus is considered to be too insensitive. The mechanism of the change is discussed.—W. H.-R.

***The Extension of Tin Crystals.** I. Obinata and E. Schmid (*Mitt. Material., Sonderheft* **23**, 1934, 67–71).—See *J. Inst. Metals*, 1933, **53**, 484–485.—J. W.

***The Distribution of Initial Velocities of Positive Ions from Tungsten.** George J. Mueller (*Phys. Rev.*, 1934, [ii], **45**, 314–319).—The positive-ion emission from tungsten in vacuum has been studied for temperatures from 1300° to 3000° K. The initial velocity distribution agrees with Maxwell's law. The positive ions emitted were not only those of tungsten, but included impurities, chiefly potassium.—W. H.-R.

***The Exact Measurement of the Specific Heats of Solid Substances at Higher Temperatures. XIII.—The Specific Heats of Vanadium, Niobium, Tantalum, and Molybdenum from 0° to 1500° C.** F. M. Jaeger and W. A. Veenstra (*Proc. K. Akad. Wet. Amsterdam*, 1934, **37**, 61–66).—[In English.] The following data have been obtained over the temperature range indicated (c_p = true specific heat, C_p = atomic heat). Vanadium $c = 0{\cdot}11846 + 0{\cdot}313734 \times 10^{-4}t - 0{\cdot}675396 \times 10^{-8}t^2 + 0{\cdot}14184 \times 10^{-11}t^3$, $C_p = 6{\cdot}0414 + 0{\cdot}1600 \times 10^{-2}t - 0{\cdot}34446 \times 10^{-6}t^2 + 0{\cdot}7234 \times 10^{-9}t^3$; niobium $c_p = 0{\cdot}06430 + 0{\cdot}772766 \times 10^{-5}t + 0{\cdot}234774 \times 10^{-8}t^2$, $C_p = 6{\cdot}0120 + 0{\cdot}722533 \times 10^{-3}t + 0{\cdot}21952 \times 10^{-6}t^2$; tantalum $c_p = 0{\cdot}533218 + 0{\cdot}4198 \times 10^{-5}t + 0{\cdot}3295 \times 10^{-9}t^2$, $C_p = 6{\cdot}0244 + 0{\cdot}38066 \times 10^{-3}t + 0{\cdot}19919 \times 10^{-7}t^2$; molybdenum $c_p = 0{\cdot}061046 + 0{\cdot}123086 \times 10^{-4}t + 0{\cdot}103636 \times 10^{-8}t^2$, $C_p = 5{\cdot}8604 + 0{\cdot}11828 \times 10^{-2}t + 0{\cdot}9949 \times 10^{-7}t^2$.—E. S. H.

***Elastic Behaviour and Elastic Constants of Zinc Single Crystals.** Alvin W. Hanson (*Phys. Rev.*, 1934, [ii], **45**, 324–331).—The elastic constants have been determined from bending and torsion experiments on single crystals prepared from 2 grades of very pure zinc, and bending experiments on polycrystalline zinc are also described. In contrast to polycrystalline metal, single crystals of zinc show a definite and reproducible elastic behaviour, although the exact elastic constants are very sensitive to impurities, and vary considerably for the two grades. For each orientation there is a definite region of proportionality between increasing stress and strain, although this region is a minimum, and very small for orientations $\phi = 45°$, where ϕ is the angle between the hexagonal axis and the axis of the rod. There is no permanent set within the elastic limit as defined by the limit of proportionality. Elastic hysteresis always occurs in bending, but in torsion it is found only for specimens which have previously been permanently strained. The variable results for polycrystalline metal are regarded as due to the difference between the elastic constants for different orientations.—W. H.-R.

***Mechanical Properties of Electrolytic Zinc Sheets.** O. Bauer and J. Weerts [with F. Beck] (*Mitt. Material., Sonderheft* **24**, 1934, 137–144).—See *Met. Abs.*, this volume, p. 67.—J. W.

***Changes in the Properties of Deformed Single Crystals by Recovery.** M. O. Kornfeld (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki* (*Journal of Experimental and Theoretical Physics*), 1933, **3**, (6), 567–570).—[In Russian.] On heating deformed single crystals of aluminium only a partial recovery occurs in the lattice structure, the residual distortions being exceptionally stable. The yield-point, corresponding with the stable state, is directly related to the degree of deformation, and at 300°–500° C. is independent of temperature.
—N. A.

†Recent Work on the Metallic State and Its Properties. Walther Gerlach (*Metallwirtschaft*, 1934, **13**, 171–172).—A review.—v. G.

Physical Change in Metals in Repose. E. E. G. Bradbury (*Iron and Steel Ind.*, 1934, **7**, 193–194).—Three main factors, age-hardening, weathering, and natural de-gasification, are considered as having an influence on metals in repose and are discussed in detail. It is considered that age-hardening on metals under such a condition is not strictly comparable with ageing in moving machinery, and that the beneficial effects of weathering as such are exceedingly doubtful. The third factor, natural de-gasification, which results from gases of various types continuing to escape from castings after they have gone cold, is considered of importance, and the bearing which such a theory of de-gasification would have, if true, on production, is discussed in the case of steel castings.—J. W. D.

***Low Temperature Specific Heats. II.—The Calibration of the Thermometer and the Resistance of Platinum, Platinum–10% Rhodium, and Constantan between − 259° and 190°.** J. C. Southard and R. T. Milner (*J. Amer. Chem. Soc.*, 1933, **55**, 4384–4391).—A constant-volume gas thermometer for calibration is described. Tables showing resistance values determined over the range 14°–90° K. are given.—R. G.

The Enhanced Tenacity of Thin Fibres, the Joffé Effect and Related Phenomena Interpreted from the Point of View of Griffith's Theory of Fracture. E. Orowan (*Z. Physik*, 1933, **86**, 195–213).—The enhanced tensile strength of thin fibres, the effects of grain-fineness and of the surrounding medium on the breaking stress are interpreted in terms of Griffith's theory of fracture (see *J. Inst. Metals*, 1921, **25**, 386). Fracture is a consequence of the infiltration of the Griffith fissure by active slip planes. This explains the results obtained by Schmid in the case of zinc (see *J. Inst. Metals*, 1925, **34**, 381). The results support Joffé's interpretation of the so-called Joffé effect, but are unable to discriminate between that interpretation and that due to Ewald and Polanyi; Smekal's interpretation, attributing the effect to penetration of liquid into the crystal mass, is not supported by the results. —J. S. G. T.

The Preparation of Sputtered Metal Films. E. O. Hulburt (*Rev. Sci. Instruments*, 1934, [N.S.], **5**, 85–88).—The technique of sputtering and the production of thin films of about 30 metals are described. The transmission of films of platinum, tantalum, and chromium is constant for wave-lengths 0·5–2·2 μ; films of silicon and carbon are relatively transparent from 1·0 to 2·2 μ.—J. S. G. T.

***Interference of Light by Thin Metallic Films.** J. B. Nathanson (*J. Opt. Soc. Amer.*, 1933, **23**, 388–393; *Chem. Zentr.*, 1934, **105**, I, 824).—Manganese and platinum foils with a maximum thickness of 10^{-4} cm. have been prepared in hydrogen in such a way that, owing to their non-homogeneity in reflected light, they show interference rings or streaks. The weight of the films calculated from their optical properties agrees with the actual weight in the case of manganese, but is greater in the case of platinum owing to the occlusion of hydrogen.—A. R. P.

***Absorption by Thin Copper, Silver, and Gold Foil in the Visible and Ultra-Violet Regions.** Alexander Smakula (*Z. Physik*, 1933, **86**, 185–194).—Cf. *Met. Abs.*, this volume, p. 119. The optical absorption constants of thin sheets of copper, silver, and gold are determined in the region 700–186 mμ. All exhibit weak absorption maxima which are attributed to transition of electrons into the crystal lattices.—J. S. G. T.

***The Electrokinetic (Zeta) Potential of Thin Metal Films.** Grant W. Smith and L. H. Reyerson (*J. Phys. Chem.*, 1934, **38**, 133–151).—A streaming potential method for determining the electrokinetic potentials of metals in contact with their ions is described, and results obtained with the systems silver–silver ion and nickel–nickel ion are given. Fundamental relations between these electrokinetic potentials and the Nernst potentials were found.—J. T.

***Photoelectric Properties and Electrical Resistance of Metallic Films.** Duane Roller and Dean Woolridge (*Phys. Rev.*, 1934, [ii], **45**, 119–120).—Thin films of the alkali metals and platinum, silver, and gold show a marked dependence of the threshold wave-length and photoelectric emission on film thickness, but cadmium and mercury do not show this effect. As the thickness of a metal film is diminished, the resistance increases from the value characteristic of the metal in bulk, at first slowly, and then more rapidly, until a "critical thickness" is reached below which the resistance rapidly becomes infinite. The critical thicknesses for cadmium and mercury are of the order $200–300 \times 10^{-7}$ cm., and are much greater than those for the other metals mentioned above for which the critical thicknesses vary from 5 to 20×10^{-7} cm. The photoelectric anomalies thus correspond with large critical thicknesses, which probably indicate less uniformly deposited films.—W. H.-R.

***Some Experiments with Pure-Metal Resistance Standards.** James L. Thomas (*U.S. Bur. Stand. J. Research*, 1934, **12**, 313–321; *Research Paper* No. 657).—National standardizing laboratories use wire-wound standards for maintaining the unit of electrical resistance. The material for these standards is usually Manganin, an alloy of copper, nickel, and manganese. This alloy corrodes rather readily and in general its resistance does not remain as constant as is desired. It is believed that coils of pure metals, especially the noble metals, will be more stable in resistance and might be used to maintain the unit. Pure-metal standards have been constructed of copper, silver, tin, gold, and platinum wire, and measured at the ice point. The gold and platinum coils have been very stable in resistance. The construction, method of measurement, and results are given.—S. G.

The Scattering of Röntgen Rays by Metals. Alexander Rusterholz (*Dissertation: Eidg. Tech. Hochschule, Zürich*, **1931**, (643), 56 pp.).—Reviews very briefly the principal phenomena and theories associated with the scattering of X-rays by metals. Determinations of the scattering function (*F*) for aluminium, copper, silver, gold, platinum are tabulated and discussed.—J. T.

The Electrothermal Homogeneous Effect in Liquid Metal—I., —II. C. Benedicks and G. Siljeholm (*Ark. Mat. Astron. Fysik*, 1933, [A], **23**, (27), 21 pp.; **24**, (1), 16 pp.; *Chem. Zentr.*, 1934, **105**, I, 348).—(I.—) In a thoroughly tempered homogeneous conductor a heat effect (positive or negative) proportional to the current density is produced by the passage of a current. This effect can most satisfactorily be studied in a liquid metallic conductor, and six types of apparatus suitable for this work are described. The effect has been detected in mercury, a 4·5% cadmium amalgam, and a 27% thallium amalgam, the magnitude decreasing in the order given. (II.—) The homogeneous effect described in (I.) produces a rising or falling linear temperature distribution in the direction of the current through the homogenized conductor. The values calculated theoretically for a mercury conductor one end of which is kept at a constant temperature have been verified experimentally.—A. R. P.

***A General Proof of Certain Fundamental Equations in the Theory of Metallic Conduction.** H. Jones and C. Zener (*Proc. Roy. Soc.*, 1934, [A], **144**, 101–117).—In modern literature of the theory of metallic conduction, certain equations which are true for free electrons are assumed to remain valid when the potential is periodic. General proofs of these equations are here given. They give (1) the relationship between the velocity and energy of a stationary state and (2) the effects of a constant electric or magnetic field on a wave packet.—J. S. G. T.

Electrical Conductivity of Metals at the Lowest Temperatures. J. C. McLennan (*Proc. Roy. Inst.*, 1932, **27**, 446–470; also (summaries) *Nature*, 1932, **129**, 858–859, and *Engineering*, 1933, **135**, 165–166.—A lecture.—E. H.

***Electrical Resistance of Heat in Metals.** Charles R. Underhill (*J. Franklin Inst.*, 1933, **216**, 629–634).—From a mathematical treatment of the subject, it is suggested that a refinement of the method outlined in the paper might lead to a general equation for temperature coeffs. of resistance at all temperatures up to near the melting points of metals.—S. V. W.

The Effect of Pressure on Galvano-Magnetic Phenomena. C. Bellia (*Nuovo cimento*, 1933, **10**, 221–229; *C. Abs.*, 1934, **28**, 694–695).—The application of hydrostatic pressure increases the Hall coeff. (*R*) in sheet bismuth and lowers it in sheet antimony. The values for bismuth are as follow, where the first figure is the pressure in atm. and the second is the coeff.: 1, 2·583; 5, 2·731; 25, 2·741; 50, 2·750. The value of the const. magnetic field (*H*) is not given. Variations in *H* gave the following data which are, in order, the field strength in e.m.u., *R* at 1 atm. and *R* at 25 atm.: (sheet *A*) 1560, 3·483, 3·510; 2600, 2·915, 2·959; 4080, 2·373, 2·408; 5500, 1·973, 2·015; (sheet *B*) 1560, 3·122, 3·150; 2600, 2·699, 2·718; 4080, 2·189, 2·220; 5500, 1·887, 1·922. The electrical conductivity was also measured in bismuth with the following results, which are in order, the pressure in atm., the conductivity × 10^6 in a field of 1485 e.m.u.: 1, 7·600, 7·488; 5, 7·740, 7·628; 25, 7·773, 7·765; 50, 7·790, 7·681. The number of free electrons per c.c. is calculated to be 753·5 × 10^{16}.—S. G.

Problems of Ferro-Magnetism. R. Sänger (*Bull. Assoc. Suisse Élect.*, 1934, **25**, 137–143).—A review of recent investigations of ferro-magnetism in which nickel, cobalt, certain nickel–iron alloys, and magnetite are considered in addition to iron. Heisenberg's theory of ferro-magnetism and Weiss's assumption of an internal molecular field are shown to be mutually confirmatory. Investigations on single crystals demonstrate the inter-relation of magnetization vector and space-lattice, and a consideration of the elastic stresses within the lattice throws light on the nature of magnetization curves.
—P. M. C. R.

II.—PROPERTIES OF ALLOYS

(Continued from pp. 167–176.)

***Influence of Alternating Torsional Stresses on the Strength and Damping Capacity of Aluminium Alloys.** Hans Frankenberg (*Metallwirtschaft*, 1934, **13**, 187–191).—The creep limit of aluminium and various binary alloys of this metal with copper, silicon, and magnesium is raised by the continued application of torsional stresses. The damping capacity is independent of the number of alternations, but during the course of the endurance test it decreases in aluminium, increases in copper–aluminium alloys, and remains constant in silicon– and magnesium–aluminium alloys, in which, however, it is very small. —v. G.

***Rate of Age-Hardening of Duralumin as Determined by Upsetting Tests.** J. O. Lyst (*Metals and Alloys*, 1934, **5**, 57–58).—The specimens are cut from $\frac{3}{8}$-in. rivet stock, so that the length is twice the diameter; they are then subjected to compression and the load noted when the length is reduced by 25 and 50% and when the first cracks appear. Cracking before a 55% reduction is always a sign that cracks will appear in the head during riveting; this is therefore the critical value (R_c). On ageing freshly quenched Duralumin at room temperature, R_c is reached in 2–2$\frac{1}{2}$ hrs., but at 0° C. only after 2–2$\frac{1}{2}$ days. If the quenched alloy is kept at − 48° C. in a " dry-ice " refrigerator, cracking does not occur below a 57% reduction even after 14 days; but if the alloy is then kept at room temperature, R_c is again reached in 2–2$\frac{1}{2}$ hrs. Hardening of the freshly quenched alloy is perceptible in 1$\frac{3}{4}$ hrs. at 20° C., and in 36 hrs. at 0° C., but never occurs at − 48° C.—A. R. P.

***The Tempering Effect in Quenched Copper–Aluminium Alloys.** W. Stenzel and J. Weerts (*Mitt. Material., Sonderheft* **24**, 1934, 73–92).—See *J. Inst. Metals*, 1933, **53**, 694.—J. W.

***On Age-Hardenable Silumin Containing Magnesium.** O. Bauer, B. Blumenthal, and M. Hansen (*Mitt. Material., Sonderheft* **23**, 1934, 60–65).—On ageing, cast Silumin containing magnesium, preferably at 150° C., the yield-point, tensile strength, and hardness are considerably increased, especially if the metal is first annealed and quenched. The hardness of an alloy with 0·3–0·5% magnesium is increased by 30–35% after ageing for 50–60 hrs., and the tensile strength of an alloy with 0·34% magnesium by about 25% after ageing for 96 hrs., whilst the yield-point is raised 65%. Elongation and reduction in area are, however, correspondingly reduced. In specimens with 1·08% magnesium, the presence of Mg_2Si could not be detected after quenching from 500° C. and ageing at temperatures up to 300° C.—J. W.

Silicon and Its Use in Modern Metallurgy. A. B. Kinzel (*Min. and Met.*, 1933, **14**, 489–492).—A review.—A. R. P.

***The Nature of the Solid Phase in the System Antimony–Bismuth.** W. F. Ehret and M. B. Abramson (*J. Amer. Chem. Soc.*, 1934, **56**, 385–388).—X-ray diffraction patterns and microscopic examination showed the antimony–bismuth alloys to consist only of one phase, corresponding with a system which forms a complete series of solid solutions. The solidus as determined by Otani was shown to be probably correct.—R. G.

Resistance Alloys for Temperatures up to 1300° C. [Megapyr]. A. Grunert, W. Hessenbruch, and K. Ruf (*Elektrowärme*, 1933, **3**, 208–212; *C. Abs.*, 1933, **27**, 5043).—See this *J.*, 1933, **53**, 550.—S. G.

Corrix, a New [Copper–Aluminium–Iron] Alloy for Propellers. Anon. (*Automobiltech. Z.*, 1934, **37**, (5), 149–150).—Cf. *Met. Abs.*, this volume, p. 170. It is stated that Corrix, a ternary copper–aluminium–iron alloy, shows exceptional resistance to corrosion, especially by sea-water; it also resists the action of saturated and superheated steam, 50% hydrochloric acid, 50% acetic acid, and weak and saturated ammonium chloride. The physical and mechanical properties of the alloy are summarized. It is considered likely to be of great use for propellers and various fittings in aircraft and transport vehicles.—P. R.

Beryllium-Copper. Anon. (*Met. Ind.* (*N.Y.*), 1934, **32**, 48–49).—The manufacture, properties, and heat-treatment of beryllium-copper alloys are described.—A. R. P.

***On the System Beryllium–Copper.** H. Tanimura and G. Wassermann (*Mitt. Material., Sonderheft* **24**, 1934, 151–153).—See *J. Inst. Metals*, 1933, **53**, 620. —J. W.

***Ageing Phenomena in Copper–Nickel–Silicon Alloys.** Enrico Crepaz (*Atti Congr. naz. Chim. pura appl.*, 1933, **4**, 454–468; *Chem. Zentr.*, 1934, **105**, I, 1104).—A copper–silicon alloy with 6·31% silicon shows a single maximum in the hardness and expansion with rise in ageing temperature, *i.e.* it ages normally. When nickel is also present, two maxima occur in the hardness, expansion, and resistivity curves; this is attributed to the primary precipitation of silicon in excess of the ratio 4 nickel : 1 silicon, followed by a secondary precipitation of the compound which produces maximum hardness. A similar behaviour has already been observed in aluminium alloys.—A. R. P.

***The Effect of Grain Boundaries on Equilibrium.** P. Wiest (*Metallurgist* (Suppt. to *Engineer*), 1933, **9**, 53–54).—A summary of a paper by W. on " X-Ray Experiments on the Solubility of Silver in Copper," *Z. Physik*, 1932, **74**, 225. See *J. Inst. Metals*, 1932, **50**, 308.—R. G.

A Flanged Bronze Celt from Birtley, Co. Durham. A. Raistrick and J. A. Smythe (*Proc. Univ. Durham Phil. Soc.*, 1933, **9**, (2), 47–54).—The material of a flanged bronze celt of the earliest Bronze period contained copper 82·73%, remainder tin, with traces of iron and nickel. The small, equi-axed, twinned, and frequently deformed α-crystals indicated that the material had undergone cold-working, low-temperature annealing, and subsequent further local cold-working. Large masses of eutectoid were present. Hardness tests, especially in comparison with the results of corresponding tests on a made-up alloy of similar composition, threw further light on the process of manufacture, which is briefly outlined.—P. M. C. R.

***Thermal Expansion of Bearing Bronzes.** Peter Hidnert (*U.S. Bur. Stand. J. Research*, 1934, **12**, 391–400; *Research Paper* No. **665**).—This paper gives data on the linear thermal expansion of cast bearing bronzes (copper–tin and copper–tin–lead) at various temperatures between 20° and 200° C. The results obtained on heating and cooling are given in diagrams and the coeffs. of expansion for various temperatures are given in a table. The coeffs. of expansion obtained in the second tests are generally higher than those obtained in the first tests. The addition of tin to copper or lead to copper–tin alloys increases the coeffs. of expansion. Equations were derived which show the relationship between the tin content and the coeffs. of expansion of cast copper–tin alloys and between the lead content and the coeffs. of expansion of cast leaded bronzes with a copper–tin ratio equal to about 7.—S. G.

Foundry Bronzes. III.—Phosphor Bronze. Anon. (*Found. Trade J.*, 1934, **50**, 186).—The composition of phosphor–bronzes, and the melting shop and foundry practice in the production of these alloys are described.—J. H. W.

***The Transformation Processes in β-Brass and β-Silver–Zinc Alloys.** J. Weerts (*Mitt. Material., Sonderheft* **23**, 1934, 38–43).—See *J. Inst. Metals*, 1933, **53**, 12–13.—J. W.

***On the Capacity for Hot Deformation of Binary and Complex Copper–Zinc Alloys.** P. Röntgen and W. Donike (*Z.V.d.I.*, 1934, **78**, 220–223).—Experiments have been made on the capacity of brasses with 63–84% copper and with various small additions of other elements to be hot-rolled and extruded. Brass made from pure zinc and copper can always be hot-worked, but after prolonged annealing oxygen diffuses into the surface and produces cracks on hot-rolling. Addition of more than 1·2% of lead to 58%, of more than 0·1%

lead to 63%, and of as little as 0·01% lead to 67 and 84% copper–brass causes fissures on hot-rolling. The upper limit of lead for extrusion is 2% for 67 and 84%, and 5% for 63 and 58% copper–brass, and that of phosphorus is 0·02% for hot-rolling and 0·4% for extrusion of α-brass, whereas several % of tin is without deleterious effect in either operation. Power measurements in the extrusion press show that the resistance to deformation of α-brass is considerably higher than that of β-brass, and therefore insoluble constituents which segregate along the grain boundaries are more deleterious in α- than in β-brass. —v. G.

***The Influence of Third Metals on the Constitution of Brass Alloys. V.—The Influence of Manganese. A Contribution to the Knowledge of the Ternary System Copper–Zinc–Manganese.** O. Bauer and M. Hansen (*Mitt. Material., Sonderheft* 23, 1934, 43–49).—See *J. Inst. Metals,* 1933, **53**, 123.—J. W.

***The Properties of Nickel–Brasses.** J. Cournot and F. Hiltbold (*Compt. rend.,* 1934, **198**, 749–751).—A systematic study has been made of the properties of the industrial nickel–brasses (copper 55–60, nickel 8–22%) as a function of their composition: (1) cold-working results in a Brinell hardness of at least 200 and still higher for alloys richer in nickel; (2) the effects of heating the cold-worked alloys are different from those observed in brasses chiefly in that the decrease of the mechanical resistance is relatively slow; (3) this slowness is also encountered in studying the effect of the time of heating; (4) for the same copper content, cold-working is effective more rapidly the lower the nickel content. The manner in which the hardness varies in perfectly annealed alloys is discussed; in annealed industrial nickel–brasses, the Brinell hardness is given by the formula: $\Delta = 81 + [20 - \frac{1}{3}(\text{Ni} - 22)^2]\frac{65 - \text{Cu}}{10}$; (5) nickel–brasses are extremely sensitive to homogenization after casting. —J. H. W.

Silicon–Brasses: A New Series of Technical Alloys. E. T. Richards (*Met. Ind.* (*Lond.*), 1934, **44**, 269–270).—A short summary of the melting, pouring, moulding, chill-casting, hot-working properties, and applications of alloys of the order: copper 84–90, silicon 4–2, zinc 12–8%.—J. H. W.

***On Lead Alloys for Cable Sheaths.—II.** T. Aizawa and K. Osanai (*Res. Electrotech. Lab.* (*Tokyo*), No. **346**, 1933, 1–32; *Sci. Abs.*, 1933, [B], **36**, 482).—[In Japanese, with English summary.] A study of the age-hardening, fatigue (under repeated tension), and corrosion phenomena of lead cable-sheath alloys. The effects of small additions of antimony, calcium, cadmium, zinc, magnesium, and tin, also combinations of these metals, are investigated. In most cases age-hardening occurs at room temperatures. The alloy with 0·5% magnesium becomes brittle, developing cracks. As to corrosion, it is shown that air and carbon dioxide play a part with buried cables, the corrosion being much accelerated by electrolytic action. A number of equilibrium diagrams is reproduced and photomicrographs of the alloys examined are included.—S. G.

***Study of Ultra-Light Alloys of Magnesium with Aluminium and Copper.—II.** Paul Bastien (*Rev. Mét.,* 1933, **30**, 528–542).—Cf. *J. Inst. Metals,* 1933, **53**, 623; and *Met Abs.*, this volume, p. 71. The physical properties studied are density and thermal and electrical conductivities, and these are correlated with the ternary equilibrium diagram. Mechanical tests on the cast, drawn, and forged alloys include tensile, bend, and fatigue tests. The fatigue limit of the aluminium–magnesium alloys (0–15% Al) increases up to the limit of solid solubility, then decreases slightly but progressively. In the case of copper–magnesium alloys the fatigue limit increases slightly and linearly with increase of copper content. Corrosion tests were made in various media in an apparatus permitting circulation of the corroding medium aerated with any desired atmosphere, and with different speeds of circulation. Forging tests showed the possibility of forging ultra-light alloys with copper content of the order of

12%, and thus obtaining good mechanical properties, hardness, and thermal conductivity satisfactory for pistons of internal combustion engines. Mechanical tests on alloys containing up to 15% of aluminium plus copper, showed the desirability of using transverse tests on the cast alloys for acceptance tests. The properties of some of these alloys compared favourably with Elektron alloys, and the fatigue properties of several alloys in the wrought condition having limits of 12–13 kg./mm.^{2} (7·6–8·2 tons/in.^{2}) were considered to be of the order of those of alloys of the Duralumin type. Corrosion tests have shown that the addition of copper with aluminium in equal amount increases susceptibility to corrosion slowly as regards attack by acid media, and very rapidly as regards attack in saline media. Addition of aluminium to copper–magnesium alloys diminishes very rapidly the rate of corrosion of the alloys, and with more than 3% of aluminium the mean rates of corrosion of the ternary alloys become generally of the same order.—H. S.

*__Investigation on Binary Solid Solution of Magnesium. I.—Röntgenographic Determination of the Boundary of the α-Solid Solution Range of Aluminium–Magnesium and Zinc–Magnesium Alloys. II.—Tensile Tests on Homogenized Aluminium–Magnesium and Zinc–Magnesium Solid Solutions.__ E. Schmid and H. Seliger (*Mitt. Material., Sonderheft* **23**, 1934, 52–58).—See *J. Inst. Metals*, 1932, **50**, 732.—J. W.

*__The Equilibrium Diagram of Magnesium–Antimony.__ G. Grube and R. Bornhak (*Z. Elektrochem.*, 1934, **40**, 140–142).—The equilibrium diagram of the magnesium–antimony system has been determined by thermal analysis. There are 2 eutectic horizontals, at 629° C. on the magnesium side and at 579° C. on the antimony side, ranging, between them, from pure magnesium to pure antimony. On the magnesium side, the eutectic occurs at 10 atomic-% of antimony, and on the antimony side at 86 atomic-%. Only one compound, Mg_3Sb_2, exists, melting at 1228° C. This high-melting compound is analogous with Mg_3Bi_2 in many respects; it forms a solid solution with excess magnesium and exists in 2 polymorphic forms. The $\alpha \rightleftharpoons \beta$ transformation of the compound occurs at between 40 and 44 atomic-% of antimony at 930° ± 2° C., and the magnesium-rich β-solid solution at 894° C.—J. H. W.

*__Electrical Conductivity and Equilibrium Diagram of Binary Alloys. X.—The Magnesium–Bismuth System.__ G. Grube, L. Mohr, and R. Bornhak (*Z. Elektrochem.*, 1934, **40**, 143–150).—The electrical conductivity of alloys throughout the whole range of the magnesium–bismuth system has been determined at 50° C. intervals between 50° and 250° C., and of the alloys containing up to 40 atomic-% of bismuth from 50° to 550° C. The equilibrium diagram has been constructed from these results and from thermal analysis and micro-examination. The results confirm the existence of the compound Mg_3Bi_2, identified in a previous investigation. This compound melts at 823° C. In the neighbourhood of 715° C., the previously assumed melting point of the compound, a newly-discovered $\alpha \leftrightarrows \beta$ transformation occurs, on the pure compound side at 700° C. and on the magnesium-rich solid solution side at 686° C. The range of homogeneity of this solid solution as well as the solubility of bismuth in solid magnesium was determined from the electrical conductivity measurements. In the range 30–35 atomic-% of bismuth, unreproducible electrical conductivity results were obtained, for which an explanation has not yet been found. If transformations in the solid state occurred in this range, they proceeded so slowly that they were not shown up by the observations taken.
—J. H. W.

*__Electrical Conductivity and Equilibrium Diagram of Binary Alloys. XI.—The Lithium–Magnesium System.__ G. Grube, H. v. Zeppelin, and H. Bumm (*Z. Elektrochem.*, 1934, **40**, 160–164).—The electrical conductivity of the lithium–magnesum alloys has been measured at 25° C. and at 50° intervals between 50° and 550° C., and a partial equilibrium diagram has been constructed from these results and those of thermal and X-ray analysis. Up to 16·3 atomic-%, the alloys solidify as magnesium-rich solid solutions, between 16·3 and 21·8 atomic-%, these solid solutions separate out as primaries. In this range, a eutectic containing 21·8 atomic-% of lithium crystallizes out at 587·5° C., and consists of the magnesium-solid solution and the phase Li_2Mg_5. Thence the liquidus rises to a flat maximum at between 28 and 30 atomic-% of lithium, and then falls steadily to the melting point of lithium. Only the eutectic crystallization between 16·3 and 21·8 atomic-% of lithium can be observed by thermal analysis. Between 21·8 and 28·6 atomic-% of lithium, the temperatures of primary and secondary crystallization lie so close together as to be indistinguishable by thermal analysis, but X-ray examination shows the existence of a heterogeneous mixture of magnesium- and lithium-solid solutions. The phase, Li_2Mg_5, crystallizes in the cubic body-centred lattice of lithium and behaves like a compound.—J. H. W.

***On the Elongation of Ternary Magnesium Solid Solutions.** E. Schmid and G. Siebel (*Mitt. Material., Sonderheft* **23**, 1934, 58–60).—See *J. Inst. Metals*, 1932, **50**, 732.—J. W.

Manufacture of Magnesium. A. Dumas (*Rev. Mét.*, 1933, **30**, (12), 511–519).—A historical survey of the extraction and applications of magnesium. Details of various methods of extraction are given, including direct methods of producing magnesium alloys.—H. S.

***The System: Manganese–Tin–Mercury.** Alan Newton Campbell and Herbert Dyson Carter (*Trans. Faraday Soc.*, 1933, **29**, 1295–1300).—Systems consisting of two metals and mercury can be studied in an analogous manner to that employed in the study of two salts and water, so that data on mutual relationships, compound formation, &c., of two metals at room temperature can be readily obtained. From a study of the system manganese–tin–mercury the formation of a compound Sn_5Mn_2 at below 30° C. has been established. No solid solution of this compound or of tin or manganese in mercury exists, nor are compounds analogous to hydrates formed.—A. R. P.

***Observations on the Rare Earths. XLI.—Electrolytic Preparation of Rare Earth Amalgams. 3.—Amalgams of Lanthanum, Neodymium, Cerium, Samarium, and Yttrium. Metallic Lanthanum, Neodymium, and Cerium by Thermal Decomposition of Their Amalgams.** E. E. Jukola, L. F. Audrieth, and B. S. Hopkins (*J. Amer. Chem. Soc.*, 1934, **56**, 303–304).—Dilute amalgams were prepared by electrolysis of concentrated solutions of the anhydrous chlorides in ethyl alcohol, using a mercury cathode. These were concentrated by vacuum distillation. Further heating up to about 1000° C. in oxide-lined crucibles in a vacuum furnace resulted in decomposition of the amalgam and isolation of the metal.—R. G.

***Composition of Crystalline Amalgams of Zinc, Lead, Tin, and Cadmium.** Henry H. Hosford (*J. Dental Research*, 1934, **14**, 33–37).—When zinc, lead, tin, and cadmium rods are immersed in mercury for many days crystalline amalgams are formed on the surface, whereas no such crystals are formed with copper or silver. The zinc crystals are a mass of closely-packed laminæ containing some hexagons and contain 41–45% zinc ($HgZn_2 = 39·46\%$ zinc; $Hg_2Zn_5 = 44·9\%$ zinc). The lead crystals are dendritic needles at right angles to the lead rod, and contain 63–65% lead ($HgPb_2 = 67·38\%$ lead). The tin crystals consist of very regular hexagonal plates containing 78–79% tin ($HgSn_7 = 80·55\%$ tin). The cadmium crystals are stubby rounded needles containing 15–16% cadmium ($Hg_7Cd_2 = 13·76\%$ cadmium; $Hg_3Cd = 15·73\%$ cadmium).—A. R. P.

†On the Manufacture of Alloys Possessing High Electrical and Heat Resistance. S. D. Zipurdeev (*Vestnik Ingenerov i Tehnikov* (*Messenger of Engineers and Technologists*), **1933**, (7), 304–306).—[In Russian.] A review of work on high-resistance alloys in Russian and foreign factories.—N. A.

***High-Grade Chromium–Nickel Alloys and Life Tests Thereon.** W. Hessenbruch and W. Rohn (*Elektrowärme*, 1933, 3, 245–249, 294–297, 317–322).—See *J. Inst. Metals*, 1933, **53**, 624–625, 697.—S. G.

***The Properties of Monel Metal and Similar Copper–Nickel Alloys.** O. Bauer, J. Weerts, and O. Vollenbruck (*Mitt. Material., Sonderheft* **23**, 1934, 21–34).—See *J. Inst. Metals*, 1933, **53**, 125–126.—J. W.

***Large Barkhausen Discontinuities and Their Propagation [in Nickel–Iron Alloys].** Raymond E. Reinhart (*Phys. Rev.*, 1934, [ii], **45**, 342–343).—A note. With a 10% nickel–iron alloy strained by combined tension and torsion it is only the component of the field (H) in the direction of maximum strain which affects the velocity (v) of propagation of large Barkhausen discontinuities. The field affecting propagation is thus $H \cos \theta$, where θ is the angle the applied field makes with the direction of maximum strain. Experiments show that the curves connecting v and H closely resemble those connecting v and I (the intensity of magnetization). If v were a function of $HI \cos \theta$ only, then in pure tension for which $\cos \theta = 1$, the values of HI should be constant for a constant value of v, and this is shown to be approximately true for the 10% nickel–iron alloy.—W. H.-R.

***The Resistances of Some Copper–Palladium Alloys.** D. Stockdale (*Trans. Faraday Soc.*, 1934, **30**, 310–314).—The specific resistance and temperature coeff. of resistance of copper–palladium alloys with 53·44–60·77 atomic-% palladium have been measured at 20°–150° C. The coeff. falls sharply from $1·9 \times 10^{-4}$ (20°–60° C.) for the alloy with 53–44 atomic-% palladium to $1·0 \times 10^{-4}$ for those with 54·28–58·53 atomic-% palladium, then rises slowly with further increase in palladium. The coeff. also falls slowly with rise in temperature, reaching zero (extrapolated) at 260° C. for the alloys with the minimum coeff. The specific resistance at 20° C. of the alloy with 58 atomic-% palladium is $46·6 \times 10^{-6}$ ohm-cm.—A. R. P.

***Some Physical Properties of Platinum–Rhodium Alloys.** J. S. Acken (*U.S. Bur. Stand. J. Research*, 1934, **12**, 249–258; *Research Paper* No. **650**).—In a continuation of the study at the U.S. Bureau of Standards of the metals of the platinum group, a series of platinum–rhodium alloys containing approximately 10, 20, 40, 60, and 80% rhodium was prepared from pure platinum and pure rhodium. The melting point, hardness, density, electrical resistivity, temperature coeff. of resistance, and thermal e.m.f. against platinum were determined for each alloy. The microstructure of each alloy appeared to be that of a solid solution. The particular qualifications of the alloys containing from 20 to 40% of rhodium, for use as resistance furnace windings for service at high temperatures, are discussed.—S. G.

Alloys of the Ceramico-Metal Type. N. Zarubin and L. Malkov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (6), 68–71).—[In Russian.] A brief review of the production methods, microstructure, and properties of super-hard alloys, *e.g.* "Pobedite," "Widia," "Carboloy," "Ramet," "Titanite," and others.—D. N. S.

***The Solubility of Copper in Zinc.** M. Hansen and W. Stenzel (*Mitt. Material., Sonderheft* **24**, 1934, 113–120).—See *Met. Abs.*, this volume, p. 13. —J. W.

†**Ageing of Metals.** N. F. Bolchovitinov (*Vestnik Ingenerov i Tehnikov* (*Messenger of Engineers and Technologists*), **1933**, (6), 260).—[In Russian.] A brief review of the position to date.—N. A.

***The Influence of Corrosion on the Endurance Limit under Alternating Stress of Steels and Non-Ferrous Metals.** Theodor Dusold (*Metallwirtschaft*, 1934, **13**, 41–44).—The following metals, as well as several steels, have been tested in the alternating torsion machine: nickel, and aluminium containing (*a*) copper 5·6, manganese 0·7%, (*b*) 10% zinc, (*c*) zinc 10, chromium 0·5, silicon 1·8, lead 1·3%, (*d*) manganese 0·7, magnesium 0·7, silicon 1%. All the aluminous alloys, even after the surfaces had been consolidated by pressure, showed a lower fatigue limit in water than in air, but nickel gave higher results in water than in air especially after application of pressure to the surface.—v. G.

Erosion-Resisting Metals. Accelerated Tests. T. F. Hengstenberg (*Power*, 1932, **76,** 118–120; *Sci. Abs.*, 1933, [B], **36,** 9).—Specimens of various metals were whirled past a water jet at speeds up to 1200 ft./second, and the results agree closely with actual observations in machines in commercial service. The materials tested were plain carbon steel, chromium–nickel alloys, nickel steel, and case-hardened nitrided steel. Up to 800 ft./second the spray had no effect on any of the materials. At higher speeds erosion commenced, and at 1200 ft./second the wear was excessive except on one of the chromium–nickels and the nitrided steel.—S. G.

Thermodynamics of Solid Solutions. I.—Perfect Solutions. Harry Seltz (*J. Amer. Chem. Soc.*, 1934, **56,** 307–311).—The concept of fugacity or activity, developed successfully in the treatment of liquid solutions, is applied in a graphical method for determining the liquidus and solidus curves for binary systems which solidify with the formation of solid.solutions. Equations are derived for calculating the liquidus and solidus curves from the temperatures and heats of fusion of the two pure solids. A comparison is made between the observed and calculated liquidus and solidus of the copper–nickel, silver palladium, and gold–platinum systems. The values for the copper–nickel system were similar, but none was in close agreement, as would be expected from the fact that Raoult's law is not obeyed over the entire range of composition.—R. G.

***Theory of Alloys in the γ-Phase.** H. Jones (*Proc. Roy. Soc.*, 1934, [A], **144,** 225–234).—The zones of allowed energies for the loosely-bound electrons in alloys with the γ-structure are discussed mathematically. The lowest group of energy levels is almost completely filled by the number of loosely-bound electrons given by the Hume-Rothery rule, and a reason for the existence of this rule is discussed. Large diamagnetic susceptibilities can be anticipated for alloys in this phase, and the Hall coeff. should change from large positive to large negative values as the composition changes through the phase in the direction of increasing number of loosely-bound electrons.—J. S. G. T.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 176–178.)

***Recrystallization Texture of Duralumin.** G. S. Zhdanov and V. I. Iveronova (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki* (*Journal of Experimental and Theoretical Physics*), 1933, **3,** (6), 579–587).—[In Russian, with a German summary.] The recrystallization texture of Duralumin annealed at 520° C. for ½ hr. and quenched after a reduction of 99·6% by cold-rolling, has been determined. X-ray photograms show a well-defined texture differing from that of rolled Duralumin and from that of other metals with a face-centred cubic lattice. Polar diagrams for the planes (111), (200), (220), and (113) show that the preferred orientation in the direction of rolling is $[\bar{2}33]$, transverse thereto [311] and normal thereto $[01\bar{1}]$. Other orientations observed in the direction of rolling are [011], $[\bar{1}21]$, $[\bar{1}20]$, transverse thereto $[\bar{2}1\bar{1}]$, $[74\bar{1}]$, $[\bar{2}10]$, and normal thereto $[1\bar{1}1]$, $[1\bar{1}3]$, [001].—N. A.

***The Kinetics of Crystallization Processes.** (Frhr.) v. Göler and G. Sachs (*Mitt. Material., Sonderheft* **23,** 1934, 3–5).—See *J. Inst. Metals*, 1932, **50,** 671.—J. W.

***On the Relation Between the Crystal Orientation in Rolled Aluminium Sheet and the Thickness of the Sheet.** G. v. Vargha and G. Wassermann (*Mitt. Material., Sonderheft* **24,** 1934, 121–126).—See *Met. Abs.*, this volume, pp. 12–13.—J. W.

***Crystal Structure and Composition of the Cubic Carbide of Chromium.** A. Westgren (*Jernkontorets Ann.*, 1933, **117**, 501–512; *Chem. Zentr.*, 1934, **105**, I, 505–506).—The lowest carbide of chromium, usually formulated Cr_4C, has *d* 6·97 and $a = 10{\cdot}638$ A.; from these figures the unit cell contains 116 atoms, and the formula of the compound should therefore be $Cr_{23}C_6$, which has been confirmed by X-ray crystallographic analysis (details of the atomic grouping are given). In a double chromium carbide of this type containing 10% tungsten the atom grouping corresponds with the formula $Cr_{21}W_2C_6$. Analogous compounds containing iron in place of chromium and molybdenum in place of tungsten have been isolated. The corresponding manganese carbide $Mn_{23}C_6$ has $a = 10{\cdot}564$ A.—A. R. P.

***X-Ray Investigation of the Solid Solubility of Aluminium in Copper.** I. Obinata and G. Wassermann (*Mitt. Material., Sonderheft* **24**, 1934, 109–112).—See *J. Inst. Metals*, 1933, **53**, 497.—J. W.

***On the Transformations in β-" Aluminium–Bronze."** G. Wassermann (*Metallwirtschaft*, 1934, **13**, 133–139).—" Aluminium–bronze " with 12% aluminium has been examined by X-rays at high temperatures. The β-phase stable above 580° C. has a body-centred cubic lattice with $a = 2{\cdot}94$ A., but the atomic distribution is random; on slow cooling this phase decomposes into α- and δ-crystallites, but on rapidly cooling to 300° C. it is converted into a β_1-phase of the same lattice structure, but with a superstructure. Below 300° C. the β_1-phase is converted into β′, which has a lattice similar to the α-phase. The $\beta \rightarrow \beta_1 \rightarrow \beta'$ transformations are reversible on heating and cooling, and the phases cannot be retained by quenching. The β_1- and β′-phases are unstable and slowly revert to $\alpha + \delta$ at 350°–580° C.; the rate of transformation below 350° C. is very slow. The stable $\alpha + \delta$ structure produced by annealing β_1 at 400°–500° C. is martensitic. On slow cooling from the β-field (above 600° C.) the $\alpha + \delta$ structure is eutectoidal.—v. G.

***The Gold–Manganese Equilibrium Diagram.** H. Bumm and U. Dehlinger (*Metallwirtschaft*, 1934, **13**, 23–25).—The alloys used by Moser, Raub, and Vincke (see *J. Inst. Metals*, 1933, **53**, 124, 235) have been examined by X-ray analysis. Above 700° C. a solid solution with random orientation occurs in the range 0–83% manganese; the lattice parameter at 1000° C. decreases from 4·07 A. for gold to 4·01 for 30, 3·93 for 60, and 3·86 A. for 83% manganese. Below 700° C. a face-centred tetragonal compound, $a = 4{\cdot}100$ A. and $c = 3{\cdot}986$ A., separates at 10% manganese, while with 22% manganese a body-centred tetragonal phase with $a = 3{\cdot}28$ A. and $t = 3{\cdot}14$ A. occurs. The atomic distribution in both cases is regular.—v. G.

***X-Ray Investigations on Antimony–Lead and Tin–Lead Alloys.** I. Obinata and E. Schmid (*Mitt. Material., Sonderheft* **23**, 1934, 49–51).—See *J. Inst. Metals*, 1933, **53**, 622.—J. W.

***Crystal Structure of Praseodymium.** A. Rossi (*Atti R. Accad. Lincei* (*Roma*), 1932, **15**, 298–300; *Sci. Abs.*, 1932, [A], **35**, 677).—The values found for the ratios between lattice planes of the praseodymium crystal and the order of reflection agree closely with those calculated for a hexagonal system, the value of the axial ratio $c : a$ being 1·60, and the side of the unit cell $a_0 = 3{\cdot}657$ A. Three weak lines, occurring in the best of the photograms obtained and not corresponding with such a hexagonal system, are regarded as due to impurities. The value given in the literature for the density of praseodymium is 6·60; that found for the material examined (99·4% praseodymium) is $6{\cdot}765 \pm 0{\cdot}008$, the calculated density being 6·777.—S. G.

Blue Na–W–Bronze. W. F. de Jong and H. J. Stek (*Z. Krist.*, 1932, **83**, 496; *C. Abs.*, 1933, **27**, 2613).—Blue sodium–tungsten–" bronze " is formed by weak reduction of the cubic sodium–tungsten–" bronze " with hydrogen or zinc, and probably has the formula $Na_2(WO_3)_5$. It is tetragonal, and rotation photographs give $a = 17{\cdot}5$ and $c = 3{\cdot}80$ A. (for cubic sodium-tungsten-"bronze" $a = 3{\cdot}83$ A.).—S. G.

***On the Structure of Technical Zinc Dust.** G. Wassermann (*Mitt. Material., Sonderheft* **23**, 1934, 34–36).—See *J. Inst. Metals*, 1933, **53**, 191.—J. W.

***X-Ray Determination of the Solubility of Cadmium in Zinc.** W. Boas (*Mitt. Material., Sonderheft* **23**, 1934, 36–38).—See *J. Inst. Metals*, 1933, **53**, 18.—J. W.

***X-Ray Investigations on Zinc–Nickel Alloys.** Vincenzo Cagliotti (*Atti Congr. naz. Chim. pura appl.*, 1933, **4**, 431–441; *Chem. Zentr.*, 1934, **105**, I, 1283).—X-ray examination of the alloys has revealed the existence of the following phases: (*a*) an ε-phase (up to 5% nickel) the structure of which has not been elucidated; (*b*) a γ-phase (with 15–22 atomic-% nickel) consisting of a solid solution of zinc or nickel in the body-centred cubic compound Ni_5Zn_{21}; (*c*) a β-phase with 46% nickel consisting of the compound NiZn with 4 atoms in the unit tetragonal lattice, $a = 3{\cdot}867$ A., $c/a = 0{\cdot}83$; and (*d*) an α-phase with 53% nickel. Solubility of nickel in the zinc lattice could not be detected.—A. R. P.

***Segregation of Polonium in a Bismuth Crystal [Evidence for Secondary Structure in Crystals].** Alfred B. Focke (*Phys. Rev.*, 1934, [ii], **45**, 219–220).—A note. Bismuth crystals containing polonium were cleaved parallel to the (111) planes. The variation of α-ray intensity with the distance from the plane was measured, and gave a curve with a number of discontinuities or steps. If the foreign atoms were distributed in periodically occurring (111) planes (see Goetz and Focke, *Met. Abs.*, this volume, p. 226), a curve of this kind would be expected, since the α-ray would travel a distance in air dependent on the depth of the layer from which it came, and this would vary discontinuously. Assuming that the steps on the curve correspond with the air-equivalent of one block of the secondary structure, the spacing of the planes containing the polonium atoms is calculated as $0{\cdot}6 \pm 0{\cdot}1\ \mu$, in good agreement with other evidence.—W. H.-R.

***Precision Measurements of the Lattice Constants of Non-Cubic Metals.** W. Stenzel and J. Weerts (*Z. Krist.*, 1932, [A], **84**, 20–44; and *Mitt. Material., Sonderheft* **23**, 1933, 5–16).—A new method of calculating the lattice constants from the röntgenograms is described which permits of the constants of non-cubic substances being calculated with as high a degree of accuracy as those of cubic substances. The following lattice constants (at 20° C.) have been determined in this way: cadmium, $a = 2{\cdot}9736$, $c = 5{\cdot}6058$ A., $c/a = 1{\cdot}8852$; zinc, $a = 2{\cdot}6590$, $c = 4{\cdot}9351$ A., $c/a = 1{\cdot}8560$; magnesium, $a = 3{\cdot}2022$, $c = 5{\cdot}1991$ A., $c/a = 1{\cdot}6236$; rhenium, $a = 2{\cdot}7553$, $c = 4{\cdot}4493$ A., $c/a = 1{\cdot}6148$; β-tin, $a = 5{\cdot}8194$, $c = 3{\cdot}1753$ A., $c/a = 0{\cdot}5456$.—J. W.

***On the Theory of Electronic Motion in a Crystal Space-Lattice.** D. Blohinzev (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki* (*Journal of Experimental and Technical Physics*), 1933, **3**, (6), 475–498).—[In Russian.] In this paper is given a generalization of Bloch's theory of the motions of firmly-bound electrons in the conditions of degenerate atomic states, as also of electrostatic motion for terms higher than *P* and *S*. Combinations of *P* and *S* terms are examined in detail. An idea is given of the electronic wave functions in the form of a Fourier series according to a method similar to Born's well-known method in the theory of the crystal lattice. Appropriate formulæ for the motion of an electron in a limited crystal are developed.—N. A.

***Large Artificial Crystals of Graphite.** K. S. Krishnan (*Phys. Rev.*, 1934, [ii], **45**, 115).—A note. The method of Goetz and Faessler (*ibid.*, 1932, [ii], **39**, 169; **40**, 1053) is criticized. (See following abstract.)—W. H.-R.

***About the Production of "Colloidal Single Crystals" [of Graphite].** Alexander Goetz (*Phys. Rev.*, 1934, [ii], **45**, 282–283).—A note. The criticisms of Krishnan (preceding abstract) are unjustified, since the azimuthal orientation was made uniform by rotating the container of the suspension within the magnetic field round an axis parallel to the direction of the [0001] axis desired for the suspensions. Photographs are reproduced of specimens obtained with and without rotation.—W. H.-R.

†***On the Factors Affecting the Reflection Intensities by the Several Methods of X-Ray Analysis of Crystal Structures.** F. C. Blake (*Rev. Modern Physics*, 1933, **5**, 169–202; correction, 288).—The different factors affecting the intensity of X-ray reflection in crystal analysis are discussed, and the mathematical equations are deduced and explained together with notes on the interpretation of experimental data. The bulk of the paper is a review of previously published work, but new matter is also included, and a comprehensive *bibliography* is given.—W. H.-R.

†**Development of X-Ray Crystal Analysis.** W. L. Bragg (*Uspehi Fizicheskih Nauk* (*Progress of Physical Science*), 1933, **13**, (2), 195–208).—[In Russian.] A historical survey of the development of X-ray analysis.—N. A.

IV.—CORROSION

(Continued from pp. 179–181.)

***On the Corrosion of Aluminium by Sodium Chloride Solution with the Evolution of Hydrogen.** Gerhard Schikorr (*Mitt. Material., Sonderheft* **22**, 1933, 22–25).—Sodium chloride solutions can produce very severe corrosion of aluminium if the conditions are such that the sodium hydroxide formed at cathodic areas and the aluminium chloride formed at anodic areas are prevented from diffusing into one another, since aluminium dissolves chemically in both solutions with evolution of hydrogen. Such conditions are set up if only a small volume of sodium chloride solution is present on the metal, or in the presence of oxygen, or if the rate of access of solution to different places varies. With prolonged time of contact the aluminium becomes covered with a protective film of crystalline aluminium hydroxide which is insoluble both in sodium hydroxide and aluminium chloride solutions. Tap-water and potassium sulphate solutions do not produce a similar corrosion.—J. W.

***Corrosion of Aluminium [in the Brewery].** M. H. Van Laer (*Petit J. Brass.*, 1933, **41**, 1216–1220; also (abstracts) *Brewer's J.*, 1934, **70**, 120, and *J. Inst. Brewing*, 1934, **40**, 49).—The tendency to corrosion depends on the degree of purity and the conditions of annealing. Insulation of the metal also plays a part, and with faulty insulation pure and well-annealed metal will rapidly corrode, whereas well-insulated plant built of impure metal is often highly resistant. Samples tested in hydrochloric acid and Mylius' reagent showed that the corrosion of 99·0% aluminium was approximately 5–6 times as great as that of 99·8% aluminium, whilst annealing at 550° C. doubled the resistance. Hammered aluminium, if tested at once, gave erratic results, but if the determinations were made after ageing, the order of the values was normal.
—H. W. G. H.

The Corrosion of Light Alloys. G. Guzzoni (*Alluminio*, 1933, **2**, 329–336; 1934, **3**, 3–12).—The electrochemical theory of corrosion and the phenomena of passivation, differential aeration, and oxide film formation on aluminium surfaces are reviewed and an account is given of the various processes of chemical and anodic oxidation. Various methods of determining by accelerated test the resistance to corrosion of light alloys are criticized, and a new salt-spray test is described by means of which the resistance to corrosion of various alloys may be determined as well as the effect thereon of composition, thermal treatment, and mechanical working.—G. G.

***Chemical Methods of Cleaning Light and Ultra-Light Metals after Corrosion.** Marcel Chaussain and Henri Fournier (*Compt. rend.*, 1934, **198**, 936–939).—Pickling experiments have been carried out and measurements of the loss in weight as a function of the temperature and concentration of the acid and the time have been made. It was found that the passivity of aluminium and its alloys is not complete in nitric acid. The loss in weight of the corroded metal always increases with the time of pickling, the more so the greater the corrosion. To measure correctly the loss in weight after corrosion, the pickling operations must be carried out under identical conditions or corrections made for the errors that occur. Theoretically identical conditions are never attained in practice. The method adopted for the pickling of aluminium and its alloys in nitric acid is to immerse the specimens for 15–20 minutes in concentrated acid at 60°–70° C. and determine their weight p_1. The operation is repeated and a second weight, p_2, obtained. If p is the weight of the actual metal, $p = 2p_1 - p_2$.—J. H. W.

Corrosion on the Inside of the Lead Sheath of Telephone Cables. O. Haehnel and H. Klewe (*Elekt. Nachr. Tech.*, 1932, **9**, 407–411; *Sci. Abs.*, 1933, [B], **36**, 250).—Discusses the observations made on 5 different telephone cables which had been in service for periods of time varying from 2·5 to 22 yrs. Metallographic and microscopic examinations of the 5 corroded lead sheaths show that the granulation enlargement in the most corroded cable is such that the lead crystals are 8 times as large as in the newly pressed sheath. The least corroded cable has the smallest granulation enlargement, the crystal size being increased only 3-fold. Since coarse-grain lead is known to be more easily cracked than fine grained, it is suggested that the corrosion is associated with the formation of microscopically fine cracks. The method of laying the cables is considered to have no influence on the formation of this internal corrosion.—S. G.

Catalytic Action of Phenols in the Corrosion of Lead-Covered Cables. E. da Fano (*Teleg. Fernsprech. Tech.*, 1932, **21**, 267–270; *Sci. Abs.*, 1933, [B], **36**, 94).—Tar used as a protective covering for lead-covered cables should not contain too much oil, as this will be partly washed out by the moisture in the soil and the water will gain access to the lead and cause corrosion. The pitch content must not be too great, or the covering will be rendered too brittle at low temperatures, and will develop flaws during transport and laying. Further, the material employed to protect against corrosion must contain as little phenol as possible, since this takes part in a cyclic process and becomes continuously regenerated. Phenol alone is not injurious, but becomes so in the presence of water and carbonic acid. When the tar layer is free from cracks and remains impervious to moisture, the presence of phenol itself cannot result in injury.—S. G.

†**Action of Water on Lead, with Special Reference to Supply of Drinking Water.** H. Ingleson (*Dept. Sci. Indust. Res., Water Pollution Res., Tech. Paper* No. 4, 1934, 115 pp.; *Bull. B.N.-F.M.R.A.*, 1934, (64), 12).—A survey of existing knowledge, carried out as a preliminary to an investigation, at the Department of Scientific and Industrial Research Chemical Research Laboratory, Teddington, of conditions affecting the action of water on lead. The survey contains the following sections: diagnosis of plumbism, lead content of drinking water, analytical determinations of lead, action of water (including consideration of technique of investigation and factors affecting results), outbreaks of plumbism and protective measures, electrical current leakage and lead contamination, external attack on lead pipes, cables, &c. There is a *bibliography* of 371 references.—S. G.

***The Dissolution of Magnesium in Aqueous Salt Solutions.—III.** L. Whitby (*Trans. Faraday Soc.*, 1933, **29**, 1318–1331).—The initial rates of dissolution of magnesium in *N*- and 0·001*N*-potassium chloride, bromide, iodide, and sulphate, in 0·001*N*-potassium hydroxide, and in saturated magnesium hydroxide solutions are always practically the same. The results obtained in these tests support the theory of primary preferential hydroxyl discharge; other anions can discharge only when the anodic current density is high enough or when sufficient local impoverishment of hydroxyl ions has occurred. The rate of attack of magnesium in sodium chloride and sulphate solutions increases as the surface area is diminished; this is shown to be in accord with the theory.—A. R. P.

***The Passivity of Magnesium in Solutions of Chromic Anhydride and Its Chemical Cleaning after Corrosion.** Marcel Chaussain and Henri Fournier (*Compt. rend.*, 1934, **198**, 1035–1037).—The usual method of eliminating the surface products of corrosion of magnesium by means of a boiling solution of chromic anhydride gives divergent results in the case of 99·8% magnesium, rolled and annealed. This was found to be due to the sulphuric acid content of the chromic anhydride used. Experiments on the passivity of magnesium in such solutions containing various concentrations of sulphuric acid showed that the passivity of magnesium rapidly becomes incomplete as the acid concentration increases. For practical purposes, this property disappears with 15% chromic anhydride solutions containing 1–1·5 grm./l. of sulphuric acid. This is analogous to the chromic passivity of iron observed by Evans. Passivity of magnesium can, however, be obtained in the presence of sulphuric acid if barium chromate is added in sufficient amount to precipitate the acid as the insoluble barium sulphate.—J. H. W.

***Causes of Black Spots on the Tin Wrappers of Process Cheeses.** Jozsef Berkó (*Mezőgazdasági Kutatások*, 1933, **6**, 308–312; *C. Abs.*, 1933, **28**, 1787).—The blackening is slower at lower temperatures. Citric acid (0·5% solution) caused black spots in 1–2 days. Application of a very small drop of 10% citric acid caused within a day a black spot that increased in 4 days so as to cover the whole tin sheet. Cheeses made of mouldy, second-class material become black more easily. The use of lacquer-covered tin sheets is proposed. —S. G.

***Soil-Corrosion Studies, 1932. Rates of Loss of Weight and Pitting of Ferrous and Non-Ferrous Specimens and Metallic Coatings.** K. H. Logan and R. H. Taylor (*U.S. Bur. Stand. J. Research*, 1934, **12**, 119–145; and *Research Paper*, No. **638**).—This report records observations on specimens removed from the more corrosive soils only. The data as a whole support the conclusions previously reached (see *J. Inst. Metals*, 1931, **47**, 655). The rate of corrosion of a given material is found to differ considerably in different soils, but to agree well in soils of the same series in the U.S. Department of Agriculture classification. Corrosion rates generally decrease with time, probably approaching a limiting fixed rate. Cast brass caps of 4 different alloys attached to lead, Muntz metal, and galvanized nipples were removed from 22 soils. Corrosion of the brass caps was small and all caps in the same soil corroded at about the same rate. The lead nipples corroded more severely, the Muntz metal showed a spongy surface appearance, and the galvanized nipples corroded severely in several soils. In no instances could corrosion of the nipples be attributed to galvanic action. Figures for lead and lead-alloy cable sheath samples still indicate slightly higher corrosion rates for 1% antimony alloy than for pure lead, but it is noted that similar tests conducted by the Bell Telephone Laboratories (with some specimens in the same trenches) show no significant difference. Commercially pure aluminium and aluminium–manganese alloys corroded less than Duralumin. Details of the weight loss of copper and copper-alloy pipes and of the condition of the various layers of pathway cable are given. Copper and copper alloys corrode less rapidly than iron in most soils. In galvanized pipe and sheet samples no influence of the base material was detected and, after 8 yrs., corrosion is still controlled by the more resistant zinc coating. In general, but not always, samples with the heaviest coating resisted corrosion best. It is concluded that a zinc coating of 1 oz./ft. should extend the life of the coated material at least 6 yrs. in very corrosive soils and much longer in favourable conditions.

Lead coatings 0·002 in. thick had no definite influence on the rate of pitting of iron pipe after 8 yrs., and calorizing reduced corrosion without affording complete protection. Sherardized and lead-coated bolts resisted corrosion better than uncoated bolts and to about the same extent. In this report also, data on the corrosion of iron pipe-line materials and fittings buried in 1922 and 1924 are presented and their interpretation discussed.—J. C. C.

***Stray Earth Currents and Electrolysis.** C. and M. Schlumberger (*Ann. Postes Télég. Téléph.*, 1932, **21**, 745–763; *Sci. Abs.*, 1933, [B], **36**, 17).—The measurements made in the authors' investigation are carried out by means of a potentiometer, which is set up and adjusted by an operator so that the galvanometer always reads zero: the adjustments so made are recorded. The sensitivity of the apparatus is very high, since the energy to actuate the apparatus is supplied by the operator. The methods adopted for the measurement of soil resistivity and the electric field due to stray currents are given. Measurements are described to investigate the origin of stray currents and their action on underground metallic conduits. The methods used are characterized by the fact that all measurements are made at the surface of the soil, without the need for excavations. The earth connection used for the measurement of p.d. is formed of an unpolarizable electrode, consisting of a porous vessel which supports a copper tube containing a saturated solution of copper sulphate.—S. G.

***Electrolysis of Underground Metallic Structures.** M. Horioka *et al.* (*J. Inst. Elect. Eng. Japan*, 1933, **53**, 943–955; *C. Abs.*, 1934, **28**, 1280).—[In Japanese.] Photographs and results are given of tests on joints and on conduits of lead with antimony, zinc, tin, and cadmium. The effect of the CO_3^{--}/Cl^- ratio in soil is considered. Means of protection are given.—S. G.

***Examples of Corrosion Occurring in Practice; Their Causes and Prevention.** Karl Mandl (*Mitt. staatl. tech. Versuchsamtes* (*Wien*), 1930, **19**, (1–3), 48–53; *C. Abs.*, 1931, **25**, 3607).—(1) Aluminium gaskets to produce tight flanged joints with an iron ammonia cooling system were found to corrode. Ammonia escaped through the gaskets, dissolved in the water condensed on the flanged joints and caused the solution of aluminium by galvanic action (the NH_3 solution being the electrolyte). Asbestos gaskets are recommended. (2) An aluminium cooling coil used in the milk industry corroded rapidly at certain definite places. Micro-examinations showed variations in grain-size due to welding and variations in composition of the two sections of aluminium welded. Uniform one-piece tubes are recommended. (3) Coils of iron used in a benzene cooling system utilizing river-water were found to corrode at the upper portions of the pipes. Slime deposits at the top of the pipes reduced the coeff. of heat transfer, increased the temperature, and caused the formation of oxygen bubbles which remained near the metal surface because the slime prevented them being washed away. Fe^{++} ions were oxidized to Fe^{+++}; this disturbed the equilibrium and permitted corrosion to continue. The methods of prevention suggested are galvanizing, charging the iron negatively, or using a waterproof paint. (4) Lead-clad steel roofs corroded rapidly in an industrial atmosphere. Imperfections in the coating set up a local cell action in which iron was anodic. A base coating of tin, or addition of 10% tin to the coating bath, is suggested. (5) Cast-iron valves with bronze fittings used for regulating the flow of a refrigerating brine were strongly attacked as a result of galvanic action. The use of valves of single metals or alloys is recommended. (6) The rotor of a centrifugal cast-iron pump used for pumping paper pulp was "graphitized." The attack is attributed to the presence of aluminium sulphate, which hydrolyzes to form sulphuric acid. In these dilute acid solutions the iron selectively dissolved leaving the graphitic skeleton. Acid-resisting bronzes or high chromium–nickel steels are recommended for pump construction.—S. G.

Between Wind and Water. Q. B. Newman (*Marine Eng.*, 1934, **39**, 96–97).—A discussion of various types of corrosion occurring in ships and in marine engines and their accessories emphasizes the important part which oxygen plays in accelerating corrosion. Among the cases dealt with are the corrosion of bronze studs and springs in reciprocating pumps, the corrosion of propeller blades, and condenser tube corrosion, and the theory that corrosion is due to nascent oxygen in expanding air is considered with reference to each case. Suggestions as to how corrosion might be minimized or prevented are also made.—J. W. D.

***The Action of Sulphur Dioxide Gas on Alloys.** G. H. McGregor and J. W. Stevens (*Paper Trade J.*, 1933, **97**, (18), 40–41).—Various steels, brass, bronze, and Monel metal were tested for resistance to corrosion at 200°–220° C. in gases containing 17–18% of sulphur dioxide, 1–2% of oxygen, and traces of sulphur trioxide; the times of exposure extended from 30 days to 10 months. High chromium–nickel–steels showed the best resistance, bronze was inferior to 18 : 8 chromium–nickel steel, and brass much inferior to bronze. Alloys with a high nickel but low chromium content were rapidly corroded.—A. R. P.

Ethyl: Some Information on the Use and Advantages Gained by the Employment of Tetraethyl Lead in Fuels for Aviation Engines. F. R. Banks (*J. Roy. Aeronaut. Soc.*, 1934, **38**, 309–372).—The effect of the products of combustion of a leaded fuel are discussed in Part II of the paper. Valve material must have a high resistance to attack by the exhaust products, particularly lead bromide, and the heat dissipation capacity of the valve seatings must be good. Thermal expansibilities of valve seat material and cylinder material must be as nearly equal as possible to secure good thermal contact. Internal cooling of valves by metallic sodium is described. Aluminium–bronze appears likely to be superseded by high-expansion alloy steels for valve seats. Types of inserts and methods of fixing are illustrated. Corrosion during standing of engines which have run on leaded fuel, "cold corrosion," and methods of avoiding trouble from this source are described. Fuel tanks made of aluminium alloys have not given trouble when used with leaded fuels, but corrosion of magnesium alloys occurs when water is present in the fuel, a matter difficult to avoid in practice.—H. S.

***On the Theory and Mechanism of the Corrosion of Metals.** Gerhard Schikorr (*Mitt. Material., Sonderheft* **22**, 1933, 3–9).—The usual simple subdivision of corrosion phenomena into two groups, corrosion accompanied by evolution of hydrogen and corrosion accompanied by absorption of oxygen, fails to cover many cases met in practice, *e.g.* the dissolution of aluminium in sodium hydroxide solution and the rusting of iron in feebly alkaline solutions, probably also the dissolution of aluminium in weak acids and the corrosion of magnesium in salt solutions. S. therefore proposes further to subdivide these groups into sub-groups according to whether the cathodic or anodic reactions are the determining factor. Alternatively, a new subdivision might be made according to whether the corrosion is or is not retarded by the presence of oxide films. These suggested classifications are discussed at some length with reference to specific examples.—J. W.

†**The Problem of Metal Corrosion and Colloido-Electrochemistry.** V. A. Kistjkovskiy (*Uspehi Khimii* (*Progress of Chemistry*), 1933, **2**, (2), 237–248).—[In Russian.] A review of the problem and exposition of K.'s film theory of corrosion.—N. A.

***The Practical Problems of Corrosion. VIII.—The Inhibitive Action of Certain Pigments on Rusting.** K. G. Lewis and U. R. Evans (*J. Soc. Chem. Ind.*, 1934, **53**, 25–33T).—The experimental work is concerned with steel, but has a wider significance. Paints protect metals either by mechanically excluding corrosive agents or by chemically inhibiting corrosion reactions. The chemically inhibitive action of pigments has been studied under conditions where corrosive agents are not mechanically excluded, such as by treating the metal with pigment, water, and air, but no oil, or by placing drops of sodium chloride solution on painted surfaces at which the surface of the metal is exposed at a single scratch. The results show that the inhibitive action of pigments rests on the same principles as inhibition by soluble reagents (such as sodium hydroxide and potassium chromate) used in the treatment of water. When the products of incipient corrosion are precipitated in physical contact with the metal, the attack stifles itself and the metal is immune.—E. S. H.

V.—PROTECTION

(Other than Electrodeposition.)

(Continued from pp. 181–184.)

†**Protection from Corrosion of Aluminium and Its Alloys.** N. D. Pullen (*Light Metals Research*, 1934, **2**, (42), 1–11; and *Met. Ind.* (*Lond.*), 1934, **44**, 133–136, 187–188).—Read before the Sheffield Local Section of the Institute of Metals. The basic problem of determining ways of forming self-healing protective films has been studied on the lines of control of purity, use of special heat-treatments, and addition of certain elements to aluminium. No conclusions appear warranted on the effect of raising the purity of commercial metal from 99 to 99·7% aluminium. Purer aluminium is probably more resistant. Copper definitely has a bad effect if more than 0·01% is present. Addition of antimony which forms a film of basic oxychloride in sea-water is made to KS–Seewasser alloy. Simpler methods of protection are obtained by painting, electro-plating, or anodic oxidation. The "MBV" process of preparing the surface before painting gives good results and consists in immersing for 3 minutes in a boiling solution containing sodium carbonate 5 and sodium chromate 1·5%. After electroplating it seems desirable to heat-treat to produce an intermediate alloy. Of anodic oxidation methods, the chromic acid group gives a reasonably flexible film, sulphuric acid films may be made hard or thin and flexible, while with oxalic acid films the greatest modifications of colour and texture are possible. Chemical methods give thinner films. In general, aluminium vessels should be kept dry and cleaned with steel wool and soap, avoiding emery.—J. C. C.

The Oxidation of Light Metals. B. M. Tareev (*Legkie Metalli* (*Light Metals*), **1932**, (12), 42–48).—[In Russian.] A description of methods of oxidizing aluminium, as employed in the U.S.S.R. and abroad, for increasing its anti-corrosion properties and especially for insulation purposes.—D. N. S.

***On the Properties of Oxide Films and Methods for Their Production.** N. V. Alexandrov, V. I. Prujinina, and N. N. Sokolov (*Elektrichestvo* (*Electricity*), **1933**, (14), 17–25).—[In Russian.] A suitable bath for the production of oxide films especially on Duralumin is described and the effect of current conditions and impurities in the metals on film formation is discussed. Elasticity of the film is due to the presence of copper (2–5%). The thickness of oxide films varies between 1μ and 0·5 mm., depending on the method and time of formation. The influence of corrosion and other factors on the resistance to perforation has been studied. Up to 400°–500° C. the thermal conductivity of the films remains practically unaltered.—N. A.

Surface Treatment of Aluminium. Anon. (*Mech. World*, 1933, **94**, 1056–1057).—Details are given of the MBV process for the surface-treatment of aluminium as a protection against corrosion.—F. J.

Special Alloys for Working Barrels and Balls and Seats. Walter F. Rogers *Proc. Amer. Petrol. Inst.*, 1933, [iv], **14**, 51–57).—Corrosion of working barrels and cup-packed valves in the pumping system employed by many oil-wells may be minimized by the choice of a suitable material. For barrels, nickel showed a poor resistance to abrasion, although its anti-corrosive properties were satisfactory as regards both saline and sulphur-rich liquids; the harder 18 : 8 alloy was preferred for general use. For balls and seats, some commercial bronzes resisted saline corrosion, but were readily attacked by hydrogen sulphide, which was also found to cause pitting and embrittlement in the 18 : 8 alloy. K–Monel metal resisted both types of corrosion, but its mechanical properties limited its use to the shallower wells; "Cyclops 17A" appeared satisfactory but required further testing under severer conditions; chromium plating, probably on account of poor workmanship, frequently failed. The high reclaim value of 18 : 8 recommends its use on economic grounds.—P. R.

Tinning of Wires. —— Kunze (*Draht-Welt*, 1933, **26**, 563–564; also (in German, English, and French) *Draht-Welt Export Ausgabe*, **1933**, (9), 70–72).—Briefly describes the plant and operations necessary for tinning wire which are in general similar to galvanizing. Mention is made of the tinning of stranded wires and of the special technique required.—A. B. W.

Tin Saving in the Centrifugal Process of Hot-Tinning Wire Articles. —— Günther (*Draht-Welt*, 1933, **26**, 755–756).—A brief description of the preparation, tinning, and centrifuging of wire articles. The latter operation saves tin, eliminates hand trimming, and enables a higher output to be obtained.
—A. B. W.

How Can Spots and Streaks be Avoided in Tinning? Anon. (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 95–96).—With good material and sufficient care, spots and streaks in tinning can be avoided. These defects are caused by corrosion and the electrolytic action set up by impurities. Copper articles should be tinned as quickly and at as low a temperature as possible, and the tin baths must be cleaned out at least once each day. The methods to be adopted and the precautions to be observed in various kinds of tinning are described.—J. H. W.

Developments in Fluxing Practice for Hot-Dip Zinc Coating. Wallace G. Imhoff (*Metal Cleaning and Finishing*, 1933, **5**, 471–473, 507–508, 517–518). —A review of recent progress.—S. G.

On Galvanizing of Wire. —— Bartel (*Draht-Welt*, 1933, **26**, 579–581).—Briefly discusses the principles of design of wire galvanizing plant—annealing, pickling, washing, drying, fluxing and coating, cooling and coiling, lay-out. A 5% zinc aluminium alloy is recommended for light spangled coating, whilst an alloy containing zinc 45, aluminium 35, tin 9, and bismuth 1% is said to be used. Attack of kettles is reduced by maintaining 100 mm. of lead at the bottom and keeping the temperature low, and also by spraying the kettles with aluminium so as to produce a superficial aluminium oxide coat. This latter treatment is patented. Weights of coatings produced by various methods are given and tests of coatings briefly outlined. A cold-drawing technique for galvanized wires involving wet drawing with 5% soap solution lubricant is also described.—A. B. W.

Hard Zinc Formation. Heinr. Meyer auf der Heyde (*Draht-Welt*, 1933, **26**, 787).—Insists on the need for temperature control of the zinc kettle. If the temperature of the bath does not exceed 475° C. hard zinc formation and attack of the kettle are kept very low.—A. B. W.

Zinc for Steel Protection.—II. Herbert R. Simonds (*Iron Age*, 1934, **133**, (12), 12–14).—Some of the more debatable factors of galvanizing are discussed, such as the protection of zinc alloys as against that of pure zinc, the best thickness of coating for specific applications, and the improvement of the bond of zinc with the base metal. An attempt is made to analyse the relative merits of electro- and hot-dip-galvanizing.—J. H. W.

†**The Various Processes for Testing Galvanizing of Wires.** R. Meerbold (*Draht-Welt*, 1933, **26**, 627–628, 643–645, 659–660; and *Glückauf*, 1933, **69**, 1142–1143).—Discusses the specifications and methods of test of galvanized coatings laid down in "Gütevorschriften für Förderseile Fachnormen Aus-

schuss für Bergbau. Berg–1254 Juli 1933." Tests show that the copper sulphate dips required for the specified coatings are quite reasonable.

Coating, grm./m.².	No. of Specified Dips.	No. of Dips Observed up to
100	1	2
120	2	2·8
150	2	3·5

The advantages and disadvantages of systematized dip tests are discussed, and reference is also made to Bauer's gravimetric method and the gas volumetric methods of Cushman, Keller and Bohacek, and Zaurke. In Bauer's process the coating is removed by solution in 2% H_2SO_4 containing 2 grm./l. As_2O_3. Coating $= \frac{w_1 - w_2}{\pi . d . l} \times 10^6$ grm./m.²,

or $= \frac{(w_1 - w_2) \times d \times 1{\cdot}95}{w_2} \times 10^3$ grm./m.².

where w_1 and w_2 are the weights before and after removal of coating, d the diameter and l the length of the wire. It is pointed out that electrodeposited and hot-galvanized coatings are easily distinguished by micro-examination or by testing the coating for iron.—A. B. W.

On the Galvanizing of Iron Containing Aluminium. A. I. Vitkin (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (5), 41–46).—[In Russian.] Hot-galvanizing practice with addition of aluminium to the zinc bath.—D. N. S.

Combating Corrosion of Production Equipment. Stanley Gill (*Proc. Amer. Petrol. Inst.*, 1933, [iv], **14**, 43–50; and (abbreviated) *Oil Weekly*, 1934, **72**, (6), 12–18).—The installation of corrosion-resistant materials is usually more economical than a series of rapid replacements of cheap material. For oil strings, galvanized wrought iron is recommended; in cases of very severe attack, short sections of bronze or brass pipe-lines are sealed into the casing. Wire-wrapped screen made of commercially pure nickel resists the action both of saline and of sulphur-rich water, and possesses satisfactory mechanical properties. In the case of tubing, galvanized wrought iron or copper-bearing steel give satisfactory results. The galvanization of sucker rods and of tanks is recommended.—P. M. C. R.

Metallization by Dispersion. A New Apparatus for Metallization. V. S. Tararykin (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (1), 57–59).—[In Russian.] A new metallization apparatus is described, differing from that of Schoop in that the metal wire is melted by an electric arc, and dispersion is carried out by compressed air.—D. N. S.

Economic Maintenance of Machinery: The Fescol Process. Anon. (*Modern Transport*, 1934, **31**, (283), 7).—An account of the "Fescol" method of reinforcing worn machine parts with an electrodeposited layer of a hard metal, usually chromium or nickel. Complete adhesion of the coating is claimed, and numerous applications of the process are described.—P. M. C. R.

***Metallic Cementation. I.—Cementation of Some Metals by Means of Zinc Dust.** Tsutomu Kase (*Kinzoku no Kenkyu*, 1933, **10**, (12), 555–572).—[In Japanese.] The cementation of metals and alloys—iron, copper, brass, nickel, &c.—by means of zinc dust at various temperatures between 250° and 800° C. was investigated. Hardness, depth of penetration, microstructure, chemical analysis, and corrosion by water and by some acids were studied. Zinc diffuses into the above-mentioned metals from a temperature of 250° C., and the rate of diffusion increases as the temperature increases. The relation between increase of weight of the specimen, or the depth of penetration, and the temperature of cementation is given by an exponential function, which breaks into 2 branches at the melting point of zinc. Similarly, the relation between the increase of weight of the specimen and the duration of cementation is given by an exponential function. The cemented surface has a better resistance to corrosion when exposed to air or water.—S. G.

Paint Driers. A. H. Sabin (*Dutch Boy Quarterly*, 1934, **12**, (1), 5–7).—A general review.—E. S. H.

Testing of Enamel Coatings. —— Freitag (*Apparatebau*, 1934, **46**, 33).—A brief note.—M. H.

VI.—ELECTRODEPOSITION

(Continued from pp. 184–188.)

The Electrodeposition of Rhodium. —— Atkinson and —— Raper (*Met. Ind.* (*Lond.*), 1934, **44**, 281–282).—Discussion of a paper read before the Electrodepositors' Technical Society, and A. and R.'s reply. See *Met. Abs.*, this volume, p. 136.—J. H. W.

The Mechanism of Electrodeposition. L. B. Hunt (*Electrochem. Soc. Preprint*, **1934**, April, 95–105).—Theoretical. Previous theories are criticized and a new theory based on the quantum–mechanical theory of electron transition is advanced to account for lattice development in the electrodeposited metal and the observed polarization phenomena. It is suggested that the metal ions are adsorbed in the double layer until the accumulation is sufficient to produce a continuous lattice layer over the face of the individual crystal, the movement of electrons through the cathode surface being dependent on the presence of adsorbed ions in such a state that they can accept electrons. —A. R. P.

On the Measurement of the Throwing Power of Plating Baths. K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1934, **7**, 149–152).—A brief summary of a paper by Onitchenko (see *J. Inst. Metals*, 1933, **53**, 709).—A. R. P.

Methods of Stripping Plated Coatings. A. Brenner (*Metal Cleaning and Finishing*, 1933, **5**, 464–466, 475; *C. Abs.*, 1934, **28**, 1312).—Methods for the removal of nickel, copper, and chromium deposits from steel or from each other for analytical purposes and for replating are described.—S. G.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition and Electro-Refining.)

(Continued from pp. 188–189.)

***Researches on the Gas Content of Electrolytic Zinc.** Werner Burmeister and Max Schloetter (*Metallwirtschaft*, 1934, **13**, 115–119).—The hydrogen content of electrolytic zinc increases with increase in current density and acidity, and is greater in moving than in stationary electrolytes. No gas is evolved on prolonged storage at room temperature.—v. G.

A 25,000 Kilowatt Rectifier for Zinc Electrolysis. Anon. (*Metallwirtschaft*, 1934, **13**, 122).—The plant described uses mercury vapour rectifiers, and has an efficiency of 95·4%. The individual rectifiers have an output of 4100 kw. —v. G.

***The Electrolysis of Molten Silicates and the Preparation of Silicon and Silicides.** L. Andrieux and M. Dodero (*Compt. rend.*, 1934, **198**, 753–755).—It has already been shown that the electrolysis of metallic borates and oxides dissolved in boric anhydride or molten borates is a method of preparing boron and borides, and it is now shown that, by an analogous process, silicon and silicides can be prepared by the electrolysis of metallic silicates and oxides dissolved in molten silicates by secondary cathodic reactions.—J. H. W.

***The Rate of Displacement of Copper from Solutions of Its Sulphate by Cadmium and Zinc.** Cecil V. King and Martin M. Burger (*Electrochem. Soc. Preprint*, **1934**, April, 115–122).—The rate of displacement of copper from dilute solutions of copper sulphate by rotating cylinders of zinc and cadmium is controlled by diffusion and electrolytic transport of the cupric ion to the surface of the zinc, cadmium, or copper already deposited. No evidence was obtained to indicate that the chemical reaction is sufficiently slow to be a controlling factor at any stirring speed. The results are compared with those obtained by Centnerszwer and Heller (*J. Inst. Metals*, 1933, **53**, 21).—A. R. P.

***The Electrolytic Potential of Metals in Pure Buffer Solutions.** Sven Bodforss (*Kungl. Fysiograf. Sällskapets I Lund Förhandl.*, 1933, **3**, 33 pp.; *Chem. Zentr.*, 1933, I, 829).—The potential of various non-ferrous metals in buffer solutions of tartrates, phosphates, acetates, or sulphates acidified to definite p_H values with sulphuric or phosphoric acid becomes more negative with increasing rate of rotation until a limiting value is reached, at 600–1000 revolutions per minute for tin, bismuth, cadmium, and lead, and at more than 2000 per minute for copper, silver, nickel, and tungsten. The limiting potential is for most metals a linear function of the p_H of the electrolyte, and also depends on the nature of the anion. The potential in the stationary electrolyte is more noble than that in the rotating, but also depends on the p_H and the nature of the anion.—A. P.

***Study of the Influence of an Electric Field on the Potential at a Metal-Solution Interface.** H. K. McClain and H. V. Tartar (*J. Phys. Chem.*, 1934, **38**, 161–170).—The effects of a moderate electric field on the potentials of gold and platinum against solutions of boric acid, potassium di-hydrogen phosphate, di-sodium hydrogen phosphate, and aluminium sulphate have been determined; the effects observed are small. The results prove the validity of one fundamental assumption in the theory of cataphoresis, *viz.*, that the charge distribution in the double layer is unaffected by the applied field.—J. S. G. T.

***The Theory of Passivity. XXII.—The Mechanism of Passivity According to the Film Theory of Passivity.** Wolf Johannes Müller (*Z. Elektrochem.*, 1934, **40**, 119–125).—It is claimed that the film theory of passivity gives a qualitative explanation of the mechanism of activation and passivity, and in many cases can be shown to give quantitative results.—J. H. W.

***The Relation Between Oxygen Overvoltage and Catalysis.** Allen D. Garrison and Johnny Fay Lilly (*Electrochem. Soc. Preprint*, **1934**, April, 171–184).—The oxygen overvoltages (O.V.) in $0{\cdot}1N$-sodium hydroxide on polished electrodes of nickel, cobalt, iron, platinum, iridium, and gold, and the rates of depolarization of oxygen gas have been measured by the direct method. If the oxygen ionization rate is represented by V, then for all the metals $\log V = A(\mathrm{O.V.}) + B$, where A and B are constants. The values found for O.V. are: nickel 0·245, cobalt 0·300, iron 0·345, iridium 0·367, platinum 0·402, and gold 0·580 v.; the corresponding values of V are 11·60, 9·95, 8·18, 7·49, 6·86, and 3·84. These values give the value of A as $-$ 3·32 and that of B as 3·26. The bearing of these results on the problem of electrolytic corrosion in oxygen and on the catalytic theory of overvoltage is discussed.—A. R. P.

VIII.—REFINING

(Including Electro-Refining.)

(Continued from p. 190.)

Copper Refining. Swansea's Modernized Works. Arthur J. G. Smout (*Times Trade and Eng. Suppt.* (*Indust. Wales Section*), 1933, **33**, (799), 23).
—S. V. W.

Copper Refining in Lancashire. Anon. (*Elect. Rev.*, 1933, **112**, 803–804).—An illustrated description of the plant and process for the production of high-conductivity copper at the works of British Copper Refiners, Ltd., Prescot.
—S. V. W.

Refining Magnesium with Fluxes. V. Y. Titov (*Legkie Metalli* (*Light Metals*), **1932**, (12), 29–34).—[In Russian.] A description of refining processes used in Germany and the U.S.A.—D. N. S.

Nickel Refining. Importance of Clydach. D. Owen Evans (*Times Trade and Eng. Suppt.* (*Indust. Wales Section*), 1933, **33**, (799), 18).—S. V. W.

A Modern "Silver Refinery" Produces Precious Metals, Selenium, Tellurium. Anon. (*Eng. and Min. J.*, 1934, **135**, (3), 106–107).—Gives flow-sheets of slime treatment, furnace refining, and electrolytic parting at Raritan Copper Works.—R. Gr.

Precipitation of Cobalt from Zinc Sulphate Solutions with Zinc Dust in the Presence of Other Metal Compounds. Günther Hänsel (*Wiss. Veröff. Siemens-Konzern*, 1934, **13**, (1), 55–60).—In the presence of 0·146 grm./l. of tin as stannous sulphate, zinc sulphate electrolytes can be freed from cobalt (50 mg./l.) by boiling with zinc dust (2·5 grm./l.). Stannic salts are much less efficient, as are also arsenic and antimony compounds.—A. R. P.

Contribution to the Precipitation of Cobalt from Zinc Sulphate Solutions in the Electrolytic Recovery of Zinc. Adelbert Grevel (*Wiss. Veröff. Siemens-Konzern*, 1934, **13**, (1), 61–71).—The effect of arsenic and antimony in assisting precipitation of cobalt from zinc sulphate electrolytes on heating with zinc dust is attributed to the formation of a surface alloy on the zinc, whereby the surface is modified and the precipitation of cobalt accelerated. Similar results can be obtained with copper-plated zinc dust if cuprous cyanide is added to the solution.—A. R. P.

IX.—ANALYSIS

(Continued from pp. 190–195.)

Spectrum Analysis of Metals. A. Pfeiffer and G. Limmer (*Arch. tech. Messen*, 1933, **3**, (30), T162; 1934, **3**, (31), T6–T7).—The methods of obtaining arc and spark spectra are reviewed, with a diagram of the requisite optical system and a brief discussion of the methods employed in estimating wave-lengths. The measurement of intensity by the absolute or "last line" method is vitiated by various considerations; alternative processes include that of comparison with standard materials and that of homologous pairs. The use of the logarithmic sector is explained and illustrated. The "three-line" photographic method is described, and a direct-vision process, limited to the visible spectrum and involving the use of polarized light, is summarized.—P. R.

Spectroscopic Examination of Materials. Kurt Schneider (*Draht-Welt*, 1934, **27**, 131–133).—Traces briefly the development of spectrographic analysis. The principles of the use of comparison spectra, homologous line pairs, and the logarithmic sector are outlined and it is pointed out that spectrographic methods are especially useful for check work by reason of their speed and economy in material, and also for estimation of impurities present in small amounts.—A. B. W.

***The Analysis of Copper–Nickel-Plated Steel Material.** E. Deiss and H. Blumenthal (*Mitt. Material.*, *Sonderheft* **22**, 1933, 32–37).—When the plating is removed with HNO_3, the Ni-rich diffusion layer is not attacked; this may, however, be removed by treatment with $HBrO_3$. In this way the composition of the plate and of the basis metal can readily be determined using only one sample.—J. W.

***Segregation in a Silver Ingot.** O. Bauer and E. Deiss (*Z. anal. Chemie*, 1933, **92**, 161–164; and *Mitt. Material.*, *Sonderheft* **23**, 1933, 65–67).—Inverse segregation in an ingot of 835-fine silver occurs in the middle porous portion of the upper end; the copper-rich eutectic is there sucked outwards by the contraction which occurs in solidification. The bearing of this fact on the sampling and analysis of the ingot is discussed.—J. W.

Cleaning Platinum Wire for Flame Tests. Wesley G. Leighton (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1934, **6**, 84).—Fusion with $KHSO_4$ is recommended.—A. R. P.

***On the Separation of Beryllium from the Other Elements of the Third Analytical Group.** P. Adami (*Ann. Chim. appl.*, 1933, **23**, 428–432; *Chem. Zentr.*, 1934, **105**, I, 578).—The hydroxides of the metals are converted into formates by repeated evaporation to dryness with $H \cdot COOH$; on heating the dry residue at 180°–200° C. *in vacuo*, $Be_4O(CHO_2)_6$ sublimes, and can be condensed as well-developed crystals. These are decomposed by boiling with HNO_3 and the Be is precipitated with NH_4OH. The residue from the sublimation is analyzed for Al, Ti, and Fe as usual. If much Ti is present, it should be removed by acid hydrolysis prior to the $H \cdot COOH$ treatment, since it tends to prevent sublimation of the Be.—A. R. P.

***Separation of Gold from Tellurium.** Victor Lenher, G. B. L. Smith, and D. C. Knowles, Jr. (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1934, **6**, 43–45).—Au may be separated from Te by precipitation with $NaNO_2$ from a boiling solution of the chlorides buffered with NaK tartrate to a p_H of 1–3. For the determination of both elements the sum is first found by precipitation with $N_2H_4 \cdot 2HCl$ and SO_2, the weighed precipitate is dissolved in *aqua regia*, the HNO_3 expelled by evaporation with HCl, and the Au alone precipitated as above.—A. R. P.

***A Method for the Separation of Ruthenium from Platinum, Palladium, Rhodium, and Iridium.** Raleigh Gilchrist (*U.S. Bur. Stand. J. Research*, 1934, **12**, 283–290; *Research Paper* No. **654**).—A procedure for the separation and gravimetric determination of Ru is described. The method of separation differs essentially from existing methods in that the Ru is distilled from a solution of its sulphate in diluted H_2SO_4 containing sodium bromate. A very suitable reagent for the quantitative absorption of the distilled tetroxide was found to be diluted HCl saturated with SO_2. The recovery of Ru is accomplished by precipitating the hydrated oxide from a boiling solution at p_H 6, after sulphite compounds have been decomposed by treatment with HCl. The hydrated oxide is ignited in the air to an anhydrous oxide which is then reduced to metal under H_2.—S. G.

***Methods for the Separation of Platinum, Palladium, Rhodium, and Iridium from One Another and for Their Gravimetric Determination.** Raleigh Gilchrist (*U.S. Bur. Stand. J. Research*, 1934, **12**, 291–303; *Research Paper* No. **655**).—A method is described for the analytical separation of Pt from each or all of the 3 metals Pd, Rh, and Ir. It is based on the complete precipitation of the hydrated dioxides of Pd, Rh, and Ir in a boiling solution containing sodium bromate and having an acidity of p_H 6. Two precipitations of the hydrated dioxides were found to be sufficient to effect the quantitative isolation of Pt. The separation of Pd from Rh and Ir, by means of dimethylglyoxime, and its subsequent determination, are also described. The procedure for the separation of Rh from Ir by titanous chloride and for the determination of these 2 metals, given in detail in a previous publication (*ibid.*, 1932, **9**, 547), is discussed only briefly in this paper.—S. G.

***Analytical Reactions of Rubidium and Cæsium.** Wm. J. O'Leary and Jacob Papish (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1934, **6**, 107–110).—Methods of separating Rb and Cs from K and from one another are critically reviewed. The following procedure is recommended: the boiling nitrate solution is treated with 9-phosphomolybdic acid to precipitate the Rb and Cs. The precipitate is washed with 1% $NaNO_3$ solution and dissolved in dilute NaOH solution, the Mo is removed by saturation with H_2S and addition of HNO_3, and the Cs and Rb are recovered by precipitation with H_2PtCl_6 in the usual way. Pt is removed by boiling with N_2H_4 hydrate and the filtrate is boiled with *aqua regia* to destroy the excess of N_2H_4. After removal of the HNO_3 by evaporation with HCl, the residue is dissolved in 50–75 c.c. of 6*N*-HCl and the Cs precipitated by addition of 1 grm. of silicotungstic acid to the cold solution. The Cs compound is dissolved in NaOH solution, which is then acidified with HNO_3 and treated with $HgNO_3$ to remove the silicotungstic acid. The Cs in the filtrate is recovered as Cs_2PtCl_6 and the Rb is also precipitated as Rb_2PtCl_6.—A. R. P.

Phenanthroline-Ferrous Ion. III.—A Silver Reductor. The Direct Determination of Iron in the Presence of Vanadium. George H. Walden, Jr., Louis P. Hammett, and Sylvan M. Edmonds (*J. Amer. Chem. Soc.*, 1934, **56**, 350–353).—See *Met. Abs.*, this volume, p. 140. The oxidimetric determination of ferrous ion using the phenanthroline-ferrous ion indicator is not interfered with by V, Ti, Cr, or Mn, when the titration is made in the presence of 5 molar H_2SO_4. To reduce Fe to ferrous state, and V to tetravalent state without further reduction, a silver reductor (described in detail) was used.—R. G.

Determination of Lead as Di-Lead Hydrogen Arsenate. C. L. Dunn and H. V. Tartar (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1934, **6**, 64).—The neutral $Pb(NO_3)_2$ solution is treated with Na_2HAsO_4–H_3AsO_4 solution and NaOH added at such a rate that the liquid remains just neutral to methyl orange throughout. The precipitate of $PbHAsO_4$ is dried at 120° C. for weighing.—A. R. P.

Colorimetric Determination of Magnesium. F. Alten, H. Weiland, and B. Kurmeis (*Angew. Chem.*, 1933, **46**, 697–698).—Any Fe and Al are separated with 8-hydroxyquinoline in dilute CH_3CO_2H, Ca is removed with $(NH_4)_2C_2O_4$, and the Mg is then precipitated with 8-hydroxyquinoline in alkaline tartrate solution. The washed precipitate is dissolved in dilute HCl and the colorimetric determination made as described for Al (see *Met. Abs.*, this volume, p. 26).
—A. R. P.

***On the Determination of Magnesium in Aluminium–Magnesium Alloys Containing Manganese.** H. Blumenthal (*Mitt. Material., Sonderheft* **22**, 1933, 42–43).—The Mg is precipitated as phosphate from alkaline tartrate solution without separating the other metals, and the Mn which is co-precipitated is determined volumetrically by the Volhard method and due allowance made.
—J. W.

***The Examination of the Tin Coating of Tinplate.** Fritz Eisenkolb (*Stahl u. Eisen*, 1934, **54**, 109–110).—The weight of the Sn coating is determined by dissolving it in HCl and titrating the $SnCl_2$ with $FeCl_3$; the Pb content is then determined by electrolysis and iodometric titration of the PbO_2. Porosity is best determined by the $K_3Fe(CN)_6$–gelatin solution method.—J. W.

On the Titration of Divalent Tin with Potassium Chlorate. E. Azzarello and F. Abramo (*Ann. Chim. appl.*, 1933, **23**, 438–450; *Chem Zentr.*, 1934, **105**, I, 734).—The method of Kulwarskaja (*J. Inst. Metals*, 1932, **50**, 676) has been found to give rather erratic results, especially if As, much Fe or even a little Cu are present. The presence of Sb seems to improve the results.—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from pp. 195–196.)

***An Apparatus for the Thermal Analysis of Alloys Containing a Segregating Constituent.** R. J. M. Payne (*J. Sci. Instruments*, 1934, **11**, 90–92).—An apparatus is described for taking heating and cooling curves of alloys which may show segregation owing to the difference in density of the constituents. The crucible is sealed and rotated about a horizontal axis, the thermocouple being contained in a tube projecting into the crucible from one end. In its original form (Bingham and Haughton, *J. Inst. Metals*, 1923, **29**, 71), the thermocouple and its sheath remained stationary within the revolving crucible, but in the present apparatus the thermocouple rotates with the crucible, and this permits the use of a close-fitting sheath, which reduces the thermal lag between alloy and thermocouple. The crucible, lid, and thermocouple tube are made of iron for use with magnesium alloys.—W. H.-R.

***A Device for Maintaining a Steady Direct Current [for Controlling Laboratory Furnaces].** H. H. Potter (*J. Sci. Instruments*, 1934, **11**, 95–96).—A note. A simple control circuit is described by which a current supplied by d.c. mains or by a main laboratory battery liable to slight fluctuations can be stabilized by taking a small compensating current from a bank of accumulators of small capacity. The method was devised for controlling small laboratory furnaces. —W. H.-R.

A New Vacuum Furnace Design. Kenneth K. Kelley (*Indust. and Eng. Chem.* (*Analyt. Edn.*), 1932, **4**, 391–392; and *Met. Ind.* (*Lond.*), 1932, **41**, 517–518).—The apparatus described is designed for calorimetric measurements at high temperatures. At 1000° C. a vacuum of 0·1 mm. may be maintained.—S. G.

New Design of a Metallographic Microscope for Cinematographic Work. B. E. Volovik (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (6), 41–42).—[In Russian.] A description of an attachment to an ordinary vertical metallographic microscope which enables photographs to be taken on a cinematographic film in order to increase the output of the microscope in mass-testing practice.—D. N. S.

Apparatus for the Redistillation of Mercury. Henry M. Miles (*Chemist-Analyst*, 1934, **23**, (1), 16–17, 22).—Methods of purifying mercury by filtration, acid washing, and distillation are described, and a Pyrex glass apparatus for laboratory distillations is illustrated diagrammatically.—A. R. P.

Evaporation Technique for Highly Refractory Substances. H. M. O'Bryan (*Rev. Sci. Instruments*, 1934, [N.S.], **5**, 125–126).—Boron, graphite, boron carbide, silicon carbide, fused quartz, molybdenum, chromium, platinum, vanadium, cobalt, nickel, zirconium, and manganese have been evaporated from a crucible heated by bombardment with electrons at 4000 v. from a tungsten filament. The crucible, of pure graphite, was heated to about 3500° C. by 100 milliamps of electron current. Low-melting-point substances, which would alloy with a tungsten filament, are readily evaporated by this method, which has been used in making X-ray targets, small mirrors, and absorbing films.—J. S. G. T.

Measuring Apparatus for Testing the Thickness of Rolled Sheets. O. Schlippe (*Metallwirtschaft*, 1934, **13**, 169–170).—Apparatus is described for the continuous control of the thickness of rolled strip and for testing the straightness and eccentricity of rolls.—v. G.

A New Method for Attaining Very High Pressures and Temperatures. C. Ramsauer (*Physikal. Z.*, 1933, **34**, 890–894).—Read before the 9th Deutsche Physikertag, Wurzburg, Sept., 1933. A cylindrical projectile is shot with high velocity into a chamber of approximately the diameter of the projectile, and compresses the air in the chamber. The possibilities of the method are briefly discussed.—J. S. G. T.

The Measurement of Specific Resistance by Eddy Current Shielding. W. B. Kouwenhoven and G. P. Daiger (*Rev. Sci. Instruments*, 1934, [N.S.], **5**, 94–101). —A new method of measurement of the specific electrical resistance of conducting material, based upon the change of inductance of a solenoid when the material is introduced into the field of the solenoid, is described.—J. S. G. T.

A Gas X-Ray Tube. Gunnar Hägg (*Rev. Sci. Instruments*, 1934, [N.S.], **5**, 117–118).—A water-cooled X-ray tube made in one piece out of a steel rod, having an aluminium cathode and brass anticathode is described.—J. S. G. T.

***Apparatus for Indexing X-Ray Photographs.** L. Tarshish (*Zhurnal Tehnicheskoy Fiziki* (*Journal of Technical Physics*), 1933, **3**, (7), 1135–1140).—[In Russian.] Apparatus for indexing X-ray photographs without evaluating them is described. The apparatus is constructed according to the Büssen–Herrmann principle, but is of universal application, and even enables the Hadding correction to be introduced. It can be used for indexing any photograph taken in any chamber. The theory of the apparatus is briefly given.—N. A.

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

(Continued from pp. 196–200.

The Metallurgical Inspection of Engineering Materials. V. E. Green. —— Chamberlain. —— Benton. Ellis Jones. H. Sutton. —— Rollason. —— Allen. T. G. Bamford (*Met. Ind.* (*Lond.*), 1934, **44**, 251–254, 277–278).—Abstract of an open discussion before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, Birmingham Metallurgical Society, and Staffordshire Iron and Steel Institute). G. stated that owing to the non-technical training of the " buyer " in many firms, inspection of material was very necessary, and he laid down 5 reasons for inspection and 5 methods of carrying it out. He discussed the qualifications of an inspector and the physical and tensile tests to be carried out.—J. H. W.

†**Numerals as an Indication of Quality in the Testing and Sale of Materials.** Adolf Fry (*Stahl u. Eisen*, 1933, **53**, 901–904).—A general criticism of modern science of testing and salesmanship.—J. W.

The Testing of Metallic Materials. E. Skerry (*Aircraft Engineering*, 1934, **6**, 77–85).—Tensile testing, testing machines, hardness tests, and hardness testing machines are described.—H. S.

***Sheet Metal Testing with the Erichsen Apparatus.** G. Sachs (*Metallwirtschaft*, 1934, **13**, 79–81).—The following modification of the Erichsen test is recommended : the usual spherical plunger is replaced by a truncated cone, whereby firstly a circular disc of the sheet being tested is torn away after a definite penetration, and secondly the hole so formed is broadened until the sides crack. The depth of penetration (D) at the first stage corresponds with the elongation, and the broadening (B) of the hole in the second stage to the reduction in area in the tensile test. Lead and very pure aluminium give very low values for D, but very large values for B. Electrolytic copper containing oxygen and phosphorus-deoxidized copper differ little in D values, but very considerably in their B values.—v. G.

***The Measurement of Small Expansions.** L. Dunoyer (*Compt. rend.*, 1934, **198**, 909–911).—For measuring very small expansions, the method, due to Fizeau, is employed in which the expansion of the specimen is compared with a certain wave length of light. Instead of carrying out the experiment *in vacuo*, a correction, m, is applied, such that $m = \frac{1 + Kt'}{K} \cdot \frac{(n_0 - 1)\alpha}{(n_0 + \alpha t)(1 + \alpha t')}$, where K and α are the coeffs. of expansion of the specimen and of air, t and t' are the lower and upper temperatures, and n_0 is the index of air at 0° C. and atmospheric pressure (supposedly constant). If K is very small and t not far from 0° C., the equation reduces to $m = \frac{3 \times 10^{-4}}{KT'}$, where T' is the upper temperature in degrees absolute, $n_0 - 1$ being about 0·0003. Another method which obviates the use of a correction factor is to adapt Chevenard's interference dilatometer method, the length of the specimen at different temperatures being compared with an identical specimen held at a constant temperature.—J. H. W.

†**The Evaluation of Fatigue Fractures.** A. Thum and H. Oschatz (*Metallwirtschaft*, 1934, **13**, 1–8).—A systematic classification of the various types of fatigue fracture is given. From the appearance of the fractured surface the nature and severity of the load causing fracture can be judged, and conclusions can be reached as to the distribution of stresses in the loaded metal.—v. G.

Fatigue Testing. Anon. (*Automobile Eng.*, 1934, **24**, 134).—A description of a simple and improved fatigue testing machine of the rotating bar type in which the test-piece, which is gripped in special chucks which make it unnecessary to drill and tap the test-piece, is carried between two spindles running in ball bearings mounted in housings running on vertical supports. The four-point method of loading is employed, so that the bending moment is constant over the length of the test-piece. The test-pieces used are $3\frac{1}{2}$ in. long and may vary from 0·2 to 0·3 in. in diameter at their smallest section, and the speed of testing is 3000 r.p.m.—J. W. D.

British Standard Forms of Notched-Bar Test-Pieces (Revised August 1933). Anon. (*Brit. Standards Inst.*, No. **131,** 1933, 1–9).—The introductory remarks describe the necessary conditions for the test and discuss briefly the different types of testing machines and test-pieces which have been used. The standard form of notch decided on is a Vee notch of 45° angle with a radius at the bottom of 0·25 mm. As round test-pieces give, in a wide range of steels, results similar to those of the standard square test-piece, their use is permissible by agreement. It is recommended that dimensions and results be expressed in metric units. The result should be the average of at least three tests. The standard test-piece is 10 × 10 mm. in cross-section. Where this size cannot be obtained from the material, subsidiary standards of cross-section 10 × 5 or 5 × 5 mm. may be employed. Eleven plates are given, showing the 5 British Standard test-pieces, 5 subsidiary forms, and 4 round test-pieces. Other particulars shown include adaptations to the Charpy and Izod machines for testing subsidiary and round standard test-pieces, and the forms of alternative three-notch test-pieces.—R. G.

Method of Testing in Detail the Uniformity of Hardness of Specimens. C. Benedicks and C. F. Mets (*Arkiv Matematik, Astron. Fysik*, 1934, [A], **24,** (15), 14 pp.; *Bull. B.N.-F.M.R.A.*, 1934, (**64**), 21).—The method consists in scratching, by means of a diamond point, a fine lattice on the surface under investigation. Local variations in hardness become apparent. The method is thought to be of value for the control of uniformity of standard hardness specimens; it is sensitive to small effects due to work.—S. G.

***Influence of the Breadth of the Test-Piece on the Brinell Hardness.** Hans Kostron (*Stahl u. Eisen*, 1932, **52,** 1272–1273; and (abstract) *Technique moderne*, 1933, **25,** 563–564).—Tests on mild steel have shown that when the Brinell hardness exceeds 100 the distance between the middle of the impression and the edge of the specimen should be at least 0·7 D when $P = 10D^2$ and at least 1·2 D when $P = 30D^2$.—J. W.

RADIOLOGY.

***Improvement of the Photographic Technique in X-Ray and Gamma Ray Testing [of Metals].** R. Berthold (*Z.V.d.I.*, 1934, **78,** 226–227).—Thick steel, aluminium, and concrete can be better illuminated by X-rays if the diffused rays are absorbed by a thin (0·5–1 mm.) lead or tin sheet and if a higher potential is used in the X-ray generator.—v. G.

X-Ray Inspection of Die-Castings in Our Factory. —— Roessler (*Loewe-Notizen*, 1932, **17,** (1) 30).—S. G.

X-Ray Testing of Welds. Ancel St. John (*Internat. Acet. Assoc. Proc.*, **1933,** 123–130).—See *Met. Abs.*, this volume, p. 95.—H. W. G. H.

Present State of Radiometallography. H. Pilon (*Bull. Soc. Ing. Soudeurs*, 1933, **4,** 1107–1125).—The progress made in the application of X-rays to the examination of welds is demonstrated by descriptions of installations—from an early induction coil outfit of 120 kv. to a modern portable apparatus of 500 kv., and an apparatus for using radium.—H. W. G. H.

A Survey of the Practical Applications of X-Rays. Charles S. Barrett (*C. and R. Bull.* (Navy Dept., U.S.A.), **1931,** (3); and *Heating, Piping, and Air Conditioning*, 1933, **5,** 208–209).—S. G.

Technical X-Ray Examination. W. E. Schmid (*Arch. tech. Messen*, 1934, **3,** (31), T10–T11).—The industrial applications of X-ray examination are considered, and the apparatus is shown in diagram, with specimen macrographs. The production, regulation, photographic recording, and sensitivity of the process are considered, and safety precautions are described.—P. R.

Principal Characteristics of Gas Tubes, and Their Working Conditions. M. Laporte (*Bull. Soc. franç. Élect.*, 1934, [v], **4**, 297–312).—The p.d. necessary to initiate glowing on the first and on subsequent occasions of lighting is shown to have a critical value, the governing conditions of which are discussed, as are the minimum p.d. requisite to maintain running, and the value below which the tube ceases to function. The structure of cathode tubes is described, and the characteristic fall of potential is given for 6 metals in a neon atmosphere; the influence of atmosphere is considered and the characteristics and working of certain types of tube are discussed.—P. M. C. R.

XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from p. 200.)

The Use of the Newest Types of Optical Pyrometers in the Metal Industry. G. K. Rusetsky (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (2), 36–44).—[In Russian.] Examples are given of the measurement of the melting points of non-ferrous and ferrous metals with the application of the "absolute black body" correction. A nomogram for optical pyrometer corrections is given.—D. N. S.

Inductive Temperature Measurements. G. Keinath (*Arch. Tech. Messen*, 1934, **3**, (31), T1).—The surface temperature of rolls is of great importance in certain industrial processes. A summary of previous methods of measurement is given. K. suggests a method based on the variation with temperature of the magnetic properties of the material of the rolls. A magnet activated by a.c. is included in a bridge circuit containing a galvanometer, the deflections of which, after balancing, correspond with variations in permeability, and hence in temperature. Meiz's device for obviating distance effects is described.
—P. M. C. R.

***Measurement of Surface Temperatures.** N. P. Bailey (*Mech. Eng.*, 1932, **54**, 553–556; and *Engineer*, 1932, **154**, 303–304; *Sci. Abs.*, 1933, [B], **36**, 17).—An account of experiments carried out to determine the accuracy of measurements obtainable with thermometers and thermocouples. An electric heater was arranged between 2 similar wrought-iron plates so that the heat loss per unit area of each plate would be constant. The actual difference of temperature between the faces of each plate was calculated from a knowledge of the thermal conductivity of the metal and the rate of heat flow per unit area. Constantan wires were welded to the plates to form iron–Constantan junctions: when the weld is covered with putty the thermocouples have accuracies close to 100%. The ordinary mercury thermometer is unsatisfactory for measuring surface temperature; the results show that a bare thermometer in contact with the surface indicates only 72% of the difference between the true surface temperature and the ambient temperature. Covering the thermometer with $\frac{3}{16}$ in. of asbestos-paste increased this factor to 90%. Thermocouples, when carefully made of small-gauge wire and fastened to a surface with a covering of insulation, will indicate as high as 98·5% of the difference between the surface and the ambient-air temperatures; $\frac{3}{16}$ in. of covering is recommended as a standard, and observations show that the effect of putty as a covering medium on the temperature indications is the same as asbestos oil paste.—S. G.

Temperature Control [in Metallurgical Practice]. [R.] Hay (*Found. Trade J.*, 1934, **50**, 216).—Abstract of a paper read before the Scottish Branch of the Institute of British Foundrymen.—J. H. W.

Paints for Recording Temperatures. —— (*Aircraft Engineering*, 1934, **6**, 76).—Early applications and recent developments are described.—H. S.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 201–202.)

Controlled Directional Solidification. George Batty (*J. Amer. Soc. Naval Eng.*, 1934, **46**, 1–20).—The potentialities of promoting a definite and controllable temperature gradient in both mould and metal with a view to producing integrally sound castings, not only of steel, which is discussed, but also of castings produced in other metals and alloys. The work of various investigators on the solidification of metals is first reviewed, then a simple mould manipulative procedure is described, in which casting by systems called " total reversal," " 30-degree reversal," and " 100-degree reversal " are dealt with in detail with special reference to gates, heads, risers, methods of pouring, and manipulation in general.—J. W. D.

Porosity in Non-Ferrous Metal Castings. G. L. Bailey (*Met. Ind.* (*Lond.*), 1934, **44**, 293–295; discussion, 295–296; and *Found. Trade J.*, 1934, **50**, 175–178).—Read before the London Branch of the Institute of British Foundrymen. The 3 main causes of porosity in castings are: (1) shrinkage, (2) the evolution of dissolved gases, and (3) the entrapping of gases. These are discussed in detail. In the discussion, *Wesley Lambert* stated that additional causes of porosity in non-ferrous castings are the use of unsuitable alloys, careless compounding and melting, and careless moulding and teeming. *A. J. Murphy* recommended the use of copper moulds. B. replied.—J. H. W.

Some Aspects of Non-Ferrous Founding. Arthur Logan (*Found. Trade J.*, 1934, **50**, 193–195, 211–213).—Read before the Lancashire Branch of the Institute of British Foundrymen. The following points in non-ferrous foundry practice are discussed: sound buying, core-blowing machinery, waster elimination, casting temperature, and the use of pyrometers, the production of sound castings, factors for economy, cold-cast castings, gas evolution, foundry faults, " burning on," the need for standardization, and sand control.—J. H. W.

Difficulties in the Manufacture of Non-Ferrous Castings. W. Fröhlich (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 119–122).—Difficulties in making nickel castings, for which 0·1–0·2% of magnesium is recommended, flanged castings, leaded red brass, and locomotive tube sockets are described and methods for overcoming them are suggested. A rapid determination of the zinc content of brass to within 0·5% by comparing the volume of sawings of test-pieces of known copper content, and the use of horn-shaped gates in casting aluminium–silicon alloys are discussed.—J. H. W.

Mixing Calculations in the Metal Foundry. Erich Becker (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 76–78).—Formulæ for calculating the constituents of the charge in making non-ferrous castings are given and the method of calculating the compositions of the resulting alloys in each of the constituents is explained with examples of copper–tin–zinc–lead alloys.—J. H. W.

***Use of Rotating Magnetic Field in Pouring Metals.** D. A. Shtanko (*Zhurnal Tehnicheskoy Fiziki* (*Journal of Technical Physics*), 1933, **3**, (7), 1085–1090).—[In Russian.] The mould was placed in the stator of a 3-phase motor. The stator was periodically connected and disconnected from the first instant of pouring until complete setting of the metal. Mixing of liquid metal (zinc, aluminium, "aluminium–bronze") in the ladle by a vertical rotating magnetic field assists removal both of gas bubbles and non-metallic inclusions. Mixing in the mould homogenizes the composition of the ingot, removes columnar crystallization, and reduces cooling stresses.—N. A.

Casting Department of a Works for Treating Light Alloys. D. A. Petrov (*Legkie Metalli* (*Light Metals*), **1933**, (5), 13–17).—[In Russian.] Experiences of the work of the Russ electric furnaces at a new factory for treating light alloys are discussed and the chief faults of the furnaces and measures for their correction are described. Conditions of casting large ingots for rolling Alclad, and hollow ingots are discussed.—D. N. S.

Melting of Aluminium Casting Alloys. —— Irmann (*Tech. Rundschau*, **1934**, (Mar. 2), 4 pp.; *Bull. B.N.-F.M.R.A.*, 1934, (**64**), 9).—Precautions to be taken in the production of sound metal are stated as follows: crucible and furnace should be dry and free from other metals; coke should be dry, and there should be no excess pressure in the furnace; the temperature of the metal should not exceed 800° C. in order to avoid gas absorption and oxidation. Purification with a dry flux is recommended.—S. G.

Beryllium-Copper Castings—Foundry Practice, Heat-Treatment, Properties. Edwin F. Cone (*Trans. Amer. Found. Assoc.*, 1933, **41**, 330–344; discussion, 344–345; and *Met. Ind.* (*Lond.*), 1933, **43**, 79–81, 101–130).—See *J. Inst. Metals*, 1933, **53**, 717.—S. G.

Difficulties in Casting Brass and Bronze Alloys. W. Fröhlich (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 97–99).—The difficulties met with in making castings in brass and bronze and the methods for overcoming them are illustrated by examples of the casting of a manganese–bronze propeller and of machine parts of copper alloys containing zinc, tin, and lead, with and without nickel.—J. H. W.

Prevention of Wasters in Gun-Metal and Brass Castings. Geo. E. Fisher (*Mech. World*, 1933, **94**, 1109).—Letter to the Editor. Defects just under the " skin " of castings were attributed to small pieces of coke getting into the crucible of a tilting furnace, using a pre-heating muffle ring. Ingress of coke was prevented by fitting the lip of the crucible with a shaped stopper of gannister which could be lifted out before pouring, by means of an iron handle round which the gannister had been rammed. The " remedy " is illustrated. —F. J.

Speculum Metal Castings. —— (*J. Franklin Inst.*, 1934, **217**, 378).—A new foundry technique which successfully overcomes the difficulties associated with the casting of Speculum metal for optical work has been developed at the U.S. Bureau of Standards. Particulars may be obtained on application to the Bureau.—S. V. W.

***On the Desulphurization of Iron [and Nickel] with Beryllium.** W. Kroll (*Metallwirtschaft*, 1934, **13**, 21–23).—Beryllium is a far better desulphurizing agent for iron and nickel than are aluminium and manganese—v. G.

The Deoxidation of Technical Silver Melts. K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1934, **7**, 132–135).—New melts from electrolytic copper and granulated fine silver require about 1 grm. of 10% phosphor–copper per kg. when a wood-charcoal protective cover is used; scrap metal melts may require as much as 10–20 grm./kg. of deoxidizer. Phosphorus–deoxidized silver alloys should not be annealed at above 650° C.—A. R. P.

A Permanent Mould Device for Pure Aluminium Spinning Vessels. H. Reininger (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 96–97).—A special permanent mould for making chill-castings of spinning vessels of pure (at least 99·5%) aluminium for use in the artificial silk industry is described. It is made of cast iron, the upper part in 2 halves enclosing a hollow core that can be withdrawn downwards when the casting is solid. A feeder and riser are provided to prevent undue piping.—J. H. W.

The Moulding of Bronze. —— Detourmignies (*Rev. Fonderie moderne*, 1943, **28**, 54–58; discussion, 59).—Read before the Association Amicale et Mutuelle de Fonderie. The composition, qualities, preparation, and mixing of sands for bronze casting are described, and the processes of moulding, feeder heads, pressure casting, rate of pouring and evolution of gas, and internal stresses are discussed, and the moulding machines are briefly described. —J. H. W.

Recent Progress in the Centrifugal Casting of Non-Ferrous Alloys. Francis W. Rowe (*Met. Ind.* (*Lond.*), 1934, **44**, 245–250).—Both sand- and chill-castings are susceptible to many disadvantages and defects which, it is claimed, centrifugal casting avoids. Details of centrifugal casting of bronzes and gun-metals are given, and the results compared with similar castings made in sand. The microstructure of centrifugal castings is small and of uniform grain-size, due to the chilling action of the mould, the constant agitation of the metal throughout solidification, and the liquid compression which compensates for the liquid shrinkage. This naturally results in higher mechanical properties. —J. H. W.

Study of Physico-Transformations of a Liquid Mass Cast in Full Section and Submitted to Centrifugal Action during Solidification. Lazare Quincy (*Rev. Mét.*, 1934, **31**, 68–89).—A method of casting ingots and centrifuging them so that a central cavity develops is described. The outer zone of the cast ingots is of superior quality.—H. S.

Pressure Casting of Aluminium Alloys. K. V. Peredelsky (*Legkie Metalli* (*Light Metals*), **1933**, (8), 31–34).—[In Russian.] A description of the operations of a die-casting machine for casting aluminium alloys.—D. N. S.

Notes on the Design of Die-Castings. F. A. W. Livermore (*Met. Ind.* (*Lond.*), 1934, **44**, 341–343).—For die-castings to be economical, large numbers are required. The relative advantages and disadvantages of die-castings and sand-castings, especially as regards aluminium alloys, are enumerated. A die of suitable metal which will be capable of withstanding the corrosive action of the aluminium alloys as well as the rapid temperature changes to which it is subjected, and the design of castings so that they can be die-cast are discussed. Details of the venting of the die, ejector pin marks, die cooling, and casting of threads are considered.—J. H. W.

Some Notes on the Subject of Pressure Casting. G. d'Ardigny (*Rev. Fonderie moderne*, 1934, **28**, 45–49).—Based on a paper read by F. Nielsen before the Association Technique de Fonderie, describing lever machines with piston injection, piston-injection and direct-action compressed-air machines, injection nozzles, mould opening, and details of pressure casting in general.—J. H. W.

Study of Moulding Sands. R. Guérin (*Rev. Fonderie moderne*, 1934, **28**, 63–66, 81–85).—The following are discussed : the mechanism of the formation of moulding sands, their constituents, properties and applications, methods of testing their cohesion permeability and refractoriness, the interpretation of the results of the tests, synthetic sands, working the sand, and automatic sand-moulding machines.—J. H. W.

Preparation and Distribution of Moulding Sands. H. L. McKinnon (*Amer. Soc. Mech. Eng. Preprint*, **1931**; and (abstract) *Iron Age*, 1931, **128**, 428–430).—Sands for non-ferrous and ferrous casting work are discussed. The subject is divided into (1) preparation of moulding sands; (2) distribution; (3) preparation or core sands; (4) continuous drying; (5) reclaiming of core sands and other dry sands. The devices used in the preparation of sands include screening, magnetic separation, mixing, mulling, and aeration. In general, it may be said that sand as received in the foundry has a high permeability, low shear strength, and low moisture content, and preparation processes are necessary to improve the sand if high-quality castings are desired. —W. P. R.

Modern Foundry Practice. Mechanization and Equipment. Vincent C. Faulkner (*Found. Trade J.*, 1934, **50**, 215–216).—Abstract of a paper read before the Sheffield Metallurgical Society.—J. H. W.

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

(Continued from p. 202.)

The Use of Aluminium Scrap in the Foundry. W. Fröhlich (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 75–76).—The use of scrap metal in aluminium castings is economical only when the scrap is of known and high quality. Since the quality of aluminium scrap varies with its price, cheaper material requires certain treatment before it can be used in the aluminium foundry. The treatment required by various kinds of scrap likely to be used in the foundry is outlined, and the qualities and composition required by this scrap are defined. —J. H. W.

Antimony Extraction by Electrolysis. C. C. Downie (*Elect. Rev.*, 1933, **112**, 483).—For the recovery of antimony from waste metallines, drosses, &c., the dross is treated in a reverberatory furnace with coal and salt cake. This converts the metals present into sulphides from which the antimony sulphide is separated by solution with water. This solution is then electrolyzed in iron vats with iron cathodes and anodes made from scrap lead. The deposit takes the form of powder or shining scales which is removed from time to time. —S. V. W.

XV.—FURNACES AND FUELS

(Continued from pp. 202–203.)

Anodes from Converter Copper. Anon. (*Eng. and Min. J.*, 1934, **135**, 107–108).—Describes a 120–150 ton reverberatory furnace with a Walker wheel for the production of anodes directly from liquid converter copper.—R. Gr.

Electric Melting and Annealing Furnaces at the Plant of the Hirsch Kupfer und Messingwerke. Thos. Metzger (*Elektrowärme*, 1933, **3**, 199–208; *C. Abs.*, 1933, **27**, 4737).—The capacity of the plant is 3000–4000 tons per month of sheets, tubes, wires, rods, shapes of nickel–brass, copper, pure nickel, and special bronzes. All copper–zinc alloys are hot-rolled; Ajax–Wyatt induction furnaces are used for melting copper and its alloys with zinc and nickel–zinc; water-cooled ingot moulds are used. Twenty-one induction furnaces with 5000 kw. are in operation for tubes up to 7 m. in length, sheets of 600 mm. in width up to 1·2 mm. in thickness, bolts, fittings, &c. Four muffle furnaces of 165 kw. each serve for annealing small strips and sheets and 8 muffle furnaces for annealing brass slabs. A continuous 80-kw. furnace for brass strip consumes 100–160 kw.-hr. per ton of material at 720° C.—S. G.

Electric Furnace for Small Runs. Anon. (*Eng. and Min. J.*, 1934, **135**, 142).—Note on a 25–100-lb. rocking electric melting furnace, with a nominal rating of 20 kw.—R. Gr.

Electric Furnaces for Aluminium Alloys. Anon. (*Aircraft Engineering*, 1934, **6**, 17–18).—Wild–Barfield electric furnaces for heat-treatment of light alloy parts are described. Circulation of air over the heating elements and through the charge is secured by a centrifugal fan, and the temperature is controlled and recorded automatically.—H. S.

Electric Furnaces and Their Use in the Industry of Hard Alloys and Rare Elements. W. S. Rakovski (*Redkie Metalli* (*Rare Metals*), **1933**, (1), 39–41).—[In Russian.] A description of furnaces which can be, and are used in the preparation of hard alloys and rare elements. The principles of designing such furnaces are discussed.—D. N. S.

Furnaces for Heat-Treatment. W. A. Thain (*Aircraft Engineering*, 1934, **6**, 13–15).—The main features of furnaces suitable for the heat-treatment of aircraft steels are discussed, and an electric furnace for heat-treatment of light alloy castings is described.—H. S.

Small Electric Furnace for Low Temperature Heat-Treatment. Anon. (*Mech. World*, 1933, **94**, 983).—A new, small furnace for low-temperature heat-treatment is illustrated and described. In one type, it is suitable for temperatures up to 400° C. and in the other, up to 650° C.—F. J.

Currents in Arc Furnaces. K. A. Lohausen (*Arch. Elektrotech.*, 1932, **26**, 611–619; *Sci. Abs.*, 1933, [B], **36**, 26).—The distribution of current in the molten bath of a 3-phase arc furnace and the consequent liberation of heat are investigated by means of a model. The results are exhibited as current contour diagrams.—S. G.

Theory and Practice of High-Frequency Induction Furnaces. W. Esmarch (*Z. Elektrochem.*, 1932, **30**, 812–825; *Sci. Abs.*, 1933, [B], **36**, 108).—Cf. *J. Inst. Metals*, 1933, **53**, 523. E. gives the theory of the H.-F. induction furnace and expressions for inductance, power consumption, and efficiency. The power factor varies between about 0·05 for a 10,000-cycle furnace to about 0·15 for a 2000-cycle furnace, and is corrected by series- or shunt-connected static condensers. A motor generator set is necessary to provide the H.-F. current, and the efficiency of the whole equipment is usually between 80 and 90%. The cost is about two-thirds of that of a corresponding arc furnace. A *bibliography* is included.—S. G.

Self-Regulating Induction Furnaces. Anon. (*Mech. World*, 1933, **94**, 1054–1055; and *Aircraft Eng.*, 1934, **6**, (59), 17).—A self-regulating furnace for heat-treatment and low-temperature metal-melting is illustrated and described. The temperature is controlled between 400° and 1000° C. by the insertion of special alloy self-regulating bars which lose their magnetism at the required temperature, the input of energy thereby immediately diminishing until the bars regain their magnetism and the load automatically increases. Thus the control is dependent on this physical constant, which is unchangeable for a given alloy. A wide range of different alloys has been selected to give a range of controllable temperatures.—F. J.

Recent Developments in Design of Electric Furnaces for Low Temperatures. J. E. Oram (*Elektrowärme*, 1933, **3**, 122–124; *C. Abs.*, 1933, **27**, 3671).—The operation of furnaces for temperatures between 200° and 450° C. has been improved by agitating the air in the furnace; this reduces the time of bringing the charge up to temperature, since at these low temperatures heat is transmitted almost exclusively by convection instead of by radiation as in high-temperature furnaces. Examples are described showing the arrangement of centrifugal blowers to achieve this end. In this manner the disadvantage of cleaning the goods after treatment in oil or salt baths is eliminated. Temperature control is of importance.—S. G.

Wire for Resistance Furnaces. A. G. Arend (*Elect. Rev.*, 1933, **113**, 248).—Short note on the use and production of nickel–chromium alloys for electric resistance furnaces.—S. V. W.

The Dependence on Temperature of the Electric Resistance of Silicon Carbide Heating Elements. L. Nawo (*Elektrowärme*, 1933, **3**, 133–135; *C. Abs.*, 1933, **27**, 3671).—Investigations on commercial silicon carbide resistors (Silit, quartzite, Globar) show that they have a fairly inhomogeneous structure. The ohmic resistance decreases with increase in temperature up to 700° C. and the more so the greater the resistivity of the element at 20° C. In the temperature range above 700° C., two kinds of heating elements must be distinguished: one type assumes a permanent increase in resistance at 700° C., or the resistance remains almost constant; a decrease of resistance does not take place. The increase of resistance above 700° C. is greater the lower the resistivity at 20° C. This was especially the case in elements with large silicon carbide crystals. The second type increases its resistance between 700° and 1200° C. and decreases again from then on; or a permanent appreciable decrease of resistance takes place at 700° C. It is not possible to give a generally applicable formula for calculating the resistance, as silicon carbide is not a uniform material, but a mixture of crystalline and amorphous material. The change of resistance with temperature is due very likely to a growth of the silicon carbide crystals.—S. G.

Waste-Heat Boiler Practice. Essential Data from Seven Metallurgical Plants. Anon. (*Eng. and Min. J.*, 1934, **135**, 105–106).—Gives data from seven American metallurgical plants.—R. Gr.

FUELS.

†**Design of Burners for Pulverized Fuel.** Anon. (*Fuel Economist*, 1934, **9**, 235–240, 244).—Principles of burner design and their relation to coal characteristics, ignition temperatures, flame propagation, the relation of air and coal mixture to early and stable ignition, the ideal burner, the application of secondary air, turbulent and streamline burners, the advantages of preheated air, and the protection of the burner are discussed.—J. S. G. T.

The Estimation of Oxygen by Measurements of Thermal Conductivity. Heinz Grüss and Fritz Lieneweg (*Arch. tech. Messen*, 1934, **3**, (32), T18–T19).—An apparatus is described for estimating oxygen in furnace gases by the comparative measurement of the thermal conductivities of (*a*) the furnace gas mixed with excess of hydrogen; (*b*) the same mixture after combustion. The difference between (*a*) and (*b*) depends on the removal of hydrogen, and consequently on the oxygen content of the original sample.—P. M. C. R.

Smoke Analysis: Carbon Dioxide or Oxygen? Heinz Grüss and Fritz Lieneweg (*Arch. tech. Messen*, 1934, **3**, (31), T8–T9).—G. and L. consider that the estimation of oxygen in exhaust gases gives a more accurate indication both of excess air and of unburnt material than does that of carbon dioxide. Curves in which oxygen and carbon dioxide contents are plotted against excess air are given in support, and the application of the principle to various industrial processes, notably coke-oven working, is discussed in detail.—P. M. C. R.

XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 203–204.)

***Special Refractories for Metallurgical Research at High Temperatures.** Donald Turner (*Trans. Ceram. Soc.*, 1934, **33**, 33–52).—A very complete account of the technique developed at the National Physical Laboratory, for the production of special and usually very pure crucibles and tubes. The paper does not lend itself to abstracting: those interested in the subject are advised to read the paper in full.—S. V. W.

German Standards for Refractories. Ernst Hermann Schulz and Fritz Hartmann (*Stahl u. Eisen*, 1932, **52**, 995–998; and (abstract) *Technique moderne*, 1933, **25**, 357–358).—Specifications of standard refractories, especially for steelworks, are given.—J. W.

Modern Combustion Chamber Walls. Anon. (*Iron and Steel Ind.*, 1934, **7**, 239; and *Metallurgia*, 1934, **9**, 174).—A brief description of an air-cooled fire-brick wall suitable for coal-, oil-, or gas-fired furnaces, which have to meet high-duty conditions. The wall consists of cast-iron carriers, high-grade fire-clay blocks, standard fire-bricks, and a steel framework, and by suitable air cooling the inner face can be kept at a temperature below that at which the slag fuses, so that the latter cannot adhere, and the wall remains perfectly clear.—J. W.D.

†**Chromite: Its Properties and Uses as a Refractory.** P. Mamykin (*Uralskiy Tehnik* (*Ural Technologist*), **1932**, (4–5), 21–29).—[In Russian.] A review of the problem, chiefly from published information. Tables are given showing the composition, fusion and softening temperatures, thermal stability, resist-

ance to compression, sp. gr., porosity, thermal conductivity, and other characteristics of Chromite bricks.—N. A.

The Action of Coal Ash on Refractories. G. W. M. Rees (*Eng. Rev.*, 1934, **47**, 668–670).—Analyses and melting-points are tabulated for 4 samples of ash: the melting-point rises as the molecular proportion of basic oxides to silica diminishes. Fusibility decreases as the composition approximates to that of aluminium silicate (Al_2O_3 45·8%, SiO_2 54·2%). Conditions governing the adhesion of clinker to brickwork, and the interaction of the materials concerned, are discussed. The constituents of coal ash are considered from the viewpoint of slagging and of corrosive attack on bricks, the work of J. J. Brennan being cited (*Combustion*, **1924**, June). Other factors in slagging are briefly summarized.—P. M. C. R.

XVII.—HEAT-TREATMENT

(Continued from p. 204.)

Heat-Treatment of Aluminium Alloys with a Protective Coating. G. Guidi (*Alluminio*, 1933, **2**, 323–326; *Chem. Zentr.*, 1934, **105**, I, 1382).—The effect of a short heat-treatment at 460°–520° C. on the tensile strength and elongation of aluminium alloys clad with a coating of the purest aluminium has been determined. Up to 505° C. the mechanical strength is improved, but at higher temperatures or after prolonged heating it is appreciably reduced. Quenching tends to produce surface blisters.—A. R. P.

†**New Working Methods for the Production of Aluminium Alloy Wire.** F. Oe (*Draht-Welt*, 1934, **27**, 67–68).—According to a new procedure developed by Carl Haase, hot-rolled or extruded alloy is aged at a temperature below 250° C., cold-drawn, and again aged, when it is possible to obtain 32 kg./mm.^{2} tensile strength and 32 $\frac{\text{m.}}{\Omega\ \text{mm.}^2}$ conductivity with alloys containing 0·3–0·6% magnesium and about 0·7% silicon.—A. B. W.

***Annealing of Aluminium Sheet.** P. A. Vargunin (*Tehnika Vosdushnogo Flota* (*Technology of the Aerial Navy*), **1933**, (9), 96–99).—[In Russian.] Aluminium sheet can be annealed satisfactorily in a nitre bath in 10 minutes at 300°–625° C. without any marked deterioration in the mechanical properties. The tensile strength, hardness and Erichsen value are the same whatever the annealing temperatures. In bending tests, sheet annealed at 625° C. is not as good as that annealed at lower temperatures. At 575° C., noticeable grain-growth begins, accompanied by the so-called "ripple" effect on the surface of the sheets at the bends. In practice, it is undesirable to exceed 550° C. —N. A.

†**For a Rational Heating Technique of Aluminium Alloys During Thermal Treatment.** A. F. Belov (*Legkie Metalli* (*Light Metals*), **1933**, (7), 28–31).—[In Russian.] A critical review of the methods of treating aluminium alloys during thermal treatment.—D. N. S.

Dry, Bright-Annealing of Copper Wire. A. R. Ryan (*Wire and Wire Products*, 1934, **9**, 75–82, 92).—Operating data on the dry, bright-annealing of copper wire in Bell-type electric furnaces are given, and the variations in the physical properties of copper under cold-working and the effects of annealing temperatures from 200°–1600° F. (95°–870° C.) are discussed.—J. H. W.

Bright Annealing. Anon. (*Mech. World*, 1933, **94**, 815).—A correspondent suggests the addition of aluminium borings or turnings to the packing powder in the annealing of thin iron and steel sheets for pressing or electrical work. The aluminium uses up any atmospheric oxygen enclosed in the boxes before luting and minimizes scaling; it should be replaced from time to time. —F. J.

Beryllium–Copper Castings—Foundry Practice, Heat-Treatment, Properties. Edwin F. Cone (*Trans. Amer. Found. Assoc.*, 1933, **41**, 330–344; discussion, 344–345; and *Met. Ind.* (*Lond.*), 1933, **43**, 79–81, 101–103).—See *J. Inst. Metals*, 1933, **53**, 717.—S. G.

Cold-Working, Low-Temperature Heat-Treatment, and Annealing of Brasses.—I.–II. W. Broniewski and T. Pelczynski (*Rev. Mét.*, 1934, **31**, 48–54, 90–96).—(I.—) Industrial brass prepared from electrolytic metals and practically free from impurities, supplied in the form of bars of about 250 mm.^{2} section and having been subjected to 20% reduction by cold-working, were used as raw material. The bars were reduced by rolling and drawing to 8 × 10 mm. section for resilience tests and to 5-mm. diam. wire for tensile and hardness tests. In all cases the bars were annealed for 2 hrs. at 550° C. before finally cold-working to the above-mentioned dimensions, the dimensions before the final cold-working being varied to give degrees of cold-working of 0–100%. Very small amounts of cold-working were obtained by applying tension. Curves representing the effect of cold-working on tensile strength, elastic limit, hardness, reduction of area, and elongation for brasses containing 67 and 60% of copper are given. The first stage of cold-working is considered in relation to Krupkowski's formula. (II.—) Three stages of cold-working are recognized. The end of the first stage is characterized by the almost complete disappearance of proportionality between elongation value and degree of cold-working, also by points of inflection in most of the curves, but in the curves showing resistance to shock. Commencement of the third stage of cold-working is indicated by a point of inflection in the reduction of area curve and other curves. The limits of the stages of cold-working occur at 30 and 70% in cartridge brass and at 35 and 75% in 60 : 40 brass. Reheating and annealing experiments show that the hardness of brasses which have been subjected to the second and third degrees of cold-working passes through a maximum, a feature not shown by brasses cold-worked in the first stage. The inflection on the hardness curves occurs at temperatures which are the lower the higher the degree of previous cold-working. Reheating and annealing of brasses for a definite time (30 minutes) at different temperatures showed that the fall in hardness is followed, for all degrees of cold-working, by a horizontal corresponding probably with the agglomeration of ultra-microscopic crystals up to the temperature of complete annealing, 700° C. for cartridge brass and 600° C. for 60 : 40 brass, the mechanical properties are dependent not only on the heat-treatment temperature, but also on the degree of previous cold-working.—H. S.

The Effect of Low Temperature Heat-Treatment on the Microstructure of Cold-Drawn Brass Tubes. James Fox (*Mech. World*, 1933, **94**, 960–961).—Cf. *J. Inst. Metals*, 1933, **53**, 629. An investigation on a wide range of specially manufactured hard-drawn brass tubes varying from "slightly hard" to "super hard" showed that heat-treatment of 3–4 hrs. at 275°–300° C. does not affect the microstructure of the tubes to any appreciable extent. The article is illustrated by a number of photomicrographs. Cf. abstract below.—F. J.

The Effect of Low-Temperature Heat-Treatment on the Properties of Cold-Drawn Brass-Tubes. James Fox (*Mech. World*, 1933, **94**, 1087–1089).—Cf. preceding abstract. An illustrated summary of a research to find the most suitable heat-treatment that may be given to hard-drawn brass tubes to eliminate internal stresses without appreciably altering the physical properties. Vickers pyramidal diamond hardness tests and compression tests were made on specimen tube-lengths after various heat-treatments. The hardness tests showed that there was no skin-hardening and that internal stresses are not due to unequal work-hardening. Generally there was an increase in hardness up to the 200°–250° C. region, the increase being greater in the more severely-drawn tubes. Softening sets in at about 250° C. irrespective of the time of anneal. The geometrical shape of the indentations undergoes a change with softening. Graphs were plotted to show the relation between yield loads and ultimate loads (in compression) and hardness values with (*a*) temperature, and (*b*) time of heating. By measuring the amount of springing in longitudinally cut strips, it was found that internal stresses did not exist in tubes heated above 250° C.—F. J.

XVIII.—WORKING

(Continued from pp. 204–206.)

Some Faults in the Working of Gold Alloys.—II. E. Raub (*Mitt. Forschungsinst. Edelmetalle,* 1934, **7**, 127–132).—In rolling 18-carat red gold alloys or 20-carat dental alloys a reduction of more than 50% is necessary between anneals in order to produce a finely crystallized structure after annealing; with smaller reductions, *e.g.* 25%, a very coarse-grained crystal structure is obtained on annealing, and on further rolling intercrystalline cracking occurs. After severe working of low-carat gold alloys, especially those containing zinc, the internal stress developed is often sufficient to produce season-cracking; such alloys should therefore be annealed more frequently during working, and should be given a low-temperature relief-anneal on finishing.—A. R. P.

High-Speed Wire-Drawing. Anon. (*Mech. World,* 1933, **94**, 790).—A British machine for drawing fine wire at high speeds is illustrated and described. A new method of stringing-up, and a new type of die-box which facilitates operation, obviates breakage of the wire and reduces wear of the die are outstanding features. An improved spooling-gear is also used. All the cones are utilized as drawing-cones, there being no idlers. Drawing-speeds up to 5000 ft. per minute can be used as required.—F. J.

Lead-Sheath Cable Presses. P. Wieghardt (*Elektrotech. Zeit.,* 1932, **53**, 915–916; *Sci. Abs.,* 1933, [B], **36**, 16).—The various modern forms of the " straight through " hydraulic extrusion press for covering cables with a lead sheath are described. The particular features of each type are briefly discussed and illustrated by photographs and diagrams.—S. G.

Manufacture of Non-Ferrous Seamless Tubes by Piercing and Extrusion Methods. Gilbert Evans (*Wire and Wire Products,* 1934, **9**, 17–20, 25).—See *J. Inst. Metals,* 1933, **53**, 718.—S. G.

Press and Tube Departments for Treating Light Alloys. A. V. Tshitaev (*Legkie Metalli* (*Light Metals*), **1933**, (5), 18–23).—[In Russian.] Basic faults and merits of the equipment of a factory as revealed by the first few months' operations are discussed.—D. N. S.

Development of Forging and Stamping of Light and Extra Light Alloys. V. Aristov (*Legkie Metalli* (*Light Metals*), **1933**, (2–3), 22–26).—[In Russian.] A review of forging and stamping practice of light alloys in the U.S.S.R. and abroad.—D. N. S.

Hot-Stamping of Non-Ferrous Metals. A. P. Guljev (*Vestnik Ingenerov i Tehnikov* (*Messenger of Engineers and Technologists*), **1932**, (12), 523–526).—[In Russian.] A brief review of the present position of the hot-stamping of non-ferrous metals.—N. A.

The New Technology as the Theoretical Basis of a Metal-Working Factory Project. B. P. Rolshtikov (*Legkie Metalli* (*Light Metals*), **1933**, (5), 9–12).—[In Russian.] First results of the experimental work of a new large factory for the mechanical treatment of aluminium alloys are described.—D. N. S.

The Production of Aluminium Foil in U.S.S.R. S. I. Berman (*Legkie Metalli* (*Light Metals*), **1933**, (1), 22–32).—[In Russian.] Prospects of the future development of aluminium foil production. The production of foil at the Moscow and Leningrad works is described.—D. N. S.

***A New Method of Fusing of Hard Alloys.** V. Romanow and P. Roshin (*Neftjanoe Khoziastvo* (*Oil Economy*), **1933**, (8), 153–154).—[In Russian.]

Data are given to show that the fusing of hard alloys on to chisels should be carried out in strips and not in a continuous layer.—N. A.

Manufacture of Pobedite Dies. —— Bader (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (5), 29–34).—[In Russian.] The manufacture and mechanical treatment of blocks of the alloy Pobedite for the preparation of dies for wire-drawing, is described.—D. N. S.

Casting and Welding, or Pressing and Sintering? Joh. Mehrtens (*Automobiltech. Z.*, 1934, **37**, 131–132).—Porosity, inaccuracy to dimensions, and consequent expense due to machining or wastage, and the presence of non-metallic impurities may be obviated to an increasing degree by the pressing and sintering of metallic powders. Uhlmann's original process is described, and the properties of Sinter-bronze and of Gittermetall are described (*ibid.*, 1933, **15**, 397; for Gittermetall, *Maschinenkonstrukteur*, 1931, **64**, 160, and *J. Inst. Metals*, 1932, **50**, 731).—P. M. C. R.

***The Characteristic Figures in the Sawing Section of Metals.** Toru Hosaka and Ichiji Moriya (*Sci. Rep. Tôhoku Imp. Univ.*, 1933, [i], **22**, 782–802; and (in Japanese) *Kinzoku no Kenkyu*, 1933, **10**, (12), 519–531).—[In English.] Two kinds of figures are usually observed in the section of metals sawn with a hack saw, the first consisting of slightly rugged streaks affected by the periphery of the section, and the second of deeply rugged streaks unaffected by the periphery of the section. They are attributed to the forced lateral oscillation of the saw during the process of sawing. The figures are most conspicuous in brass, and least in soft and tenacious metals, such as copper and lead.—E. S. H.

XIX.—CLEANING AND FINISHING

(Continued from pp. 207–208.)

Electrolytic Degreasing and the Limits of Its Applicability. K. W. Fröhlich (*Mitt. Forschungsinst. Edelmetalle*, 1934, **7**, 111–120).—Cf. *J. Inst. Metals*, 1933, **53**, 708. Further examples are given of the deleterious effect of electrolytically degreasing 835-fine silver articles prior to plating, if they have been made from an alloy containing an excess of phosphide or cuprous oxide eutectic. The nascent hydrogen reduces both compounds to spongy copper and the subsequent silver plate is porous and blistery.—A. R. P.

Methods of Colouring Copper and Copper Alloys Brown. H. Krause (*Mitt. Forschungsinst. Edelmetalle*, 1934, **7**, 141–147).—Numerous pickling baths with a basis of dilute copper sulphate solution and various addition agents, *e.g.* acetates, alum, &c., are described and their efficiencies are compared with those of permanganate and chlorate pickles.—A. R. P.

XX.—JOINING

(Continued from pp. 208–211.)

Electric Pressure Brazing of Cable Terminals. Joseph A. Kendrick (*Power Plant Eng.*, 1934, **38**, 140–141).—The method is applicable to solid cable if tinned, and to stranded cable if the strands be tinned, or if sheet solder be inserted among the strands. The composition of the solder is : lead 90 and tin 10%. A higher tin content may cause embrittlement of the cable. Mechanical pressure is applied to the cable end and terminal thimble, whilst a carefully regulated current sufficiently heats the parts to bring the material into a plastic condition. The outfit is described and illustrated, and its application to certain abnormally conditioned work is recommended.—P. M. C. R.

***[A Bunsen Burner for] Soldering and Brazing.** J. H. Field (*J. Sci. Instruments*, 1934, **11**, 96).—A note. A burner suitable for delicate soldering work, and giving a fine Bunsen flame of length 5–15 mm., is obtained by using coal gas with the " O.T.A." single-jet acetylene burner. Acetylene needs so much more air than coal-gas that the burner's air passages designed to give a bright acetylene flame produce a fine Bunsen flame with coal-gas.—W. H.-R.

New and Improved Hard Solders of Low Melting-Point. Anon. (*Illust. Z. Blechindustrie*, 1934, **63**, 177).—The high melting-point (740° C. or above) of the silver–copper–zinc soldering alloys tends to restrict their application. Certain copper–silver–phosphorus alloys are described as giving reliable joints and as being easily applied, whilst possessing a melting-point of 610°–627° C. The compositions of 3 such alloys are tabulated with their respective melting-points.—P. M. C. R.

***Soldering of Aluminium in the Electrical Industry.** W. Usow (*Vestnik Elektropromishlennosti* (*Messenger of the Electrical Industry*), **1933**, (11), 16–19). —[In Russian.] The properties of a solder of composition tin 55, zinc 43·5, silver 1·5% are as follows: tensile strength 8–10 kg./mm.^{2}, Brinell hardness 20–30, electrode potential in 3% sodium chloride, − 0·83 v. It easily forms coatings on aluminium and copper, and gives strong solderings. The soldering temperature is 500°–550° C. Methods of soldering aluminium strip, tyres, and wire are given.—N. A.

Soldering and Welding of Pobedite and Widia Plates on to Chisel Stems. D. T. Spirin (*Avtogennoe delo* (*Autogenous Practice*), **1933**, (1), 23).—[In Russian.] A description of the method of soldering on cutting edges of superhard alloys with copper as practised at the Sormovo works.—D. N. S.

The Welding of Aluminium. H. Schulz (*Illust. Z. Blechindustrie*, 1934, **63**, 261–263, 290–292).—The efficient removal of aluminium oxide is an essential condition for successfully welding aluminium, and the properties of a suitable flux are considered. Methods and extent of pre-heating, the preparation of work of various thicknesses, bench-tests for welding wire, the regulation of the oxy-acetylene flame, and of the actual welding process are briefly discussed. The possibilities of subsequent mechanical and thermal treatment are reviewed, and practical examples are described in detail.—P. M. C. R.

Electric Arc Welding of Aluminium and Hydronalium. L. Anastasiadis (*Werkstatt u. Betrieb*, 1934, **67**, (5/6), 98–101; (7/8), 138–139).—A flux is described which can be modified for use with Hydronalium. Directions are given for selecting appropriate sizes of electrode and for current strengths for the welding of 9 thicknesses of aluminium and Hydronalium sheet. A table gives the tensile strength, elongation, and in certain cases Brinell hardness of welds in both materials, and the results of X-ray examination and of corrosion tests are summarized, the effects of the latter on loss of weight, (tensile) strength, and elongation being illustrated graphically.—P. M. C. R.

***The Arc Welding of Aluminium and Some Properties of the Welded Metal.—II.** L. Anastasiadis (*Z. Metallkunde*, 1933, **25**, 285–286).—Cf. *J. Inst. Metals*, 1933, **53**, 669; and also *Met. Abs.*, this volume, p. 104.—M. H.

Arc Welding of Aluminium. W. M. Dunlap (*Elektroschweissung*, 1932, **3**, 194–195).—Long abstract from *J. Amer. Welding Soc.*, 1930, **9**, (10), 8–16; see *J. Inst. Metals*, 1931, **47**, 765.—H. W. G. H.

Gas and Arc Welds in Aluminium. G. O. Hoglund (*Machinist* (*Eur. Edn.*), 1934, **78**, 112–114).—Information of gas and arc welding of aluminium alloys as applied at the present day and data on the 2 processes are given.—J. H. W.

Arc Welded Aluminium Tanks for Chemical Storage. Anon. (*Welding J.*, 1934, **31**, 52–53).—Describes tanks made in U.S.A. from " 3 S " aluminium, by arc welding with Lincoln electrodes.—H. W. G. H.

Construction and Repair of Locomotive Copper Fire-Boxes. Anon. (*Soudeur-Coupeur*, 1933, **12**, (11), 18).—The repair of typical failures, such as cracked tube plates, is carefully described with numerous illustrations. Wherever possible, two welders work simultaneously from opposite sides of the plate to be welded. No flux is used and successive thin layers of metal are deposited. In many cases, repairs are made impossible by the severe oxidation existing in the plates. Nevertheless, the statistics of one railway company show that 1382 fireboxes were successfully repaired up to September 1933.—H. W. G. H.

Copper Chemical Still Arc Welded by New Process. W. J. Chaffee (*Welding*, 1934, **5**, 18–20).—The still columns were 28 ft. long and 18 in. diam. and the complete still was fabricated from ¼ in. thick ordinary copper by the "Long-Arc" process. This is a carbon arc process in which the arc is held 1 in. long. 40 v. at up to 600 amp. are necessary. A special welding rod containing tin and phosphorus is used, and joints of strength at least equal to that of annealed copper are obtained. The ductility is such that butt-welds will bend through 180° without showing signs of cracking.—H. W. G. H.

The Welding of Copper with the Oxy-Acetylene Flame. L. C. Percival (*Inst. Weld. Eng. Proc.*, 1932, **4**, 173–180; discussion, 181–183).—See *J. Inst. Metals*, 1932, **50**, 501.—S. G.

Lead Welding. A. J. T. Eyles (*Elect. Rev.*, 1933, **112**, 628).—Notes on materials and operation.—S. V. W.

Arc-Welding of Lead. I. I. Kachenov (*Avtogennoe delo* (*Autogenous Practice*), **1932**, (10), 11–15).—[In Russian.] Successful experiments on welding lead sheets by means of the arc instead of oxyhydrogen flame are described.—D. N. S.

Autogenous Welding of Lead and Its Alloys—Ancient and Modern. E. B. Partington, Jr. (*Inst. Weld. Eng. Proc.*, 1932, **4**, 3–22; discussion, 23–28).—See *J. Inst. Metals*, 1932, **50**, 113.—S. G.

Nickel and Its Non-Ferrous Alloys, with Special Reference to Welding. J. McNeill (*Inst. Weld. Eng. Proc.*, 1932, **4**, 57–78; discussion, 79–84).—See *J. Inst. Metals*, 1932, **50**, 384.—S. G.

Cracking of Welds [in Nickel and Monel Metal]. W. E. Warner (*Machinist* (*Eur. Edn.*), 1934, **77**, 751E).—A short article. The cracking of welds in nickel and Monel metal is often due to the materials being fragile at a temperature just below their freezing points. Re-fusion should never be started at an exposed edge, but an inch or two of cold metal should be left to bear the thermal stress. Another cause of cracking is overfluxing when the seam is first made.
—J. H. W.

Welding Symbols and the Drawing Office. F. O'Connor (*Welder*, 1933, **6**, 24–25).—An explanation and discussion of the system of symbols issued by the British Standards Institution.—H. W. G. H.

Report of Oxy-Acetylene Committee [of the International Acetylene Association]. —— (*Internat. Acet. Assoc.*, **1933**, Sept., 1–106).—Contains a brief review of welding and cutting in 1933, but is mainly devoted to a classification of oxy-acetylene welding and cutting applications with recommendations for correct practice with different materials. In the non-ferrous field, copper, brass, bronze, aluminium, nickel, and Monel metal are considered. A tabular abstract of the more widely recognized specifications in the U.S.A. is given.—H. W. G. H.

Shop Practice in Welding. W. Gibson (*Aircraft Engineering*, 1934, **6**, 20–22).—Details of acetylene welding in aircraft practice are given and special attention is paid to welding of aluminium.—H. S.

The Scientific Fundamentals of Fusion Welding. Albert Portevin (*Bull. Soc. Ing. Soudeurs*, 1933, **4**, 901–925).—See review of reprint, *Met. Abs.*, this volume, p. 112.—H. W. G. H.

Innovations and Tendencies in Fusion Welding. R. Granjon (*Bull. Soc. Ing. Soudeurs*, 1933, **4**, 876–900).—See *J. Inst. Metals*, 1933, **53**, 673; and *Met. Abs.*, this volume, p. 42.—H. W. G. H.

Carbon Arc Welding. A. Y. Stirrat (*Inst. Weld. Eng. Proc.*, 1932, **4**, 139–152; discussion, 152–153).—See *J. Inst. Metals*, 1932, **50**, 385.—S. G.

The Development of Carbon Arc Welding. K. Ruppin (*Elektroschweissung*, 1933, **4**, 233–236).—A review of German, French, Austrian, English, and American patent literature from 1885 to the present time.—H. W. G. H.

Direct Current Arc Welding With Special Reference to Magnetic Deflection of the Arc. Karl Reiter (*Welding Industry*, 1933, **1**, 271–274).—The development of modern methods of carbon arc welding is reviewed and the advantage of using a short arc is explained. The principles of the magnetically directed arc are discussed with particular reference to its effects on heat distribution in the arc, surface resistance, and magnetic disturbances.—H. W. G. H.

Application of the Arcatom Welding Process in the Building of Boilers and Containers. H. Blomberg (*A.E.G. Mitt.*, **1934**, (3), 70–73).—Examples of welded vessels are described and illustrated. Special advantages claimed for the process are the protection of materials from atmospheric and other contamination, and the applicability of the method to positions where access is difficult.—P. M. C. R.

Welding Generators. M. Mathieu (*Bull. Soc. franç. Élect.*, 1932, [v], **2**, 1081–1087; *Sci. Abs.*, 1933, [B], **36**, 110).—Certain semi-empirical formulæ relating the generator power to the section of material and the total welding time, respectively, given by M. (*ibid.*, 1928, **8**, 822–834) have been adversely criticized by Languepin. The matter is here further discussed and an appeal is made to manufacturers to furnish more detailed information for the satisfactory determination of this and allied problems. Resistance welding is principally in view.—S. G.

Seam Welding with Transformer Regulator. B. Kalkner (*A.E.G. Mitt.*, **1934**, (3), 68–71).—The welding plant described illustrates the trend of resistance welding towards operation by frequently interrupted rather than by steady current, the resulting seam being built up from a number of adjacent spot-welds.—P. M. C. R.

Welding as an Aid to Modernization of Breweries. D. S. Lloyd (*J. Amer. Weld. Soc.*, 1934, **13**, 24–29).—A brief description of the process for making beer is given in order to explain the equipment required. The various materials used are enumerated and the scope for welding in fabricating them is demonstrated. Maintenance and repair are also discussed.—H. W. G. H.

"Rightward" or Left-Hand Welding? F. Hermann (*Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens*, 1933, **8**, 18–22).—See *Met. Abs.*, this volume, p. 39.—H. W. G. H.

The Design of Jigs and Fixtures for Welding. Owen C. Jones (*Welding J.*, 1934, **30**, 278–282).—From *J. Amer. Weld. Soc.*, 1933, **12**, (8), 35. See *Met. Abs.*, this volume, p. 41.—H. W. G. H.

Tests for Trainee Welders. C. A. Oakley (*Mech. World*, 1933, **94**, 982–983).—Observations of movements show that accuracy of aim and ability to trace straight lines and curves on inclined planes form the bases of skill in welding.—F. J.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 212–217.)

***Extent of Retention of Ingested Aluminium.** E. W. Schwartze *et al.* (*J. Amer. Med. Assoc.*, 1933, **101**, 1722–1725; *Bull. B.N.-F.M.R.A.*, 1934, (**64**), 9).—The conclusions reached from experiments are that no systematic pharmacological effects can be ascribed directly to absorbed aluminium; that aluminium does not appear to be cumulative in the tissues; and that no harmful effects can be expected from soluble aluminium occurring naturally in foods or introduced by utensils into a diet of normal phosphorus content.
—S. G.

Beer Scale on Aluminium Vessels. H. Schnegg (*Z. ges. Brauw.*, 1934, **57**, 1–2, and 5–10; *J. Inst. Brewing*, 1934, **40**, 116–117).—The efficiencies of several proprietary preparations for removing scale from aluminium vessels are compared with those of various concentrations of nitric acid.—H. W. G. H.

Aluminium in the Construction of Switchgear. M. Preiswerk (*Aluminium Broadcast*, 1933, **4**, (13), 1–6).—Translated from *Schweiz. Tech. Z.*, **1933**, 220–225. See *J. Inst. Metals*, 1933, **53**, 676.—J. C. C.

Aluminium Conductors. G. Onnis (*Elettrotecnica*, 1933, **20**, 121–124; *Sci. Abs.*, 1933, [B], **36**, 333).—Bauxite is found in abundance in Italy, and experiments have been carried out in the use of nationally-produced aluminium for power cables on board ship. When bare conductors are used, aluminium compares favourably with copper, but the position is very different when the conductors are made up into armoured cables, since the greater bulk of the aluminium entails a greatly increased weight of lead sheath and armouring, which more than offsets the saving in weight due to the lightness of the conductors. Experiments were accordingly made with a cable consisting of aluminium conductors insulated with gutta-percha and armoured with Aldrey instead of the usual steel wire. No lead sheath is required in such a cable. Preliminary trials were satisfactory and gave a favourable comparison with copper conductors. Two objections, however, cannot be ignored: (1) there is the difficulty of making soldered joints in aluminium, but this can be overcome on board ship where joint boxes, fitted with terminals, can be used; (2) there is the more serious objection that aluminium is easily corroded. Conditions on board ship are favourable to corrosion, particularly at the cable terminals, where the bare conductors have to be made accessible for maintenance. Various methods for protecting aluminium have been developed experimentally, and this difficulty will presumably be overcome eventually. The general conclusion is that the subject is encouraging enough to warrant a rigorous trial under severe conditions.—S. G.

Aluminium–Steel Cables for Overhead Lines. H. Carpentier (*Rev. gén. Élect.*, 1932, **32**, 691–694; *Sci. Abs.*, 1933, [B], **36**, 118).—C. refers to methods for calculating the values of elastic modulus, temperature coeff. and density of steel-cored aluminium cable in terms of the relative cross-sections of aluminium and steel. He then gives equations for determining the relative distribution of tensile stress under load between the two metals and shows that this is, to a certain extent, dependent on conditions of manufacture. In this connection C. defines 3 temperatures: (1) manufacturing temperature; (2) equilibrium temperature, at which there is no tension in either steel or aluminium when the cable is unloaded; and (3) critical temperature, at which there is no tension in the aluminium strands when the cable is strung under the specified conditions. C. suggests that in special cases it is advisable to specify limits for the equilibrium temperature, which should preferably be in the neighbourhood of 0° C. —S. G.

Hollow-Core Bare Transmission Cable. Moss Akent (*Wire and Wire Products*, 1934, **9**, 69–74, 89–90, 92).—A description of the special machines and methods devised to produce a hollow-core bare copper transmission conductor for 290,000 v. is given. The conductors are 1·4 in. in diameter and are copper tubing made of segments tightly interlocked and laid in a spiral, producing a flexible copper cylinder with relatively thin walls and very high tensile strength and resistance to crushing.—J. H. W.

The Progress of Aluminium Lorry-Tanks. J. Bally (*Rev. Aluminium*, 1934, **11**, 2333–2338).—The specifications of aluminium lorry-tanks of various types for the transport of petrol, oil, and gas are given. The robustness of these machines is made clear from the manner in which a large tank of aluminium–manganese alloy withstood being overturned with its lorry through a distance of 5 metres without breaking.—J. H. W.

Better Gas Engines. G. D. Welty (*Metal Progress*, 1934, **25**, (4), 28–31).—Light alloys find increasing application as aero- and automobile engine parts, more on account of their advantageous effect on performance than because of the reduction in weight. Instances specially considered are the cylinder head, the crank case, and the forged light alloy piston. For the latter the alloy " 32 S " (silicon 12, magnesium 1%, remainder aluminium) is recommended. —P. M. C. R.

Pistons of Light Alloys. B. M. Tareev (*Legkie Metalli* (*Light Metals*), **1933**, (5), 29–30).—[In Russian.] Advantages and drawbacks of pistons for internal combustion engines made from light alloys are enumerated and a list of such alloys is given.—D. N. S.

The Use of Light Metals in the Electrical Industry. B. M. Tareev (*Legkie Metalli* (*Light Metals*), **1933**, (1), 17–22).—[In Russian.] An examination of the feasibility of using light metals and alloys as electrical conductors. —D. N. S.

The Use of Aluminium in Shipbuilding. N. I. Mikhailov (*Vestnik Metallopromishlennosti* (*Messenger of the Metal Industry*), **1933**, (5), 47–52).—[In Russian.] The characteristics of aluminium alloys used in shipbuilding are described.—D. N. S.

The Result of the International Competition for Aluminium Chairs. Walter Gropius (*Metallwirtschaft*, 1934, **13**, 9–11).—An illustrated description of various types of chairs made of aluminium.—v. G.

Alfol Heat Insulation. A. von Zeerleder (*Schweiz. Bauzeit.*, 1934, **103**, (4); *Bull. B.N.-F.M.R.A.*, 1934, (64), 9).—A description is given of the nature and applications of this system of aluminium foil insulation. A comparison is made of the insulating properties of Alfol with other insulating materials.—S. G.

Thermal Insulation with Aluminium Foil : " Alfol." A. Mainelli (*Alluminio*, 1934, **3**, 25–29).—The value of aluminium foil as a heat insulator is discussed and the physical characteristics of " Alfol," its technical uses and advantages, insulating power, non-inflammability, ease of application, &c., are described.—G. G.

Aluminium Paint for Exterior and Interior Use. R. Schwarz (*Aluminium Broadcast*, 1934, **4**, (21), 1–9).—Translated from *Farbe u. Lack*, **1933**, 437–438, 449–450, 463. See *Met. Abs.*, this volume, p. 47.—J. C. C.

Report of Committee B-5 [of A.S.T.M.] on Copper and Copper Alloys, Cast and Wrought. C. H. Mathewson and D. K. Crampton (*Proc. Amer. Soc. Test. Mat.*, 1933, **33**, (I), 258–261).—See *J. Inst. Metals*, 1933, **53**, 593.—S. G.

Tentative Specifications for Hard-Drawn Copper Transmission Cable (B 87–32 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 250–253).—See *J. Inst. Metals*, 1933, **53**, 169.—S. G.

Tentative Specifications for Copper-Base Alloys in Ingot Form for Sand-Castings (B 30–32 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 242–246).—See *J. Inst. Metals*, 1933, **53**, 170.—S. G.

Tentative Specifications for Sand-Castings of the Alloy : Copper 80 Per Cent. ; Tin 10 per Cent. ; Lead 10 Per Cent. (B 74–32 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 238–241).—See *J. Inst. Metals*, 1933, **53**, 171.—S. G.

Strong New Metals for Shipbuilders. W. E. Blewitt (*Metal Progress*, 1934, **25**, (4), 36–41).—The selection of suitable materials for structural, engineering, and decorative purposes is reviewed from the viewpoint of the special conditions of marine service. The composition of 3 recommended alloys for condenser tubing is given in the short discussion of problems arising from corrosion. —P. M. C. R.

Patching Fractured Tube Plates. Ewart J. Reece (*Mech. World*, 1933, **94**, 1060).—A method of repairing the fractured copper tube-plate of a locomotive boiler is illustrated.—F. J.

Gold as a Protection Against Corrosion. P. Steen and O. P. Van Steewen (*Chem. Apparatur*, 1933, **20**, Suppt., 37–39).—Owing to the high resistance of gold to oxidation and to the action of acids and alkalis, to the good adherence, small grain size, and low porosity of electrodeposited coatings, and to its high thermal coeff. of expansion gold is very suitable for plating articles for use in corrosive media if they are not subjected to wear or mechanical stresses. Methods of plating are described.—A. R. P.

Friction Bearings and Their Lubrication. Ernst Meier (*Automobiltech. Z.*, 1934, **37**, 138–142).—The causes of failure in crankshaft bearings are analyzed. The selection and testing of bearing alloys are discussed and illustrated, and the results of certain tests are tabulated for 2 lead–bronzes, 2 ordinary bronzes, and 2 bearing metals. The best results were obtained with lead–bronzes, which are recommended for use with hardened shafts; a facing of Gittermetall should be added for ordinary shafting. Further investigations are stated to be in progress.—P. M. C. R.

The Use of Lead in the Fight Against Noise. Jacques Mahul (*Aciers speciaux*, 1933, **8**, 402–410).—The nature, origins, and propagation of industrial noises and the methods commonly adopted to diminish their effect and to localize them are discussed. The application of lead sheet or foil allied to asbestos or cork for antivibration foundations in the U.S.A. are described.

—J. H. W.

Magnesium Metal for Water Treatment. H. Bach (*Gesundheitsing.*, 1933, **56**, 545–547; *Chem. Zentr.*, 1934, **105**, I, 1092).—In the purification of water, magnesium turnings can be used for the removal of excess chlorine and acidity, and for making the water alkaline up to the solubility of magnesium hydroxide.

—A. R. P.

Tentative Specifications for Magnesium-Base Alloy Castings (B 80–31 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 229–231).—See *J. Inst. Metals*, 1932, **50**, 106–107.—S. G.

Tentative Specifications for Magnesium-Base Alloy Sheet (B 90–32 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 234–235).—See *J. Inst. Metals*, 1933, **53**, 172.—S. G.

Tentative Specifications for Magnesium-Base Alloy Wrought Shapes (Other than Sheet) (B 91–32 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 236–237).—See *J. Inst. Metals*, 1933, **53**, 172.—S. G.

Tentative Specifications for Ferro–Molybdenum (A 132–31 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 166–167).—See *J. Inst. Metals*, 1931, **47**, 671.—S. G.

Tentative Specifications for Low-Carbon Ferro–Molybdenum (A 145–32 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 168–169).—See *J. Inst. Metals*, 1933, **53**, 106.—S. G.

Nickel Production, Resources, and Utilization. E. S. Moore (*Trans. Amer. Inst. Min. Met. Eng.*, 1932, **102**, 252–264).—See *J. Inst. Metals*, 1932, **50**, 569.—S. G.

Nickel and Interesting Problems of Naval Construction. Jean Galibourg (*Japan Nickel Rev.*, 1934, **2**, 53–66).—[In French and Japanese.] So far as non-ferrous materials are concerned, the following are the principal points in the article. White metals containing copper 60 and nickel 5–30% are generally employed for internal fitments, but cupro–nickels containing high percentages of nickel are preferred. Nickel–brasses are used because of their enhanced physical properties, examples of which are given. Monel metal is being increasingly used for turbine blading and other copper–nickel alloys for condenser tubing.—W. A. C. N.

Tentative Specifications for Drawn or Rolled Alloy, 80 Per Cent. Nickel, 20 Per Cent. Chromium, for Electrical Heating Elements (B 82–31 T). —— (*Amer. Soc. Test. Mat. Tentative Standards*, **1933**, 261–264).—See *J. Inst. Metals*, 1932, **50**, 107.—S. G.

chromium–nickel steel or (perhaps better) chromium-plated steel is recommended. For valves bronze, nickel–chromium, and chromium alloys can be used. Bronze is best when a non-magnetic material is required; it stands up well to hydrogen sulphide, but does not resist wear sufficiently for general purposes. Monel metal is satisfactory, but chromium-plated steel is apt to lose its protective coating in places which then begin to corrode.—A. R. P.

†**Materials for Chemical Plant.** Anon. (*Metallurgist* (Suppt. to *Engineer*), 1934, **10**, 100–102).—A review, including references to developments in special alloys, bonded sheets, &c.—R. G.

Metallic Materials in Water-Pipe Construction. L. W. Haase and E. Naumann (*Z. Gesundheitstech. Städtehyg.*, 1933, **25**, 18–24; *C. Abs.*, 1934, **28**, 1434).—A review of the advantages and disadvantages of iron, copper, lead, tin, zinc, aluminium, nickel, and chromium pipes for water.—S. G.

Metals and Alloys Used in Naval Construction. Auguste Le Thomas (*Science et Industrie*, 1934, **18**, 69–74).—A paper read before the Conference au Salon Nautique, 1933, with comments by L. Guillet. Materials are considered from the viewpoint of structure, working stresses, corrodibility, and limitations imposed by service conditions. The non-ferrous alloys especially discussed are certain light alloys, α and β brasses, 80 : 20 and 70 : 30 cupro–nickels, and (by Guillet) "aluminium–bronze." The corrosion phenomena of the brasses receive special notice.—P. M. C. R.

XXII.—MISCELLANEOUS

(Continued from pp. 217–218.)

†**The Principles of Planning and Erection of a Works for Treating Light Metals.** S. M. Yampolsky (*Legkie Metalli* (*Light Metals*), **1933**, (5), 5–8).—[In Russian.] Conclusions, based on the practical experience of building a big works for treating light alloys, are discussed. Directions and advice are given on the design and erection of subsequent similar works in the U.S.S.R.—D. N. S.

Our Present Knowledge of Casters' Fever. H. Safir (*Veröff. Gebiete Medizinalverwaltung*, 1932, **38**, 599–628; *Bull. B.N.-F.M.R.A.*, 1934, (**64**), 11).—S. surveys the present knowledge of the condition variously known as brass-founder's ague, casters' fever, spelter shakes, zinc fever, or metal fume fever. Information is presented under the headings of: history, technique of casting, clinical aspects, pathogenesis, therapy, prevention. There is a long *bibliography* which does not, however, make reference to the work of Drinker and his collaborators at the Harvard School of Public Health.—S. G.

Metallurgical Problems of Quantity Production. E. C. Dickinson (*J. Trans. Junior Inst. Eng.*, 1932, **42**, 49–56).—In quantity production the metallurgist is principally concerned with ensuring that the metals chosen and received are suitable for use. His attention is primarily concentrated on a particular product and he must follow it through all its phases of manufacture. The aspects mainly dealt with are (1) choice of material; (2) inspection of incoming materials; (3) heat-treatment; (4) manufacturing difficulties; (5) post-mortem examinations; (6) research; (7) methods of testing.—W. A. C. N.

Electrical Power in Metallurgical Works. H. Bauer (*Elektrotech. Z.*, 1933, **54**, 1008–1009).—Electrical apparatus developed during the past year is briefly described.—B. Bl.

Recent Advances in Non-Ferrous Metallurgy. Chemical Engineering Aspects. Anon. (*Indust. Chem.*, 1933, **9**, 411–413).—Brief notes are given on beryllium–copper, oxygen-free high-conductivity copper, electro-sheet copper, nickel alloys, Silal and Nicrosilal, tellurium–lead, new aluminium alloys, protection of magnesium against corrosion, electrodeposition of metals, creep of metals, and corrosion-fatigue.—E. S. H.

The Non-Ferrous Metal Manufacturing Industries of Australia. Clement Blazey (*Chem. Eng. Mining. Rev.*, 1933, **25**, 29–33).—A brief review of the situation of the non-ferrous industries in Australia and of the principal works where rolling, drawing, and extrusion of non-ferrous metals are, or have been, carried on.—J. H. W.

Historical Aspects of Mining and Metallurgical Engineering. Thomas T. Read (*J. Eng. Education*, 1933, **24**, 229–258).—Three lectures delivered at the Summer School for Engineering Teachers, University of Wisconsin, July 1933. A historical survey of developments in metallurgical processes.
—P. M. C. R.

The German Research Institute. Carl Wittmann (*Aircraft Eng.*, 1933, **5**, 121–125 and 137).—A description of the Deutsche Versuchsanstalt für Luftfahrt (D.V.L.) at Berlin-Adlershof. About half a page is occupied by a brief account of the work and scope of the materials department.—H. S.

The Shipping, Engineering, and Machinery Exhibition at Olympia. Anon. (*Mech. World*, 1933, **94**, 855–880, 892–899).—The various exhibits, including instruments and meters, testing-machines, cutting and welding, alkaline storage cells (nickel–cadmium), metals, and heat-treatment furnaces, are described *seriatim*.—F. J.

S.A.E. Standards Committee Acts. Anon. (*Automotive Ind.*, 1933, **68**, 116, 123).—A summary of the revised specifications issued by the Standards Committee of the Society of Automotive Engineers, U.S.A.—P. M. C. R.

Report of Committee E–8 [of A.S.T.M.] on Nomenclature and Definitions. Cloyd M. Chapman and R. E. Hess (*Proc. Amer. Soc. Test. Mat.*, 1933, **33**, (I), 496–499).—See *J. Inst. Metals*, 1933, **53**, 536.—S. G.

Report of Committee E–9 [of A.S.T.M.] on Research. H. F. Moore and C. L. Warwick (*Proc. Amer. Soc. Test. Mat.*, 1933, **33**, (I), 500–502).—See *J. Inst. Metals*, 1933, **53**, 534.—S. G.

The Place of Research in Industry. F. B. Jewett (*Proc. Amer. Petrol. Inst.*, **1931**, Sect. III, 27–33; and *Bell Telephone Labs. Pubn.*, **1932**, March, 1–14).—S. G.

Report of Committee E–10 [of A.S.T.M.] on Standards. T. R. Lawson and C. L. Warwick (*Proc. Amer. Soc. Test. Mat.*, 1933, **33**, (I), 503–508).—See *J. Inst. Metals*, 1933, **53**, 537.—S. G.

XXIII.—BIBLIOGRAPHY

(Continued from pp. 219–222.)

(Publications marked * may be consulted in the Library.)

Abegg, R., Fr. Auerbach, und J. Koppel. Herausgegeben von. *Handbuch der anorganischen Chemie.* In 4 Bänden. Band 4, Abt. 3, Teil 3, Lieferung 1.—*Kobalt und seine Verbindungen.* Pp. xvi + 626. 1934. Leipzig: Hirzel. (M. 58.)

***Aizawa, T., and T. Osanai.** *On Lead Alloys for Cable Sheaths.* (Part II.) [In Japanese, with brief English summary.] (Researches of the Electrotechnical Laboratory, No. 346.) 4to. Pp. 32, with numerous illustrations. 1933. Tokyo: Electrotechnical Laboratory.

***Aluminum Company of America.** *Aluminum in Architecture.* Demy 8vo. Pp. 234, illustrated. 1932. Pittsburgh, Pa.: Aluminum Company of America. ($1.00.)

American Institute of Mining and Metallurgical Engineers. *Year-Book.* Pp. 105. 1934. New York: The Institute.

American Iron and Steel Institute. *Year-Book.* Pp. 221. 1933. New York: The Institute, 75 West St.

American Society for Testing Materials. *A.S.T.M. Standards on Preservative Coatings for Structural Materials (Paints, Varnishes, Lacquers, and Paint*

Materials). Pp. 350. 1933. Philadelphia, Pa.: The Society, 1315 Spruce St. ($1.25.)

[Contains 92 standard and tentative standard specifications, methods of test and definitions issued by the A.S.T.M. This group is compiled in a separate single publication for the first time.]

***American Society for Testing Materials.** *Book of A.S.T.M. Standards.* Issued Triennially. Med. 8vo. Part. I.—*Metals.* Pp. xx + 1002, illustrated. Part II.—*Non-Metallic Materials.* Pp. xxvii + 1298, illustrated. 1933. Philadelphia, Pa.: The Society, 1315 Spruce St. (Cloth, $7.50; half-leather, $9.00, per part.)

Austin, R. G. *Aids to Qualitative Inorganic Analysis.* With an Introduction by R. H. A. Plimmer. Pp. x + 204. 1933. London: Baillière, Tindall and Cox. (3*s.* 6*d.*)

***Belaiew, N. T.** *La Cristallisation des Métaux.* Conférences de Métallurgie faites à l'École Royale des Mines, Collège Impérial, sous les auspices de l'Université de Londres. Traduit de l'anglais par **G. R. Delbart.** Revu et mis à jour par N. T. Belaiew avec la collaboration de Mlle. L. Bloch-Sée. Préface de Henry Le Chatelier. Demy 8vo. Pp. 128, with 75 illustrations. 1934. Paris: Institut de Soudure Autogène, 32 Boulevard de la Chapelle. (20 francs.)

Bennett, H. *The Chemical Formulary.* Volume I. Pp. 595. 1933. Brooklyn, N.Y.: The Chemical Formulary Co., 950 Third Avenue. ($6.00.)

[The contents range over a very large field, from matters of technical interest (such as sections on plating, and on polish, abrasives, and metal cleaners) to those of the most homely domestic nature.]

Berl, Ernst, und **Georg Lunge.** *Chemisch-technische Untersuchungsmethoden.* Herausgegeben von **Ernst Berl.** Band 5. 8., umgearb. u. verm. Auflage. Pp. xlvii + 1640. 1934. Berlin: Julius Springer. (Lw. M. 136.)

Bernstein, G. D., and **N. P. Aristow.** *Technology of Metals.* Volume I.—*Metallurgy of Black and Coloured Metals.* [In Russian.] Pp. 380. 1933. Moscow: MAI. (Rbl. 8.)

Briscoe, H. V. A., J. H. Jones, and **C. B. Marson.** *An Investigation of the Accuracy of Routine Analytical Determinations on Coal and Coke.* (Department of Scientific and Industrial Research. Fuel Research. Physical and Chemical Survey of the National Coal Resources, No. 29.) Pp. vi. + 38. 1933. London: H.M. Stationery Office. (9*d.*)

British Cast-Iron Research Association. *Recommended Methods for Sampling and Analysis of Cast Ferrous Metals and Alloys.* (B.C.-I.R.A. Special Publication No. 1.) Pp. 44. 1933. Birmingham: The Association. (10*s.* 6*d.*)

***British Chemical Abstracts.** *Collective Index of British Chemical Abstracts (A) Pure Chemistry and (B) Applied Chemistry 1923–1932, including the Abstracts Published with the Journal of the Chemical Society and the Journal of the Society of Chemical Industry during 1923–1925.* Part I.—*Index to Authors, A–K.* Pp. 1–1092; *L–Z.* 1093–2101. 4to. 1934. London: Bureau of Chemical Abstracts, 46 Finsbury Sq., E.C.2. (Members, £4 3*s.* 6*d.*; non-members, £8 for names and subjects index complete.)

British Industrial Gases, Ltd. *British Industrial Gases Manual of Oxy-Acetylene Welding and Cutting.* Pp. 128. London: British Industrial Gases, Ltd., 34 Victoria St., S.W.1. (1*s.* 6*d.*)

Brunnckow, Wilhelm. *Pressen von Nichteisenmetalle.* 8vo. Pp. 20. 1934. Berlin: VDI-Verlag G.m.b.H. (M. 1.60; VDI members, M. 1.45.)

Burton, E. F. Edited by. *The Phenomenon of Superconductivity.* 8vo. Pp. 112. 1934. Toronto: University of Toronto Press; London: Oxford University Press (Humphrey Milford). (8*s.* 6*d.* net.)

Cambridge University Press. *A Catalogue of Books Published by the Cambridge University Press.* Pp. xiv + 322. 1934. London: Cambridge University Press.

***Canada, Dominion of.** *Sixteenth Annual Report of the National Research Council 1932–1933.* Roy. 8vo. Pp. 113. [1934.] Ottawa: National Research Council.

Cazaud, R. *Métallurgie.* (Agenda Dunod.) Pp. 354. 1933. Paris: Dunod. (20 francs.)

Deutsche Gesellschaft für Metallkunde. Herausgegeben von der. *Nachtrag VI zum Werkstoffhandbuch "Nichteisenmetalle."* DIN A5. Pp. 33. 1934. Berlin: Beuth-Verlag G.m.b.H. (R.M. 2.20.)

***Dow Chemical Company.** *Dowmetal: Properties—Shop Practice—Specifications—Availability.* 8½ in. × 11 in. Pp. 67, illustrated. 1934. Midland, Mich.: The Dow Chemical Co. ($1.00.)

***Dow Chemical Company.** *Dowmetal Laboratory Methods. Physical and Mechanical Testing—Metallography—Chemical Analysis.* 8½ in. × 11 in. Pp. 35, illustrated. 1933. Midland, Mich.: The Dow Chemical Co.

Duckworth, E. H., and **R. Harries.** *The Laboratory Workshop.* Pp. 246. 1933. London: George Bell and Sons, Ltd. (10*s.*)

[This book contains a remarkably large amount of information likely to be of value to anyone engaged in experimental work. The section dealing with materials—how they are sold and where they may be obtained—is particularly useful, and for this alone the book might well find a place in any laboratory.—*Bull. B.N.-F.M.R.A.*]

***Durrer, R.** *Die Metallurgie des Eisens.* (Aus Gmelins Handbuch der anorganischen Chemie. Achte völlig neubearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft.) Med. 8vo. Pp. vii + 423–1166, with 410 illustrations. 1934. Berlin: Verlag Chemie, G.m.b.H. (Steif Kartoniert R.M. 32; geb. R.M. 36, post free inland.)

***Elbourne, Edward Tregaskiss.** Assisted by Kenneth B. Elbourne and P. J. Amer. *Fundamentals of Industrial Administration. An Introduction to Industrial Organization, Management, and Economics.* Demy 8vo. Pp. xviii + 644, with 53 illustrations. 1934. Macdonald and Evans, 8 John St., Bedford Row, W.C.1. (12*s.* 6*d.* net.)

Englefield, E. *A Short History of Pewter.* Pp. 85. 1933. London: Brown and Englefield, Little James St., Gray's Inn Rd. (3*s.* 6*d.*)

Filippow, K. W. *Technology of Metals.* [In Russian.] Pp. 274. 1933. Leningrad: Isdat. Kubutsch. (Rbl. 4.50.)

Fowle, F. E. *Smithsonian Physical Tables.* Eighth, revised edition. Pp. 682. 1933. Washington, D.C.: Smithsonian Institution. (18*s.*)

Gaertner, ——. *Elektrochemie. Ein Lehr- und Hilfsbuch für Studierende, Techniker und Fabrikanten.* Pp. 408. Wien und Leipzig: Deutscher Verlag für Jugend und Volk. (Ganzleinen, R.M. 20.)

Gajew, I. S. *Testing of Metals.* [In Russian.] Pp. 368. 1933. Leningrad: Isdat. Kubutsch. (Rbl. 4.50.)

Garner, Walter. *Industrial Microscopy.* A Book Dealing with the Use of the Microscope and the Preparation of Specimens for all who Use the Microscope in Industry. 8vo. Pp. vi + 389, illustrated. 1933. London and New York: Sir Isaac Pitman and Sons. (21*s.*; $5.00.)

Glasstone, S. *Recent Advances in Physical Chemistry.* Second edition. Pp. 498. London: J. and A. Churchill. (15*s.*)

***Great Britain.** *Final Report on the Fourth Census of Production (1930).* Part II.—*The Iron and Steel Trades; The Engineering, Shipbuilding,* *and Vehicle Trades; The Non-Ferrous Metal Trades.* Med. 8vo. Pp. xviii + 506. 1934. London: H.M. Stationery Office. (7*s.* 6*d.* net.)

[Under the heading of "The Non-Ferrous Metal Trades" are included: General Report; The Copper and Brass Trade (Smelting and Rolling, &c.); The Aluminium, Lead, Tin, &c. Trade (Smelting, Rolling, &c.); The Gold and Silver Refining Trade; The Finished Brass Trade; The Plate and Jewellery Trade; and The Watch and Clock Trade.]

***Gregg, J. L.** *The Alloys of Iron and Tungsten.* (Alloys of Iron Research Monograph Series.) Med. 8vo. Pp. xii + 511, with 184 illustrations. 1934. New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd. (36*s.* net.)

[Includes a bibliography of 558 references.]

***International Advisory Committee for Carbide and Welding Technique.** *Encyclopædia of Oxy-Acetylene Welding.* Volume 4.—*Welding of Non-Ferrous Metals.* 8¼ in. × 11¾ in. Pp. xvi + 80, illustrated. [1934.] London: The Acetylene and Welding Consulting Bureau, Ltd., 637–638 Grand Buildings, Trafalgar Sq., W.C.2. (10*s.*)

King, A., and **J. S. Anderson.** *Chemical Calculations: Their Theory and Practice.* 8vo. Pp. x + 181. 1933. London: T. Murby and Co. (4*s.* 6*d.*)

King, B. T. *Introducing the 19th Edition of Patents and Trade Marks.* 1934. London: King's Patent Agency, Ltd.

Krapiwin, S. G. *Quantitative Analysis.* [In Russian.] Fourth Edition. Part I. Pp. ii + 110. 1933. Moscow and Leningrad: Goschimtechisdat. (Rbl. 1.50.)

Krause, Hugo. *Rezepte für die Maschinen- und Metallwaren-Industrie.* (Bibliothek des gesamten Technik, Nr. 370.) 3., verbesserte Auflage. 8vo. Pp. 232. 1934. Leipzig: Max Jänecke. (nn. M. 4.50; Lw. M. 6.)

Krohnke, O., und **L. Stiegler.** *Entstehung und Verhütung der Korrosion an Heizungs- und Warmwasserbereitungsanlagen.* Pp. 152. 1933. Halle: Industrie-Verlag Carl Haenchen. (M. 5.)

Lea Manufacturing Company. *Buffing and Polishing Methods.* Med. 8vo. Pp. 56. Waterbury, Conn.: Lea Manufacturing Co. (Gratis.)

Lincoln Electric Company. *Design for Arc Welding. Second Lincoln Arc Welding Prize Competition Papers.* Edited by A. F. Davis. Cleveland, O.: Lincoln Electric Co.; London: Buck and Hickman, Ltd. (17*s.* net.)

Lloyd, P. *Theory of Industrial Gas Heating.* With a Foreword by S. Lacey. Pp. x + 104. 1933. London: W. King, Ltd. (6*s.*)

Lowe, F. *Optische Messungen des Chemikers und Mediziners.* 2 Auflage. Pp. 194. 1933. Dresden und Berlin: Theodor Steinkopf. (Geh., M. 9; geb., M. 10.)

McPhail, G. *Quantitative Chemical Analysis.* Third edition, revised and enlarged. Pp. xii + 199. 1933. New York: Macmillan Co.; London: Macmillan and Co. (12*s.*)

Mellor, J. W. *A Comprehensive Treatise on Inorganic and Theoretical Chemistry.* Volume XIII.—Fe (Part II). Med. 8vo. Pp. ix + 948, with 381 illustrations. 1934. New York: Longmans, Green and Co. ($20.00.); London: Longmans, Green and Co. (63*s.* net).

***Metal Statistics.** *Metal Statistics,* 1934. Twenty-Seventh Annual Edition. Post 8vo. Pp. 544. 1934. New York: American Metal Market. ($2.00.)

[In addition to general information, statistics are given regarding: *Iron and Steel*; *Fuels*; *Aluminium:* Canadian exports; exports; imports; N.Y. prices; U.S. production; scrap prices; U.S. secondary production; stocks of bonded aluminium; world production; *Antimony:* U.S. consumption; prices 1898–1910; imports; U.S. production; N.Y. prices; stocks of bonded antimony; world production; *Copper:* brands; prices; U.S. and world's consumption; exports; imports; production; scrap prices; U.S. secondary production; sellers; shipments; stocks; uses; world consumption and production; *Copper, Brass, and Bronze Products:* deliveries; price changes; exports; imports; *Lead:* analyses; prices; brands; U.S. and world's consumption; exports; imports; producers; U.S. and world's production; shipments; stocks; *Nickel:* production of by-product nickel; imports; exports; prices; Canadian production and exports; *Platinum metals:* U.S. and world production; imports and exports; consumption; prices; stocks; *Silver:* brands; U.S. consumption and imports; U.S. and world production; prices; shipments; stocks; *Tin:* analyses; consumption; deliveries; imports; prices; production; scrap prices; stocks; supplies, &c.; *Zinc:* analyses; brands; concentrate prices; consumption; exports; imports; grades; prices; U.S. and world's production; scrap prices; U.S. secondary production; stocks; world's consumption; retorts in operation, by years; *Gold:* prices; world's production; *Magnesium:* U.S. prices, imports and consumption; *Quicksilver:* U.S. production; N.Y. prices; imports.]

***Möller, Hermann,** und **Josef Barbers.** *Über die röntgenographische Messung elastischer Spannungen.* (Mitteilungen aus dem Kaiser-Wilhelm-Institut zu Düsseldorf. Herausgegeben von Friedrich Körber. Abhandlung 247.) 8¼ in. × 11¾ in. Pp. 21–31, with 24 illustrations. 1934. Düsseldorf: Verlag Stahleisen m.b.H.

***Nickel-Informationsbüro G.m.b.H.** *Nickel–Chrom.* I. Teil: *Korrosionsbeständige Nickellegierungen.* (Nickel-Handbuch.) 5¾ in. × 8¼ in. Pp. iv + 60, with 24 illustrations. [1934.] Frankfurt a. M.: Nickel-Informationsbüro G.m.b.H.

Partington, J. R. *A Text-Book of Inorganic Chemistry.* Fourth Edition. Pp. 1070. 1934. New York: Macmillan Co. ($4.25); London: Macmillan and Co. (15*s.*).

Piping. *Industrial Piping. A Case of Proven Practices and Methods.* Pp. 286. 1933. Chicago: Engineering Publications, Inc. ($3.50.)

Prideaux, E. B. R. *Phosphorus.* (A Text-Book of Inorganic Chemistry. Edited by J. Newton Friend. Volume VI, Part II.) Pp. xxviii + 238. 1934. London: Charles Griffin and Co., Ltd. (18*s.*)

Rakowski, A. W., E. F. Krause, and **A. E. Bogomolow.** *Text-Book of General and Inorganic Chemistry.* Volume I. [In Russian.] Pp. 420. 1933. Moscow and Leningrad: Goschimtechisdat. (Rbl. 7.)

Reilly, J., and **W. N. Rae.** *Physico-Chemical Methods.* Second edition. Pp. 822. 1933. London: Methuen and Co., Ltd. (42*s.*)

Roches, Camille. *Le matériel des industries chimiques.* Pp. 388. 1934. Paris: J.-B. Baillière et fils. (Broché, 80 francs; relié, 95 francs.)

***St. John, Ancel,** and **Herbert R. Isenburger.** *Industrial Radiography.* Med. 8vo. Pp. ix + 232, with 70 illustrations in the text and 6 charts. 1934. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. (21*s.* 6*d.* net.)

[Contains a bibliography of 426 references.]

Schmidmer, Ernst. *Ein Beitrag zur Statischen und dynamischen Härteprüfung.* (Forschungsarbeiten über Metallkunde und Röntgenmetallographie. Herausgegeben von Maximilian Frhr. v. Schwarz. Folge 5.) 8vo. Pp. 102. 1933. München und Leipzig: Fritz und Joseph Voglrieder. (R.M. 4.50.)

v. Schwarz, (Frhr.) M., und **Oskar Summa.** *Praktische Auswertungshilfsmittel für Feinstrukturuntersuchungen.* (Forschungsarbeiten über Metallkunde und Röntgenmetallographie. Herausgegeben von Maximilian Frhr. v. Schwarz. Folge 6.) 8vo. Pp. 40. 1933. München und Leipzig: Fritz und Joseph Voglrieder. (R.M. 12.)

Scott, L. G. *Electrodeposition of Metals.* London: The Printing Industry Research Association.

***Siebel, Erich,** und **Egon Osenberg.** *Über den Einfluss der Reibung und der Querschnittsabmessungen auf den Materialfluss beim Walzen.* (Mitteilungen aus dem Kaiser-Wilhelm-Institut zu Düsseldorf. Herausgegeben von Friedrich Körber. Abhandlung 248.) 8¼ in. × 11¾ in. Pp. 33–50, with 45 illustrations. 1934. Düsseldorf: Verlag Stahleisen m.b.H.

Society of Automotive Engineers. *S.A.E. Handbook, 1933.* Pp. 733. 1933. New York: The Society, 29 W. 39th St.

[Contains, among other matters, the S.A.E. specifications for non-ferrous materials, accounts of protective coatings for aluminium and of nickel and chromium plating, and numerical data on extruded aluminium alloy structural shapes. The sections mentioned form, however, only a small part of the book, which deals with every aspect of the materials used in automobile construction, maintenance, and operation.]

Starck, H. P. *Volumetric Analysis.* 8vo. Pp. viii + 228. 1934. London: Baillière, Tindall and Cox. (7*s.* 6*d.*)

***U.S. Department of Commerce, Bureau of Standards.** *Marking of Gold Filled and Rolled Gold Plate Articles Other than Watch Cases.* Commercial Standard CS 47–34. Demy 8vo. Pp. 9. 1934. Washington, D.C.: Government Printing Office. (5 cents.)

***U.S. Department of Commerce. Bureau of Standards.** *Standards and Specifications for Metals and Metal Products.* Nationally Recognized Standards and Specifications for Ores, Metals, and Manufactures Except Machinery, Vehicles, and Electrical Supplies. (Miscellaneous Publication. No. 120.) Imp. 8vo. Pp. xi + 1359, with 1144 illustrations. 1933. Washington, D.C.: Superintendent of Documents. (Buckram, $3.00.)

[A most valuable collection, in full or in abstract, of the standard specifications dealing with metals issued by nationally recognized bodies in the United States. This volume should be in every reference library.]

***West, Clarence J.,** and **Callie Hull.** Compiled by. *Industrial Research Laboratories of the United States, including Consulting Research Laboratories.* Fifth edition. (Bulletin of the National Research Council, No. 91.) Sup. Roy. 8vo. Pp. 223. 1933. Washington, D.C.: National Research Council of the National Academy of Sciences. ($2.00.)

[This most useful publication contains information regarding 1575 industrial and consulting laboratories. Laboratories connected with federal, state, or municipal governments or with educational institutions have been excluded, although they are frequently engaged on investigations of industrial problems. Particulars given include name and address of the laboratory, personnel (the name of the chief of the research staff being included in the majority of the cases) and the nature of the research problems on which the laboratory is engaged. Indexes of geographical distribution and of subject classification of the activities of the laboratories complete the volume.]

Wiersma, E. C. *Eenige onderzoekingen over paramagnetisme.* Pp. 122. Den Haag: M. Nijhoff. (3.60 guilders.)

Worden, E. C. *United States Chemical Patents Index, 1915–1924.* Volume III.—*Index of Subjects F, G, H, I, J, K, and L.* Pp. 1004. 1933. Volume IV.—*Index of Subjects M, N, O, P, Q, and R.* Pp. 1132. 1934. New York: Chemical Catalog Co., Inc. ($25.00 per volume.)

Wright, Milton. *Inventions, Patents, and Trade Marks—Their Protection and Promotion.* Demy 8vo. Second Edition. Pp. 310. 1933. New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd. (15*s.* net.)

NEW PERIODICAL

Metals Technology. First issue. January, 1934. American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York. Contains the Technical Publications issued heretofore as separate copies. Published twice quarterly. Subscription price, $7.00 per annum, Canadian and Foreign postage 50 cents extra; single copies, $1.00.

XXIV.—BOOK REVIEWS

(Continued from pp. 222–224.)

A Manual of Foundry Practice. By J. Laing and R. T. Rolfe. Pp. vii + 276, with 150 illustrations. 1934. London: Chapman and Hall, Ltd. (15*s.* net.)

During the last two decades there has been a vital movement in foundry practice from empiricism to scientific control. The old rule-of-thumb methods have, in part, given place to others, more ordered and based on careful investigation; where they still remain they are in a new guise, retained because their fundamental soundness has withstood the test of rigid proof. This changing aspect of foundry work has, in a great measure, outstripped the written word, and it is only within the last two or three years that books describing modern practice have started to appear. Of these the one under present review is an example.

The book is intended for the instruction of all, from the student to the foundry manager. It deals first with basic principles, and proceeds to expound the most advanced technique; yet in no part can it be said to be of an elementary character, for from first to last a certain amount of prior knowledge is presupposed. In this sense the book would be of less service to the actual founder—the man who does the job—than to the student or to the trained metallurgist or engineer.

In the Preface it is claimed that the methods described are those embraced in modern British practice. This claim is made good; but one has a feeling that in some cases Continental or American practice might be ahead of ours, and that, where this is so, it would not have been out of place to include or mention it. It is often complained that references to British practice are not made in foreign publications; it is equally, if not more, fatal to be similarly insular ourselves.

The greater part of the book is given over to moulding technique. The next greater part is devoted to ferrous alloys. Only 15 pages are taken up with non-ferrous founding. Perhaps this is because of the authors' opinion that " non-ferrous founding differs from that of iron in the much greater value of the material, and the consequent diminished thickness of the castings. Moulding thus requires greater care, but, owing to the smaller variation in size and shape of the casting, it scarcely requires the same initiative." This does not excuse the authors from giving such meagre information about non-ferrous metals and alloys and their use in castings, the advance in the use of which is probably greater than that of iron or steel.

In one other direction it seems that the book is ill-balanced. We have already mentioned the authors' intention in writing the book—to expound the greater scientific basis of modern foundry work. It must be remembered, however, that the latter does not entirely consist of moulding. Greater progress has been made in the study of alloys than in the latter. But the two are interdependent. and for the best work consideration must be given to both In this book, however, the attention given to alloys is not of the best, nor is the enquirer referred to other treatises where he may find more detailed information. The iron–carbon diagram is, indeed, explained. but in language understood only by the man trained in such work, and its incidence to foundry work is not clearly dealt with. As for equilibrium diagrams of non-ferrous alloys, there is but one, and that of some antiquity.

Despite these criticisms, however, there is much to commend the book. It is, moreover, clearly printed, and the diagrams, illustrations, and photomicrographs are well done.

—W. A. C. Newman.

Formerei und Giesserei. Von A. Velten. (Spanlose und spanabhebende Formung in Maschinenfabriken. Die Arbeitung der Metalle durch Giessen, Schmieden, Schweissen, Härten, und durch Werkzeuge und Werkzeugmaschinen. A.—Spanlose Formung der Metalle in Maschinenfabriken durch Giessen, Schmieden, Schweissen, und Härten. Band I. Med. 8vo. Pp. 148, with 254 illustrations. 1933. Leipzig: Max Jänecke. (R.M. 3.20.)

This is the tenth edition of this small book, which is in itself a testimony to its utility and general acceptance. Advantage has been taken of republication to revise and extend the contents very considerably. The central idea still kept in mind has been to provide the young engineer with a concise explanation of foundry processes. The particular volume deals with the methods of forming metals and alloys by melting and casting, and is divided into three main sections, dealing, respectively, with iron, steel, and non-ferrous castings. In each section a comprehensive exposition of moulding, melting, types of furnaces, and methods of pouring the metal into the moulds is given. Especial attention is paid to the characteristics of suitable moulding sands and to their preparation, and also to the making of different types of cores. Although the portion of the book which deals directly with non-ferrous work is comparatively small, there is much throughout the other parts which is applicable; but perhaps the worst feature is the brevity with which descriptions of the properties of non-ferrous materials have been attempted. The thumb-nail sketches given are not nearly adequate, and may, in some cases, actually be misleading. A special description of pressure and die-casting is included. Throughout the book the diagrams and illustrations are clear, and at the end there are some special photographic reproductions of modern machines for foundry work.—W. A. C. Newman.

Mitteilungen aus dem Giesserei-Institut der Technischen Hochschule, Aachen. Herausgegeben von E. Piwowarsky. Dritter Band. 1934. Aachen: Achener Verlags- und Druckerei Gesellschaft.

This is a collection of reprints of 29 papers on foundry subjects published by Dr. Piwowarsky and his collaborators in various technical journals during 1932 and 1933. The papers are printed in the type and style of the journal in which they were published, and the pages are numbered as in the original; one paper is written in French and one in English, the remainder in German. Only one paper, that by Nipper on the gas absorption of cast aluminium alloys, has any non-ferrous interest. To the general foundryman, and more particularly to those interested in casting iron and steel alloys, this collection of papers should prove very useful, since it saves reference to a large number of periodicals, and the papers contain much valuable practical information of recent developments and improvements in foundry technique.—A. R. Powell.

Technologie des Aluminiums und Seiner Leichtlegierungen. Von Alfred von Zeerleder. Med. 8vo. Pp. 289, with 204 illustrations. 1934. Leipzig: Akademische Verlagsgesellschaft m.b.H. (R.M. 14.)

Recent years have seen a number of important additions to the literature of aluminium and its alloys, and the needs of the specialist are now fairly well catered for. The present little volume makes no claim to compete with these larger works, but aims rather at bringing the merits and properties of light alloys to a wide circle of potential users. To force within a space of 250 pages a complete account of the technology of the metal and its alloys has required drastic compression, but even so there is much of interest in this book for the specialist, and it should prove most valuable to those less well informed on the subject.

Although the scope of the book is wide, perhaps its greatest interest lies in the excellent account it contains of the various processes of fabrication. The first two chapters, which deal with the reduction process and constitutional theory, are too brief and superficial to be of any value, but the ensuing chapters, taken as a whole, give a remarkably complete, concise, and up-to-date review of the properties, fabrication, and treatment of light alloys, including protection from corrosion. They show what can be done with aluminium and how to do it, and in these respects we know of no corresponding work in the English language.

To those, therefore, to whom the language is no bar, Dr. von Zeerleder's book can be heartily commended, and we might add that his style is so extremely lucid, and the elucidation of the text so admirably assisted by numerous clear illustrations, that the book should be intelligible even to those possessing but the minimum knowledge of the language. It is not free from minor errors and inaccuracies, but these will no doubt be corrected in future editions.—A. G. C. Gwyer.

La Fonderia D'Alluminio. By Carlo Panseri. Roy 8vo. Pp. xvi + 582, with 307 illustrations. Milano: Ulrico Hoepli 1934. (L. 65.)

The author of this book on the founding of aluminium and light alloys is well known by his numerous papers and researches on metallurgical subjects, especially light alloys, and here he sets out his wide knowledge of the subject for the benefit of workers in the light alloy foundry. It is not only a technical book, but a scientific work in the widest sense of the word, since the technique involved in the production of sound castings of aluminium and its alloys is elaborated in the light of the most modern and comprehensive metallographic science. The first part deals with the most important aspects of metallography (crystal structure, equilibrium diagrams, the melting and freezing of alloys, thermal analysis, formation of dendrites, segregation) as applied to aluminium alloys. The scientific facts are well combined with practical details, and this feature, which is the most important and really excellent characteristic of the book, becomes more and more evident in the following chapters, in which the mechanical properties, resistance to corrosion, heat-treatment, control of castings, &c., are described. The second part of the book deals with the various foundry aluminium alloys, for general use, for resistance to corrosion, and for heat resistance (piston alloys). The third and fourth parts are of a more practical character and discuss the technical problems of the foundry, from melting furnaces to moulding technique, and the refining of aluminium alloys. There is a useful appendix on standards of the A.S.T.M. and B.S.I. The book contains also much hitherto unpublished material which should be of great interest for the research worker, *e.g.*, a table with the Mylius values for numerous aluminium alloys Throughout the book the descriptions are accurate and concise, and many excellent photomicrographs are reproduced; the printing leaves nothing to be desired, and the paper and illustrations are of high quality.

The book should be much appreciated by all who are acquainted with aluminium alloys in the works, foundries, or laboratories, as it is a very well written treatise on metallography and founding technique of all the most interesting alloys of aluminium.—G. Guzzoni.

The Alloys of Iron and Tungsten. By J. L. Gregg. (Alloys of Iron Research, Monograph Series.) Med. 8vo. Pp. xii + 511, with 184 illustrations. 1934. New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd. (36*s.* net.)

This is the third volume of the monograph series, the first being "The Alloys of Iron and Molybdenum" (1932) and the second "The Alloys of Iron and Silicon" (1933).

The very heavy task of collecting in one volume, and in systematic form. the published data on the alloys of iron and tungsten has been carried out very thoroughly. The book is more in the nature of a dictionary than a text-book, and as such will be of considerable value to all engaged in research on special steels, and to many requiring specific information on these particular alloys. It is evident, however, that there is a great deal of work yet to be done to complete our knowledge of these alloys.

The book is divided into chapters dealing with, first, the binary and then the ternary alloys of iron, tungsten, and carbon, constitution, properties, and preparation being dealt with in each case. About half the book is devoted to various aspects of the structure and uses of the special tungsten steels. The book can be strongly recommended for what it is, namely a summary of published work. One could have wished that it was presented in a more critical manner, and one feels that the author himself is not expert in certain fields but leaves the reader to discriminate between the results and opinions of the different authors quoted. This feeling is enhanced by the frequent references to "private communication" and "according to —— in conversation."

The sections dealing with constitution are invariably excellent. Those dealing with the more practical aspects of preparation and manufacture are much weaker. For example, the manufacture of pure tungsten for electric lamps is described in detail, but the methods actually used for making tungsten for steel-making are merely outlined. Again, the manufacture of tungsten steels is completely dismissed in about a dozen pages. Some of the data might be more conveniently arranged. On p. 140 there are three tables of analyses of ferro-tungsten, one arranged horizontally and two vertically, and even in these the order of the elements is changed. It is almost impossible to compare the results in the different tables.—C. J. SMITHELLS.

Die Walzenlager. Von Erich Becker. Pp. 96, with 53 illustrations in the text. 1933. Halle (Saale): Martin Boerner. (R.M. 5.)

This little book gives an extremely interesting and detailed study of rolling-mill bearings—their materials of construction, design, lubrication, and treatment—partly mathematical, but eminently practical. It is significant of this age of specialization that such a book could be either written or published. Much of the material has been collected from engineering and metallurgical journals (mainly German), but the author has obviously himself made a detailed study of the subject, and the book is much more than a mere collection of data already available. Its primary interest is for the engineer who is specializing in rolling-mill design and building, but it will well repay close study by works' metallurgists and engineers.

The sections dealing with lubrication, for example, are vitally important, and the author does well to suggest in his introduction its value for those actually in charge of rolling-mill operating. One fears that since the book is in German, few such workers in England will be able to avail themselves of it.

The latter section of the book deals with the modern development of roller bearings in rolling-mill construction, and can be specially commended to the attention of those responsible for new mill plant and extensions.—W. R. BARCLAY.

Die Verchromung, unter besonderer Berücksichtigung ihrer Anwendung im Automobilbau. Von O. Bauer, H. Arndt, und W. Krause. 8vo. Pp. 256, with 216 illustrations. 1934. Berlin: M. Krayn. (Geh., R.M. 20; geb., R.M. 22.)

A full account is given of an investigation carried out for the German National Automobile Manufacturers' Association, assisted by the Ministry of Transport, on the quality of chromium-plated motor-car fittings. A large number of typical industrial samples were provided, and others were specially prepared as representing coatings which could be prepared under optimum conditions. Particular attention was paid to estimating the appearance, adhesion, hardness and the resistance to wear, high temperatures, and corrosion. Special methods were devised for testing. and measurements were made of the thickness both of the chromium plate and of the intermediate coatings.

The results of these important investigations are fully described, and they form a valuable record of existing practice and a guide to possible limits of standardization.

Physical Constants. Selected for Students. By W. H. J. Childs. Post 8vo. Pp. viii + 77. 1934. London: Methuen and Co., Ltd. (2*s.* 6*d.* net.)

It is difficult to know exactly to whom this little booklet will appeal. It appears as one

of a series "intended to supply readers of average scientific attainments with a compact statement of the modern position in each subject." Where and how this book fits into such a series is more than I can tell. Judged entirely on its merits as a collection of physical constants, it has very little to commend it. It is altogether too restricted in its scope, conforming with the author's contention that "it is the experience of most students and research workers that the constants which are in everyday use are so limited in number that they could be collected into quite a small volume." Tables included which will be of most use to metallurgists are those relating to elastic constants, thermal conductivities, expansion coefficients, magnetic properties, and resistivities. Fourteen pages, almost a fifth of the book, are devoted to tables of logs and anti-logs, trigonometrical functions, reciprocals, and squares. There are a number of errors that should be corrected in a second edition. Thus (p. 3), the unit of volume is now the milli-litre, not the c.c. The definition of work on pp. 3 and 4 is meaningless. The electromagnetic unit of charge (p. 4) is defined in terms of current. What shall we say of resistance, defined as "allows unit E.M.F. to produce unit current," and e.m.f. defined as "confers on 1 e.m.u. the power to do 1 erg of work"? The unit of magnetic field strength is now the oerstedt, not the gauss (pp. 5 and 45). One Baumé scale of densities is referred to on p. 24; I know at least 30 such scales. The book contains seven useful nomograms. Despite this feature, I am unable to see what useful purpose it may serve, "et que diable fait il dans cette galère?"
—J. S. G. Thomas.

Annual Reports on the Progress of Applied Chemistry. Vol. XVIII.—1933. Demy 8vo. Pp. 770. 1934. London: Society of Chemical Industry. (12*s.* 6*d.*; members, 7*s.* 6*d.*)

The volume deals with the progress during 1933. The matter is sub-divided into 25 sections as in previous years. Each section deals with a branch of applied chemistry, and is written by an expert in that branch of the subject. This year there is no report on explosives, otherwise there is no change in the field covered last year. The work of compilation has been done with discretion and thoroughness. Among the sections we may notice those on the non-ferrous metals (19 pages), by A. R. Powell; electro-chemical and electro-metallurgical industries (35 pages), by S. Wernick; and refractories, ceramics, and cement (21 pages), by T. R. Lynam and W. J. Rees.

The whole of the material considered has been dealt with faithfully and carefully, so that the volume presents a clear, reliable, and illuminating account of the year's progress. The present volume exceeds its immediate predecessor in size by about 50 pages. The book is a very valuable production, useful to chemists as a whole, but particularly useful to those engaged in industrial chemistry. The thanks of the body of chemists are due to the Society of Chemical Industry for once more procuring for them so excellent and concise an account of what has been happening on the industrial side of their subject during the past year. This is a volume which must find a place in the libraries of all chemical works, and should also be found in the possession of all chemists. It can be very warmly recommended.—James F. Spencer.

Made by

EXTRUDED RODS AND SECTIONS

PRESSINGS, CHILL CAST BARS, AND INGOTS:

McKECHNIE BROTHERS LIMITED

Brass Rods, Stampings and Non-ferrous Ingot Metal Manufacturers.

METAL WORKS: ROTTON PARK STREET, BIRMINGHAM 16

Telephone: Edgbaston **0380** (7 *lines*).
Telegrams: "McKechnie, Birmingham."
LONDON—17 Victoria St., Westminster, S.W. 1.
NEWCASTLE-ON-TYNE—90 Pilgrim Street.
MANCHESTER—511-13 Corn Exchange Bldgs. 4
LEEDS—Prudential Buildings, Park Row.
SMELTING WORKS: WIDNES, LANCS.

PITMAN'S BOOKS

METALLOGRAPHY OF IRON AND STEEL
By C. HUBERT PLANT, F.I.A.C., Member of the Staffordshire Iron and Steel Institute. Demy 8vo, cloth gilt, 218 pp., illustrated. **12/6** net.

ALUMINIUM AND ITS ALLOYS
By N. F. BUDGEON, Ph.D., M.Sc. Demy 8vo, cloth gilt, 298 pp., illustrated. **15**/- net.

METALLURGY OF BRONZE
By H. C. DEWS. Discusses the latest scientific research in the light of up-to-date metallurgical practice. Demy 8vo, cloth gilt, 160 pp. **12/6** net.

METALLURGY OF CAST IRON
By J. E. HURST. A study of the mechanical and physical properties of cast iron. Demy 8vo, cloth gilt, 326 pp., illustrated. **15**/- net.

PRACTICAL IRON FOUNDING
By J. HORNER, A.M.I.M.E. Fifth Edition revised by WALTER J. MAY. A standard work for students and practical foundrymen. Crown 8vo, cloth gilt, 418 pp., illustrated. **10**/- net.

THE PRINCIPLES OF ELECTRIC WELDING
By R. C. STOCKTON, A.I.M.M., A.M.C.T. Describes the Metallic Arc Process fully and clearly. Crown 8vo, cloth gilt, 186 pp., illustrated. **7/6** net.

Write for a complete list of Pitman's Technical Books, post free from:
SIR ISAAC PITMAN & SONS, LTD., PARKER ST., KINGSWAY, W.C.2